WYOMING GAME & FISH DEPARTMENT

State Wildlife Action Plan

2017

Foreword

State Wildlife Action Plans (SWAPs) are comprehensive wildlife conservation strategies to maintain the health and diversity of wildlife within a state, including preventing the need for future listings under the Endangered Species Act. Plans are coordinated with other wildlife and natural resource agencies and organizations, as well as receive public input during their development and implementation.

Wyoming's abundant wildlife, native habitats, and outdoor recreational opportunities are defining features of the state. Wyoming is home to 120 species of mammals, 426 species of birds, 12 species of amphibians, 27 species of reptiles, 78 species of fish, probably several thousand species of invertebrates, and well over 13,100 species of plants (Wyoming Game and Fish Department 2005, NRCS Plant Database). Some of the largest migratory populations of big game animals in North America are found within the state (Sawyer et al. 2005). Wyoming also has among the highest participation rates in wildlife recreation in the country. About 39% of Wyoming resident's fish, 18% hunt, and 67% engage in wildlife related activities. In 2011, state residents and nonresidents spent $1.1 billion on wildlife recreation (U.S. Department of Interior 2011).

During the late 19th and early 20th century, North America experienced one of the greatest wildlife conservation success stories in history. The enactment of wildlife laws brought back many wildlife species from the brink of extinction as a result of unregulated harvest, commercial exploitation, and habitat loss. Concurrently, the establishment of wildlife agencies, the creation of a funding system for wildlife management through license sales and taxes on hunting and fishing equipment, the development of professional disciplines in wildlife and natural resource managements, and formation of a host of non-profit conservation organizations combined to create arguably the most effective wildlife conservation system in the world.

In order for this success story to continue throughout the 21st century, new challenges must be met. Many past advancements occurred through improvements in understanding and application of wildlife conservation principles. In the future, the availability of suitable habitat will increasingly become the most limiting factor for maintaining viable wildlife populations as the human population grows and natural resource demands increase. Developing strategies to effectively address this concern will involve by engaging partners and disciplines outside the traditional wildlife management field.

Accordingly, issues addressed and recommended conservation actions within Wyoming's SWAP frequently cross jurisdictional boundaries and involve a variety of natural resource interests. Implementation of recommendations within this plan will require commitment and dialogue among numerous government agencies, landowners, industry, and the public. Wyoming's SWAP will certainly evolve overtime as successes are expanded, shortcomings corrected, new information becomes available, threats change, and new partners become engaged.

Many organizations and individuals were involved in the 2010 and 2017 revision of Wyoming's SWAP. Their names can be found at the end of the sections of the SWAP to which they contributed. The Wyoming Game and Fish Department is grateful for their time and expertise. Special recognition goes to:

Wyoming Game and Fish Habitat Technical Advisory Group

Wyoming Game and Fish Department Nongame Section

Wyoming Game and Fish Department Habitat Section

Wyoming's State Wildlife Action Plan Inter-agency Advisory Team

Wyoming Natural Diversity Database

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Acronyms Used throughout the SWAP

AIS Aquatic Invasive Species
ATV All Terrain Vehicle
AWVED Assessment of Wildlife Vulnerability to Energy Development
BCT Bonneville Cutthroat Trout
BLM Bureau of Land Management
BMP Best Management Practices
BTU British Thermal Unit
CCT Colorado Cutthroat Trout
CCVI Climate Change Vulnerability Index
CER Categorical Exclusion Review
CEQ Council on Environmental Quality
COA Conditions of Approval
CRM Coordinated Resource Management
CRP Conservation Reserve Program
CSU Controlled Surface Use
CWCS Comprehensive Wildlife Conservation Strategy
DEQ Department of Environmental Quality
DSS Decision Support System
DU Ducks Unlimited
EIS/EA Environmental Impact Statement/Environmental Assessment
ENSO El Niño-Southern Oscillation
EPA Environmental Protection Agency
EPAct Energy Policy Act
EQIP Environmental Quality Incentives Program
ES Ecological Systems
ESA Endangered Species Act
FONSI Finding of No Significant Impact
FOOGLRA Federal Onshore Oil and Gas Leasing Reform Act
FRPP Farm and Ranchland Protection Program
FSA Farm Service Agency
GIS Geographic Information Systems
GRP Grassland Reserve Program
GYE Greater Yellowstone Ecosystem
HACCP Hazard Analysis and Critical Control Point
HTAG Habitat Technical Advisory Group
HUC Hydrologic Unit Code
IAT Interagency Advisory Team
IBI Index of Biotic Integrity
IPCC Intergovernmental Panel on Climate Change
ISC Industrial Siting Council
IWJV Intermountain West Joint Venture
JIO Jonah Interagency Office
LCC Landscape Conservation Cooperative
LSC Leatherside Chub
MDWG Mule Deer Working Group
MICD Modified Index of Centers of Density
MMS Mineral Management Services
MOU Memorandum of Understanding
MW Megawatts
NAWCA North American Wetlands Conservation Act
NEPA National Environmental Policy Act

NFHAP	National Fish Habitat Action Plan
NFMA	National Forest Management Act
NGO	Non-governmental Organization
NGPJV	Northern Great Plains Joint Venture
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Services
NREL	National Renewable Energy Lab
NSO	No Surface Occupancy
NSS	Native Species Status
NWGAP	Northwest Gap Analysis Project
NWPCP	National Wetlands Priority Conservation Plan
PEIS	Programmatic Environmental Impact Statement
POD	Plan of Development
RCRA	Resource Conservation and Recovery Act
RMP	Resource Management Plan
ROW	Right-of-way
SARA	Superfund Amendments and Title III Reauthorization Act
SCORP	Statewide Comprehensive Outdoor Recreation Plan
SGCN	Species of Greatest Conservation Need
SHC	Strategic Habitat Conservation
SHP	Strategic Habitat Plan
SRC	Snake River Cutthroat Trout
SWAP	State Wildlife Action Plan
SWG	State Wildlife Grant
TNC	The Nature Conservancy
UNEP	United Nations Environment Programme
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USNVC	United States National Vegetation Classification
WAFWA	Western Association of Fish and Wildlife Agencies
WGA	Western Governors' Association
WGFD	Wyoming Game and Fish Department
WGFC	Wyoming Game and Fish Commission
WHIP	Wildlife Habitat Incentives Program
WISC	Wyoming Industrial Siting Council
WJVSC	Wyoming Joint Ventures Steering Committee
WLCI	Wyoming Landscape Conservation Initiative
WMO	World Meteorological Organization
WOGCC	Wyoming Oil and Gas Conservation Commission
WOS	Wildlife Observation System
WREZI	Western Renewable Energy Zones Initiative
WRP	Wetlands Reserve Program
WSA	Warmwater Stream Assessment
WWDC	Wyoming Water Development Commission
WWNRT	Wyoming Wildlife Natural Resource Trust

WYBWG	Wyoming Bat Working Group
WyGISC	Wyoming Geographic Information Science Center
WYNDD	Wyoming Natural Diversity Database
YNP	Yellowstone National Park
YSC	Yellowstone Cutthroat Trout

Activities since the 2010 State Wildlife Action Plan

State Wildlife Action Plans (SWAP) are comprehensive strategies designed to maintain the health and diversity of wildlife within a state including preventing the need for the listing of new species under the Endangered Species Act. Wyoming's first SWAP was completed in 2005 (at that time SWAPs were referred to as Comprehensive Wildlife Conservation Strategies). This plan was revised and approved by the Wyoming Game and Fish Commission in January 2010 and later approved by the U.S. Fish and Wildlife Service (USFWS) in July 2011. Developing a SWAP is required in order to receive funding through the federal State Wildlife Grant (SWG) program. The intent of the SWAP is to not only direct the Wyoming Game and Fish Department's (WGFD) activities, but also to serve as a guide for the combined efforts of government agencies, conservation organizations, academia, tribes, and individuals in conserving Wyoming's Species of Greatest Conservation Need (SGCN). Wyoming's SWAP is also part of a national framework of similar plans established in all U.S. states and territories.

Revision of SGCN List

Wyoming's SGCN list was revised for the 2017 SWAP. Starting in September 2015, all wildlife species under the jurisdiction of the WGFD were evaluated to determine their SGCN status. A revised list of SGCN was presented to the Wyoming Game and Fish Commission for approval in January 2016. The 2017 SGCN list identifies 229 SGCN. This includes 80 birds, 51 mammals, 28 fish, 9 amphibians, 24 reptiles, 8 crustaceans, and 29 mollusks. Mollusks and crustaceans include five and one groups of species respectively. In the 2010 SWAP, 180 species received the SGCN designation. The 2010 SWAP list included 56 birds, 46 mammals, 30 fish, 8 amphibians, 21 reptiles, 5 crustaceans, and 14 mollusks. The complete 2017 list of Wyoming SGCN and information about the SGCN designation process is found in the introduction to the Wyoming Species of Greatest Conservation Need chapter of the SWAP (Page IV – i - 1).

New and Revised Species Accounts

Each SGCN identified in the SWAP has a species account that provides information on the species and its conservation needs. New species accounts were created for SGCN not identified in the 2010 SWAP. Species accounts are stored in databases which are continually updated. Drafts are printed and submitted to the USFWS for approval with each revision of the SWAP.

For the 2017 SWAP, bird and mammal species accounts were jointly produced by the WGFD and the Wyoming Natural Diversity Database (WYNDD). In the past, both organizations produced and maintained documents similar to species accounts. Establishing one official species account for each bird and mammal SGCN for the state was believed to reduce confusion and duplication as well as tofacilitate information sharing. For these species accounts, new sections were added to the previous format including an expanded section on regulatory and conservation status, taxonomic and physical descriptions, phenology, intrinsic and extrinsic vulnerabilities, and ecological information needs.

WYNDD will update and maintain bird and mammal species accounts going forward. These species accounts, which are available to the public electronically, were submitted and approved by the USFWS with the 2017 SWAP. Going forward, electronic versions will identify which information was included with the 2017 SWAP and which has been added subsequently.

Fish, reptile, amphibian, mollusk, and crustacean species account formats remained unchanged since the 2010 SWAP, but accounts were updated with new information as it became available.

Improved Terrestrial Habitat Prioritization Identification Process

Providing improved maps for conservation planning was a priority for the 2017 SWAP revision. A revised terrestrial SGCN habitat priority identification process was established to meet these goals based on four electronic map layers:

1. SGCN richness
2. Habitat intactness
3. Land ownership of various habitat types
4. SWAP terrestrial habitat types.

All maps are electronically available to the public individually and in combination to enable users to receive SGCN geographic data in relation to their project needs. Mapping layers are provided through the Natural Resource and Energy Explorer (NREX) application. This allows maps to be accessed by users without GIS software.

A summary reporting function is also being created for all GIS mapping hexagons and associated delineated project boundaries that displays:

1. Total number of SGCN species,
2. Species by sorted by Conservation Tier and Wyoming Native Species Status rank,
3. Links to SWAP terrestrial SGCN species accounts,
4. Endangered Species Act listed species,
5. Percent SWAP terrestrial habitat type,
6. Land management status, and
7. Habitat intactness.

This mapping system is planned to be completed by the second quarter of 2017. More information about the terrestrial habitat prioritization identification process is found in the introduction to the Terrestrial Habitat Types and Aquatic Basins chapter of the SWAP (Page III – i - 2).

Vulnerability Analysis of Wyoming Terrestrial SGCN and Habitats

The Wyoming Chapter of the Nature Conservancy, WYNDD, and WGFD completed research evaluating the vulnerability of Wyoming 2010 SGCN and the 11 SWAP terrestrial habitat types to climate change, residential development, energy development, and wildlife disease, as well as cumulative vulnerability to all four of these stressors. Vulnerability was investigated by evaluating each species' potential exposure and sensitivity to these threats. Research results are found within the Leading Conservation Challenges sections on energy development, rural development, and climate change, as well as within all terrestrial habitat chapters. Research results were also incorporated into the SGCN identification process for the 2017 SWAP. The complete report can be viewed at: http://www.nature.org/media/wyoming/wyoming-wildlife-vulnerability-assessment-June-2014.pdf

Sensitive Species Funding Sources

The WGFD has received more than $3,190,000 from the SWG program for fiscal years 2011-2016.

State budgets for the 2011–2012, 2013-2014 and 2015-2016 biennium provided general fund appropriations to the WGFD for all aspects of its nongame/sensitive species program. Over that period, the Wyoming Legislature awarded $4.4 million to the department for maintenance and operations, including existing personnel and administrative support, and $688,000 in direct general fund appropriations for specific SGCN project work. This funding, in conjunction with $5.56 million from the Governor's Endangered Species Account, has aided the WGFD with inventory work to fill data gaps for SGCN and to address Endangered Species Act listing petitions. These dollars are also important for matching SWG program funds, which require a 35% contribution from the state for most projects.

The USFWS continued their memorandum of agreement with the State of Wyoming and the WGFD in fiscal years 2011 through 2013 to facilitate coordination on sensitive species projects, including projects on current or potentially listed threatened or endangered species. Projects initiated during this period include researching habitat and species vulnerability, determining the origins of burbot and sauger in the Wind River, and assessing spruce fir habitat in Wyoming, among others. The WGFD has received a total of $778,000 as a result of this agreement through fiscal year 2016.

Lastly, in 2005, the Wyoming Legislature created the Wyoming Wildlife and Natural Resource Trust (WWNRT) to "enhance and conserve wildlife habitat and natural resource values throughout the state." The WWNRT is funded by donations, legislative appropriations, and the interest earned on a permanent account. The WGFD and the Wyoming Game and Fish Commission have been able to use WWNRT grants to augment SWG funding to support various SGCN monitoring and recovery efforts.

Strategic Habitat Plan
In early 2015, the WGFD revised its Strategic Habitat Plan (SHP). The recent revision of the SHP incorporates SGCN into the planning process and includes SGCN considerations in identifying "crucial" and "enhancement" areas as well as prioritizing projects for funding. Moreover, the mitigation policy developed by the Wyoming Game and Fish Commission for species and habitats that are being unavoidably impacted by growth, development, and land use changes includes SGCN. The WGFD Habitat Technical Advisory Group's role in developing both the SHP and SWAP allowed for coordination between the two plans.

SGCN Projects
Detailed information about SWAP-related projects conducted since 2010 can be found in this plan within individual species accounts and in the "Conservation Initiatives" topic heading of aquatic basins and, to a lesser extent, terrestrial habitat types. Annual reports are completed for all bird and mammal SWAP projects and can be found at https://wgfd.wyo.gov/Hunting/Job-Completion-Reports. The following are examples of some, but not all, SWAP-related projects since 2010.

Birds and Mammals
Funding was utilized to conduct numerous large scale bird monitoring efforts within the state. These include colonial waterbird surveys, Integrated Bird Monitoring in Conservation Regions (IMBCR), juniper obligate birds surveys, and grassland bird monitoring. Baseline and trend data was collected for bald eagle, golden eagle, ferruginous hawk, common loon, greater sage-grouse, long-billed curlew, peregrine falcon, trumpeter swan, American bittern, mountain plover, upland sandpiper, burrowing owl, great gray owl, black rosy-finch, and goshawk. Sage-grouse habitat-use studies, including investigations into brood rearing locations, summering and wintering habitats, and seasonal movements have been completed. Research has also been conducted on the risk of nest abandonment by raptors due to human disturbances. The effects of energy development, including from wind power, on birds is being studied. Sage-grouse, golden eagles, and ferruginous hawks are receiving special attention for this research.

SWG grants have also supported baseline data collection and surveys on water voles, white-tailed prairie dog, several species of bats, pika, fisher, shrews, juniper obligate mammals, pocket mice, pygmy rabbit, and swift fox. Annual surveys were completed on black-footed ferrets to determine their status and distribution at reintroduction sites, to map ferret habitat, and to make additional reintroductions.

Multiple projects have been initiated to study wolverines in Wyoming. A wolverine study in the Yellowstone ecosystem researched wolverine densities, population viability, habitats important to wolverine persistence, travel corridors between isolated mountain ranges, effects of human recreation, reproductive and survival rates, and mortality factors. Similarly, a study on the effects of winter recreation trails on small and mid-sized mammals, including lynx and wolverine, was conducted. The WGFD, in cooperation with Washington, Idaho, and Montana has initiated a landscape wolverine occupancy monitoring project. This project incorporates standardized survey protocols to monitor wolverine populations across their range. The project also focuses on identifying population connectivity and genetic variation. A study to develop GIS models of caves which might be susceptible to colonization of white-nose was conducted. SWG funds were additionally utilized to examine the feasibility of utilizing guard hairs to identify shrew species.

Fish
Numerous projects to better understand and conserve the state's native fish have been undertaken since the 2010 SWAP (see Conservation Initiatives section of Aquatic Basins for individual project descriptions). Notable examples include a study to better understand how intermittency influences prairie fish communities (Compton and Hogberg 2017), and a complete inventory of Northern leatherside chub (Schultz and Cavalli 2012), and assessment of mountain whitefish (Edwards 2014) in the state.

Projects to remove nonnative fishes that were negatively influencing SGCN were completed to conserve endemic populations of Colorado River and Yellowstone cutthroat trout as well as roundtail chub, flannel mouth sucker and bluehead sucker (see Conservation Initiatives section of Aquatic Basins for individual project descriptions).

Reptiles and Amphibians
The WGFD Herpetologist and numerous grant funded crews completed significant progress in defining the distribution and relative abundance of reptiles and amphibians in the state. Cursory inventories have now been completed in most of the Aquatic Basins of the state and have allowed for a narrowing focus of effort towards specific species and habitat types. Monitoring regimes for reptiles and amphibians are in development and in depth studies of several SGCN have been completed (see Conservation Initiatives section of Aquatic Basins). Notable accomplishments include inventories of northern Wyoming herptiles (Snoberger and Walker 2016) and Southeastern Wyoming herptiles (Snoberger and Walker 2013).

Mollusks and Crustaceans
Considerable strides were made in inventorying native mussels in Wyoming. Cursory surveys were completed in all of the Aquatic Basins of the state with an emphasis on sites where historic evidence exists for mussel presence (see Conservation Initiatives section of Aquatic Basins). Notable accomplishments include inventories of native mussels in the Platte drainage (Mathias 2015), Bear and Snake drainages (Mathias 2014), and Wind-Bighorn drainages (Mathias 2016). Numerous new observations and first attempts to describe relative abundance resulted in NSS classification of all but one native mussel.

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Wyoming's 2017 SWAP Conservation Approach

In 2001, the U.S. Congress created the State Wildlife Grant (SWG) Program and charged each state and territory with developing a Comprehensive Wildlife Conservation Strategy (CWCS) as a condition of receiving federal funds through the program. Wyoming completed its first CWCS in 2005.

CWCSs, now referred to as State Wildlife Action Plans (SWAPs), are intended to be broad-based strategies to maintain the health and diversity of wildlife within a state, including preventing the need for additional species to be listed under the Endangered Species Act. Special emphasis is given to addressing wildlife species that have received less conservation attention in the past, including those that are not hunted or fished. All 50 states have developed SWAPs, providing a comprehensive framework for planning and coordination on wildlife issues that cross state boundaries.

In the legislation defining SWAPs, Congress outlined eight requirements (Table 1). Beyond these requirements, Congress and the U.S. Fish and Wildlife Service (USFWS), the agency that reviews and approves SWAPs, provide substantial flexibility for each state to develop approaches that fit their unique wildlife, habitats, management context, and local issues.

Table 1. Eight Required Elements for SWAPs

1. Information on the distribution and abundance of species of wildlife, including low and declining populations as the state fish and wildlife agency deems appropriate, that are indicative of the diversity and health of the state's wildlife;
2. Descriptions of extent and condition of habitats and community types essential to the conservation of species identified in (1);
3. Descriptions of problems which may adversely affect species identified in (1) or their habitats, and priority research and survey efforts needed to identify factors which may assist in restoration and improved conservation of these species and habitats;
4. Descriptions of conservation actions proposed to conserve the identified species and habitats and priorities for implementing such actions;
5. Proposed plans for monitoring species identified in (1) and their habitats, for monitoring the effectiveness of the conservation actions proposed in (4), and for adapting these conservation actions to respond appropriately to new information or changing conditions;
6. Descriptions of procedures to review the plan at intervals not to exceed 10 years;
7. Plans for coordinating the development, implementation, review, and revision of the plan with federal, state, and local agencies and Indian tribes that manage significant land and water areas within the state or administer programs that significantly affect the conservation of identified species and habitats; and
8. Broad public participation is an essential element of developing and implementing these plans, the projects that are carried out while these plans are developed, and in maintaining the species in greatest need of conservation.

While state wildlife agencies are responsible for developing and implementing SWAPS, many issues necessary for their success are beyond their jurisdiction and resources. Accordingly, SWAPs are required to be coordinated with other state, federal, and local natural resource organizations and agencies. The U.S. Forest Service, U.S. Park Service, and the Bureau of Land Management have all signed an instructional memorandum for cooperation in developing and implementing SWAPs. In addition, many of Wyoming's most valuable wildlife habitats occur on private land, which requires both developing conservation strategies that respect private property rights and nurturing strong functional partnerships with private landowners.

Conserving Wyoming's wildlife species is heavily dependent upon the future quantity and quality of available habitat, both terrestrial and aquatic. The amount and condition of wildlife habitat is influenced by the success in developing strategies to address the issues which are having the greatest impact on wildlife and habitat resources. With this in mind and to most effectively focus conservation efforts and organize information within this plan, Wyoming's SWAP is organized by a three-tiered approach:

Statewide	Leading Wildlife Conservation Challenges
Habitat	Terrestrial Habitat Types and Aquatic Basins
Species	Species of Greatest Conservation Need

As the reader moves through the SWAP, the identified threats and conservation actions progress from general statewide issues and actions to habitat-specific issues and actions, and finally to conservation strategies for individual Species of Greatest Conservation Need (SGCN), which are presented within each species account.

Each level of conservation is addressed in a separate chapter which is further broken down into sections. Within each section, the eight required elements for SWAPs are addressed (Table 2). Exceptions are elements 6 and 8, dealing with public involvement and plans for revising the SWAP, which are both addressed in separate chapters. Various sections are frequently cross-referenced throughout the SWAP to provide the reader with additional information on a given topic, but each section is also composed to function as a standalone document. This format was adopted because Wyoming's SWAP is most frequently accessed through the Internet for information on specific subjects, as opposed to being accessed as a single document in its entirety. Additionally, individual sections of the SWAP are often duplicated and distributed.

The 2010 and 2017 revisions of Wyoming's SWAP extensively utilize the expertise and feedback of wildlife and natural resources conservation experts. The broad scope of the SWAP and associated time and resource limitations made it impractical to conduct independent scientific analyses on each topic. Additionally, SWAPs are required to be developed using broad professional and public involvement and to discuss and address not only scientific issues, but also social, economic, and administrative considerations. Two committees assisted in the coordination of internal and external comment and feedback:

The WGFD Habitat Technical Advisory Group

The WGFD Habitat Technical Advisory Group (HTAG) facilitated the coordination of intra-agency expertise during SWAP revisions, as well as linking SWAP efforts to existing department activities and priorities. During SWAP revisions, HTAG helped to develop the plan's outline, identify experts within the WGFD to contribute information, evaluate various conservation and prioritization strategies, review draft sections, and provide a forum for discussing revision-related issues and making recommendations to the WGFD's administration. HTAG also has a central role in the implementation of the plan through recommending funding approval for SWG projects and other SWAP-related funds. A list of HTAG members can be found in Appendix A.

The SWAP Interagency Advisory Team

The SWAP Interagency Advisory Team (IAT) was created to support the involvement of other wildlife and natural resource agencies in developing and implementing the SWAP. Their role includes communicating respective agency expertise and concerns, identifying common priorities and opportunities, minimizing the duplication of efforts, facilitating information-sharing, and conveying SWAP issues and activities to agency employees and constituencies. IAT contributed to the 2010 revision of the SWAP by providing input on the plan's outline, identifying leading issues and conservation actions, soliciting input from experts within their organizations, and reviewing draft documents. A list of IAT members can be found in Appendix B.

With the help of these two committees, input for the chapters on Leading Wildlife Conservation Challenges and Terrestrial Habitat Types was solicited from personnel representing agencies and organizations which have significant jurisdictional authority, financial resources, and/or technical expertise on each subject. Information was received either through focus groups or through individual written submissions to questions based on the subject headings of each section. This approach was considered to be both time-efficient for gathering information, as well as encouraging the involvement of entities whose participation is important for the implementation of the SWAP. Near the end of each section within these chapters is a list of individuals who reviewed the document and provided feedback on the subject matter. Individuals who participated in both the 2010 and 2017 SWAP revisions are included. The input of contributors was compiled and then further supported by independent research. Existing conservation initiatives pertaining to Wyoming's wildlife and natural resources were consulted and referenced throughout the revision process.

Mammal and bird species accounts were created cooperatively by the WGFD and the Wyoming Natural Diversity Database. Wildlife Management sections within these species accounts were solely authored by the WGFD. All accounts were reviewed by the WGFD Fisheries Management Coordinator and the Statewide Wildlife and Habitat Management Supervisor. Species accounts were also made available to the Wyoming Natural Diversity Database for review.

The SWAP should not be viewed as providing an exhaustive overview of each subject. Rather, it is intended to identify threats and conservation actions that are considered most important throughout the state, on which there is general consensus among the experts consulted, and for conservation actions, have some probability of being attained in the future. The breadth of information in each section and the specificity of conservation actions vary, based upon existing knowledge, the availability of information, and the input provided by contributors. This reduced the consistency of identified threats and conservation recommendations between sections according to the priorities of the contributors. With this in mind, and with the knowledge that many listed conservation actions cross jurisdictional boundaries, the intent of many conservation recommendations is more to provide strategic guidance than to set specific courses of action. Agencies and organizations helping to implement the SWAP will need to select and adapt recommendations to fit their individual mandates and priorities.

The content of this SWAP only reflects conditions and issues from one snapshot in time. It is the intent of the WGFD to formally revise its SWAP every 10 years with interim updates likely (see Reviewing and Updating the SWAP). Items and priorities addressed in the 2017 SWAP will change as new information becomes available, conditions change, and additional agencies, organizations, and individuals become engaged.

Table 2. Road Map to Required SWAP Elements

Required SWAP Element	Location in SWAP
Element 1. Information on the distribution and abundance of wildlife including SGCN.	• Species accounts for each SGCN contain information on rangewide and statewide abundance, as well as Wyoming range and distribution maps. • Terrestrial habitat types and aquatic basins have lists of associated SGCN and information on wildlife diversity. (Page III –1i – 1 to III - 11 - 17)
Element 2. Descriptions of extent and condition of habitats essential to SGCN.	• SWAP habitat types and aquatic basins contain information about their distribution throughout Wyoming and physical and biological conditions. (Page III – 1 – 1 to III – 17 - 17) • Maps found within habitat types and aquatic basins show their locations within Wyoming. (Page III – 1 – 1 to III – 17 - 17) • SWAP priority area maps evaluate level of habitat intactness based upon 8 habitat disturbances. Land ownership and associated level of protection is also displayed for all terrestrial habitat types. (Explanation and statewide maps Page III – i - 6 to 14, individual terrestrial habitat types III – 1 – 1 to III – 11 - 17) • Species accounts describe habitat requirements for each SGCN.

Element 3. Descriptions of problems that may adversely affect SGCN and their habitats.	• The SWAP Leading Wildlife Conservation Challenges chapter addresses the five statewide threats that are most significant to SGCN and their habitats including climate change. (Page II 1 - 1 to II – 5 – 21) • Leading threats to each terrestrial habitat type and aquatic basin are listed within these sections. (Page III – 1 – 1 to III – 17 - 27) • Each species account lists threats to SGCN. For mammals and birds threats are included in Conservation Concerns and are broken down by Abundance and Population Trend as well as Intrinsic Vulnerabilities and Extrinsic Stressors. • Priority research and survey efforts are identified within the individual sections on leading wildlife conservation challenges, terrestrial habitat types, aquatic basins, and species accounts. (Page II 1-1 to II – 5 – 21, Page III – 1 – 1 to III – 17 - 17)
Element 4. Descriptions of conservation actions to conserve SGCN and their habitats.	• Conservation actions needed to conserve SGCN and associated habitats and to address the most significant statewide wildlife conservation issues are found within individual species accounts, terrestrial habitat types, aquatic basins, and leading wildlife conservation challenges. (Page II - 1 - 1 to II – 5 – 21, Page III – 1 – 1 to III – 17 -17)
Element 5. Proposed plans for monitoring SGCN, their habitats, and the success of conservation actions.	• Existing and needed monitoring is included within the Monitoring/Research and Conservation Actions sections found within fish, amphibian, reptile, crustacean, and mollusk species account. Monitoring is address within Key Activities in Wyoming and Management in Wyoming sections in mammal and bird species accounts. • Terrestrial habitat types and aquatic basins include monitoring recommendations. Existing monitoring is addressed within the Current Conservation Initiatives section. (Page III – 1 – 1 to Page III – 17 - 27) • Each of the five leading wildlife conservation challenges contains a section on recommended monitoring to track impacts and evaluate the success of conservation actions. (Page II 1- 1 to II – 5 – 21)

Element 6. Descriptions of procedures to review the SWAP.	• These procedures are found in the Reviewing and Updating the SWAP chapter. (Page V – 1)
Element 7. Plans for coordinating the development and implementation of the SWAP with other agencies.	• The role of the SWAP Interagency Advisory Team in developing and implementing the SWAP is described in the chapter on Conservation Approach. This chapter also explains how information was collected from various agencies, organizations, and experts in developing the SWAP. (Page I - 2 --3) • A list of individuals from various agencies/organizations who contributed information or reviewed the 2010 SWAP is found in Appendix C of this section (Page I – 2 - 7 to 15) • The 2017 SWAP external review process is described within the chapter on Public Participation. . (Page VI – 1 – 1 to VI – 1 – 4)
Element 8. Public participation.	• Public Participation chapter. (Page VI – 1 – 1 to VI – 1 – 2)

Appendix A

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Wyoming's Leading Wildlife Conservation Challenges

Introduction

Wildlife conservation in Wyoming is influenced by a wide range of issues. A few issues, however, have larger defining roles in determining the future health, abundance, and diversity of species throughout the state. When wildlife and natural resource professionals were surveyed during the 2010 revision of Wyoming's State Wildlife Action Plan (SWAP), the following five issues were consistently identified as the most significant challenges facing Wyoming's wildlife:

- rural subdivision and development
- energy development
- invasive species
- climate change
- disruption of historic disturbance regimes

Further, these issues, or issues related to them, were most commonly listed as concerns within individual SWAP terrestrial habitat types, aquatic basins, and species accounts.

The exclusion of other challenges from this chapter does not imply they are unimportant to Wyoming's wildlife and habitat resources. Other important wildlife conservation issues include such concerns as disease, off-road vehicle recreation, certain agricultural practices, and pollution, among others. In comparison to the challenges identified above, however, these problems may not be as widespread, may not have the same level or scope of impact, or may be closely related to other issues, including the five leading challenges. Issues such as restoring and maintaining habitat connectivity for the movement of wildlife, while important, are better discussed as conservation strategies, typically in response to broader threats. These conservation concerns, and others not covered in this chapter, are addressed in the sections for the terrestrial habitat types, aquatic basins, and species accounts where they have the greatest impact.

Focusing attention on the five leading wildlife conservation challenges is not intended to be an indictment of any industry or group. Wildlife is one of many considerations in managing Wyoming's land and natural resources to meet society's current and future needs. Instead, the emphasis placed on the issues discussed in this chapter is meant to encourage appropriate and timely planning so that benefits for all interests, wildlife and other, can be maximized. Accordingly, the recommended conservation actions within this chapter tend to apply to a greater number of stakeholders, and often must be addressed at the policy level.

Rural subdivision and development, energy development, invasive species, climate change, and disruption of historic disturbance regimes are five important conservation issues that extend across a majority of Wyoming's habitat types and wildlife species. Addressing these issues as separate chapters in the SWAP provides in-depth background to supplement other sections of the SWAP where they are discussed. These conservation challenges are interrelated. For example, the spread of invasive species is commonly facilitated by broken and bare ground associated with new roads and construction from rural subdivision and energy development. In turn, the establishment of invasive species, cheatgrass for example, can alter historic disturbance regimes such as fire, to the detriment of indigenous plant communities (Whisenant 1990). A warmer, more variable climate, which some predict for Wyoming, may provide a competitive advantage for cheatgrass over native plants, further facilitating its spread (Bradley et al. 2008).

Leading wildlife conservation challenges addressed within the SWAP will likely change over time as new challenges emerge, as government agencies are encouraged to evaluate the potential impacts of issues that are considered national priorities, or as existing threats diminish or are mitigated. The issues addressed within this chapter will be re-evaluated with each revision of Wyoming's SWAP.

Literature Cited

BRADLEY, B. A. 2009. Regional analysis of the impacts of climate change on cheatgrass invasion shows potential risk and opportunity. Global Change Biology 15:196–208.

WHISENANT, S. G. 1990. Changing fire frequencies on Idaho's Snake River Plains. Ecological and management implications. Pp. 4–10 *In* E. D. McArthur, E. M. Romney, S. D. Smith, and P. T. Tueller, compilers. Symposium of cheatgrass invasion, shrub die-off and other aspects of shrub biology and management. USDA. For. Ser. Gen. Tech. Rep. INR-276.

Rural Subdivision

Photo courtesy of WGFD

Table of Contents

Background

Wyoming is internationally known for its scenic beauty, abundant wildlife, numerous recreational opportunities, and friendly small-town atmosphere. Between 2000 and 2010, Wyoming's population grew by approximately 70,000 people, which represents a 14 percent increase to the overall state population (Hamerlinck, et. al 2013).

Residential development is expected to continue increasing in Wyoming with an estimated 11 percent increase in rural homes expected between 2010 and 2030 under a moderate growth scenario (Copeland et al. 2013). The majority of rural subdivision and development in Wyoming is occurring on privately owned ranchlands. Forty-three percent of Wyoming is privately owned land, of which 93% is in agricultural production (Taylor 2003).[1] Cropland in Wyoming is limited, due to a relatively arid climate, and most agricultural lands are large tracts of rangelands used for grazing. Wyoming ranked 11th nationally in total land in farms and ranches and 1st in average size of farms and ranches. The average size of farms or ranches in Wyoming is over 2,598 acres which represents a drop of 1,145 acres since 1990 (U.S. Department of Agriculture 2014).

Wyoming receives many benefits from population growth and development, which are important components of the state's present and future economic prosperity. Enjoying open spaces and living close to nature are attributes that define Wyoming and the character of its people. However, the location, design, and rate of rural subdivision and development in some areas can have negative consequences for wildlife and wildlife habitat.

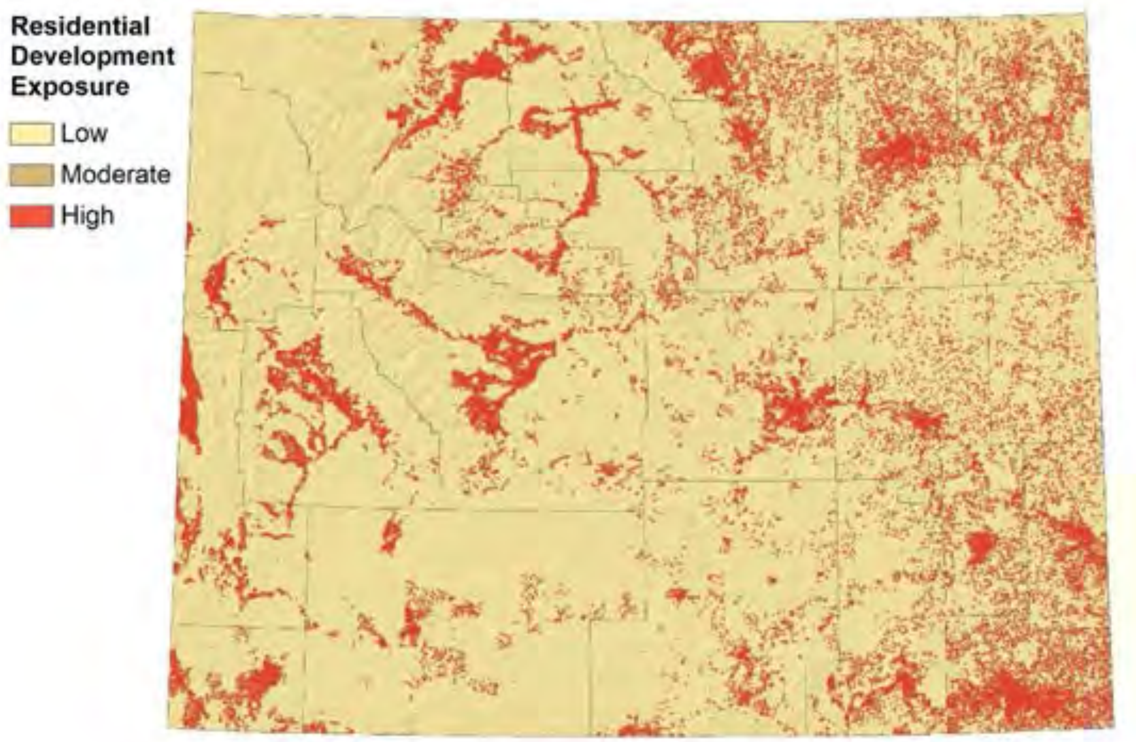
Privately owned ranchlands in Wyoming contain disproportionately high amounts of crucial wildlife habitat. Historically, ranches were established along valleys and waterways. These lands are not only the most agriculturally fertile, but also the most biologically productive and diverse.

Today, private ranchlands provide crucial winter range, travel corridors, and birthing sites for many of Wyoming's wildlife species. Fifty percent of the winter habitat for Wyoming's major big game species is located on private land (Coupal et al. 2004). Additionally, more than 80% of wildlife in Wyoming relies on riparian zones (McKinstry et al., 2002), which are frequently located on private agricultural lands.

Rural development and subdivision can reduce both the quantity and quality of wildlife habitat. The amount of wildlife habitat is reduced as natural vegetation is replaced by homes, roads, out-buildings, and other infrastructure. As barriers to wildlife movement, such as roads and fences, increase, habitat quality may decline. Invasive species spread, and animals avoid areas with greater human and pet activity. Additionally, water quality may decline from increasing sedimentation levels and contamination from pesticides, herbicides, fertilizers, and other chemicals found in runoff from nearby roads and lawns. Research indicates that rural development contributes more to the vulnerability of Wyoming Species of Greatest Conservation Need (SGCN) than oil, gas, or wind development (Copeland et al. 2014).

[1] Fifty-four percent of Wyoming is public land that is managed by either the state or federal government. Tribal lands represent just over 3% (Hulme et al. 2009).

Figure 6.



Exposure to residential development represents the relative impact of housing development on the landscape and was calculated for all 30-meter raster cells across Wyoming. Cell values ranged from 0, which reflects minimal potential for impact, to 1, which reflects complete conversion of native habitat. The scores ranging from 0 to 1 were assigned to categories as follows: low (<0.33), moderate (0.34-0.66), and high (>0.67) (Pocewicz et al. 2014). Exposure to residential development includes existing houses (2010), as well as projected residential development (2030). Existing houses were based on 2010 US census data, and future housing locations were based on spatial models representing the likelihood of potential development, combined with published growth projections used to populate the highest probability locations with house points, while excluding those areas where residential development would be legally prohibited (Copeland et al. 2013). The residential development exposure raster dataset was created from the housing points by assigning a maximum disturbance (value=1) at existing or projected housing points and applying a logistical decay to zero over a distance of 1 km (Pocewicz et al. 2014).

References cited:
Copeland et al 2013, Pocewicz, et al. 2014.

Scope and Challenges of Rural Subdivision and Development and Wildlife Conservation

Nationally, Wyoming ranked 11th in population growth rate between 2000 and 2010. Slightly more than two-thirds of this growth occurred in urban areas (incorporated cities and towns); however, on a percentage basis, rural areas of the state grew slightly faster than urban areas (Taylor 2012).

Because of agriculture's predominance on the land base, the fate of much privately owned wildlife habitat in Wyoming is closely tied with the future of the agricultural and livestock industries. Low profit margins from agriculture, the lure of large financial returns from the sale of ranchlands, the increasing number of agricultural producers entering retirement age, and low recruitment of new farmers and ranchers are leading factors contributing to the sale and conversion of ranchlands to residential uses.

Additionally, the future of federal grazing leases is uncertain, due to competing uses of federal lands, such as energy development and recreation, as well as court challenges over the valuation and environmental impacts of public land grazing. Agricultural operations with federal land grazing permits control 20.4 million acres of private land in Wyoming, or 60% of Wyoming's total private land base (Hulme et al. 2009). Continued access to public land grazing is central to the profitability of most of these agricultural operations.

The price of agricultural land in Wyoming continues to rise and is driven in part by an increasing demand for natural and outdoor recreational amenities.

About 8.7 million acres of agricultural land in Wyoming are managed by operators aged 65 and older (Hulme et al. 2009). The future of ranchlands held by retiring agricultural producers remains uncertain.

Accordingly, State of Wyoming Board of Equalization records indicate there was a 600,000-acre decrease in the amount of land classified as agricultural between 2003 and 2006. This is an area similar in size to the state of Rhode Island (Hulme et al. 2009).

In addition to the reduction of habitat quantity and quality, subdivision and rural development have other impacts on the state's ability to effectively manage and conserve wildlife. Human wildlife conflicts frequently increase in areas with high rural development. Deer in particular can damage lawn and garden plants, and high densities often lead to increased road collisions. Bears, skunks, raccoons, and other unwelcome wildlife visitors are often attracted to human food and garbage.

Controlling wildlife numbers through hunter harvest often becomes more difficult as the land becomes fragmented and many properties are too small or do not allow hunting. Revenue for state wildlife agencies can decline as hunting license sales diminish. Excessively large big game herds can over-utilize their habitat, decreasing its quality for other wildlife species and increasing damage to nearby agricultural crops. Additionally, some historic habitat management techniques needed to sustain native plant communities, such as periodic fire, are no longer feasible with rising safety and liability concerns as a result of growing numbers of people and structures. Water conflicts may also become more common as demand for water resources increases. Population growth heightens the need for water storage and diversion structures which can be detrimental to the movement of some aquatic species and the continuation of natural flow regimes required to sustain native riparian vegetation and aquatic communities.

Current Initiatives Related to Addressing Rural Subdivision and Development

The proliferation of rural subdivisions has become an issue in Wyoming relatively recently, especially when compared to other regions of the United States. This may be partly explained by Wyoming's small population and a population growth rate that has lagged behind other western states. Most efforts to mitigate the negative impacts of accelerated rural subdivision and development fall into five categories:

- increasing the profitability of land uses that maintain wildlife habitats
- enhancing the effectiveness of land planning
- improving the design of rural developments
- working directly with landowners to conserve land through voluntary land purchases and land use agreements
- increasing public and landowner awareness about rural land management issues including wildlife needs

Increasing the Economic Viability and Profitability of Land Uses that Maintain Open Spaces
The Wyoming Business Council's Agribusiness Division has a variety of programs that assist farmers and ranchers with strategies to increase profits and provide added value to their businesses. The Business Council works one-on-one with farmers and ranchers to identify new marketing opportunities, develop agricultural diversification strategies, and enhance their business and marketing skills. The Business Council also has a workbook available for agricultural producers interested in assessing their current operations to better utilize their existing resources to sustain their operation.

Some ranchers have established side businesses related to hunting/fishing outfitting, eco-tourism, and dude ranching to bring in extra income. More recently wind development is adding to the profitability of some agricultural operations, but this type of renewable energy development may also alter wildlife habitat and impact hunting access.

Enhancing the Effectiveness of Land Planning
Wyoming law requires that both municipal and county governments develop a comprehensive land use plan (Hulme et al. 2009). Unincorporated cities or towns may develop a land use plan, but are not obligated to do so. Local entities responsible for land use decision-making include county commissioners, planning and zoning commissions (city and county), and municipalities.

There have been a number of efforts in Wyoming to increase the knowledge levels of county commissioners, town councils, and planning/zoning commission members about land planning issues and techniques. The Sonoran Institute, Wyoming Association of County Commissioners, and Wyoming Planning Association all provide workshops on topics related to rural development including methods of minimizing negative environmental impacts and potential land use conflicts.

Until recently, Wyoming counties did not have authority to review the subdivision of land where parcel size was 35 acres or more. Counties were able to use zoning, however, to regulate the minimum parcel size to exceed 35 acres if desired. This lack of subdivision review encouraged the creation of very large tracts without public comment or governmental oversight. In 2008, the Wyoming legislature passed legislation allowing counties, through resolution, to regulate subdivisions between 35 and 140 acres (Wyoming Statute § 18-5-316/7, et seq. 2008). The legislation included exemptions for parcels existing prior to July 1, 2008, and for the division of up to 10 parcels of 35 or more acres to be created without undergoing subdivision regulation review (Wyoming Statute § 18-5-316/7, et seq. 2008).

Improving the Design of Rural Developments

The concept of conservation or cluster development is to minimize negative impacts to the environment and maximize residents' enjoyment and use of the natural amenities of the land. This type of development is often approached by increasing housing densities and allowing common open space to be shared by all residents of the subdivision. Developers can benefit by selling more lots clustered on a portion of the development as compared to selling a smaller number of large parcels. As long as cluster developments are not located too far from town and city service centers, they can potentially lower the net costs of service and save money for local governments. Generally speaking, it is cheaper to provide services to houses located in a confined area as compared to residences that are scattered across the landscape.

In 2009, the Wyoming Legislature passed HB0009 to provide incentives for conservation design and cluster development in rural areas. Incentives allow an exemption for subdivision application requirements for housing developments that use density bonuses to preserve open space. Preserved lands should contribute to the protection of wildlife habitat or the enhancement and maintenance of the rural character of land that is contiguous to agricultural lands. To qualify, two-thirds of the total area of the parcel being divided must be retained in open space and remain under this designation for at least 65 years. After 65 years, there must be a process by which the owners of the lots in the development can renew the designation. Each board of county commissioners has authority to allow this exemption.

Voluntary Land Purchases and Land Use Agreements

Conservation easements are voluntary agreements that limit the amount and type of development that can occur on a property with the purpose of maintaining its natural open space value, wildlife and habitat value, or productive features (e.g., agricultural uses). Most conservation easements are placed on the land title in perpetuity. This means the development restrictions run with the land title regardless of landownership. Landowners typically receive tax incentives and/or direct payments for entering into a conservation easement. There are currently 559,000 acres of land across Wyoming under conservation easement agreement, or approximately 2% of the privately owned land in Wyoming (National Conservation Easement Database).

Conservation easements have become the predominant method of private land conservation in the West because they are voluntary and incentive-based, they retain land in private ownership and on local tax rolls, and they do not require future upkeep costs since land management responsibilities are typically retained by the landowner. Land trusts are organizations that typically hold and monitor conservation easements. Land trusts may be either government or non-profit organizations. Some of the more active organizations in Wyoming that hold conservation easements are: Ducks Unlimited, Jackson Hole Land Trust, National Wild Turkey Foundation, Rocky Mountain Elk Foundation, Sheridan County Land Trust, The Nature Conservancy, The Conservation Fund, Wyoming Game and Fish Commission, and the Wyoming Stock Growers Agricultural Land Trust.

In recent years, the use of conservation easements has been further incentivized by increased federal tax incentives[2] and new state funding sources. The Wyoming Wildlife and Natural Resource Trust was established by the

[2] In 2015, Congress enacted one of the most powerful conservation measures in decades. New, permanent incentives allow landowners to deduct $25,000 (50% of income) for the year of the donation and for each of an additional 15 years. This would result in a total of $400,000 in deductions. If the landowner is a farmer or rancher, he or she can deduct $50,000 (100% of income) in the first year and then for each of the following 15 years, realizing a maximum of $800,000 in deductions.

Wyoming Legislature in 2005 with the purpose of enhancing and conserving wildlife habitat and natural resource values throughout the state. Annual interest from this account and annual appropriations are available for habitat improvement projects including conservation easements. Funds established to enhance planning and offsite mitigation for energy development have also been used to purchase conservation easements. Examples include the Jonah Interagency Office, Pinedale Anticline, and Wyoming Land Conservation Initiative. In 2015 the corpus of the trust was approximately $105 million and interest earnings available for habitat conservation and other projects totaled about $4.5 million.

In Wyoming, land purchases to conserve wildlife habitat have been limited due to expense and political opposition to reductions in the private land base. Land purchases may have the added wildlife management benefit of allowing public access, which while possible with conservation easements, is typically not part of the terms of easement agreements.

Increasing Public and Private Landowner Awareness

There are several initiatives within Wyoming designed to inform policy-makers, landowners, developers, and the general public about rural subdivision issues and habitat conservation options. One of the most notable is the University of Wyoming's William D. Ruckelshaus Institute of Environment and Natural Resources' (Ruckelshaus Institute) *Open Space Initiative*. Established in 1993, the Ruckelshaus Institute has conducted research, disseminated information, and facilitated public dialogue on a number of topics associated with land-use change and the impacts of that change within Wyoming. Some of the topics addressed through the *Open Spaces Initiative* include: public opinion on land conservation and open space, private land and big game habitat, residential development and the cost of community services, conservation easements, population growth and land use trends, and big game migration corridors (see Additional Resources for Open Space Initiative publications).

Lastly, the University of Wyoming's Cooperative Extension Services program *Barnyards & Backyards: Rural Living in Wyoming* focuses on providing information to small acreage landowners, new landowners, or backyard enthusiasts on rural landownership issues including pasture management, wildlife habitat, and invasive species.

Federal land management agencies have also taken steps to educate and train agency personnel to work more effectively with local land planners and private landowners in order to conserve the quality of lands that are adjacent to publicly managed lands and to help promote conscientious development. Privately held land that is within public land boundaries (i.e., private in holdings) and land that borders national parks and national forests are at high risk for development due to their desirable locations. Additionally, these publicly managed lands, many of which provide essential habitat for Wyoming's wildlife, are also vulnerable to human-caused disturbances such as predation by domestic pets and invasive species used in residential landscaping. The U.S. Forest Service has worked with the Ruckelshaus Institute to develop a toolkit for Wyoming's public land managers that compiles information on many of the technical and financial resources that are available for the conservation of private land. The goal of the toolkit is to aid Wyoming's public land managers in becoming more involved in local land planning efforts.

Current Challenges to Conserving Private Wildlife Habitat and Mitigating the Potential Negative Impacts of Rural Subdivision and Development

Growth planning and land conservation efforts can be contentious.

Individual freedom and avoidance of excessive government intrusion are strongly held values in Wyoming. Many mechanisms to address growth planning limit future land uses, resulting in an inherent tension between balancing the protection of individual and private property rights with providing public benefits. The controversial nature of growth-planning issues often causes public officials to be reluctant to address them.

Uncertainty about the future profitability of agriculture, access to federal grazing leases, and land use regulations can make farmers and ranchers unwilling to enter into agreements which place long-term development restrictions upon their land.
While many landowners have a desire to retain wildlife habitat on their land and continue to farm or ranch, uncertainty about the future economic viability of agriculture may cause some to be reluctant to enter into conservation agreements in perpetuity or support land use planning which would prevent them from selling their land for alternative land uses.

Wyoming's large public land base may decrease the perception that conservation of wildlife habitat is necessary.
Fifty-four percent of Wyoming's land is owned by either the state or the federal government (Hulme et al. 2009). Much of this land has some level of protection against future subdivision and housing development. However, relying solely on public land to provide habitat for Wyoming's wildlife discounts the disproportionate amount of crucial habitat, especially winter range, birthing sites, and migration corridors located on private land. Some habitat types, including lowland riparian areas and shortgrass prairie, are predominately found on private land in Wyoming.

There is a need for a greater number and diversity of tools available for landowners to retain wildlife habitat.
Many landowners, particularly those who rely on agriculture for their livelihood, do not have the earnings to take advantage of income tax incentives for entering into conservation easements. The number and type of incentives for entering into land conservation agreements should be expanded and include incentives supporting sustainable land uses which maintain open spaces in addition to land use restrictions.

For subdivisions outside of municipal boundaries, fewer administrative hurdles exist and development is typically cheaper.
Rural development is currently encouraged because it is often cheaper and less administratively burdensome than developments inside incorporated municipal boundaries. Connecting to municipal infrastructure such as water, sewer, and electricity can add to development costs. Wyoming statutes make it easy to develop rural areas since few counties have chosen to opt for review and permitting of parcels which are 35 acres or larger. Additionally, relatively few county building codes and development standards may reduce costs of rural developments. Current difficulties with municipal annexation have been identified as discouraging developments within city and town limits in favor of rural subdivision. Also, sales tax revenue is often allocated between counties and cities based on the number of residences. This has led to a perception among some counties that large numbers of residents will enhance county revenue; although costs for providing services to rural residents may exceed financial gains.

Landowners, developers, and local governments need to be provided with more options for growth planning supported by examples based in Wyoming.
Many people involved with land use decisions and designing developments are unaware of the options to address growth planning and habitat conservation. Additionally, although a diversity of techniques have been used throughout the country, Wyoming examples are lacking.

Raise awareness about the potential benefits of planning for growth and habitat conservation.
Growth control and land conservation efforts often encounter the belief that all growth is beneficial and development limitations are generally disadvantageous. Effective wildlife habitat conservation efforts can support

traditional land uses and local economies through activities such as agriculture, tourism, hunting, and angling. In Cody alone, sportsmen and wildlife watchers are estimated to contribute $30.1 million its economy annually (Southwick Associates 2012).

Conserved properties can increase property values, save tax dollars, and retain community features most valued by residents and sought-after by businesses. A study conducted in Wyoming in 2001 found that to provide community services such as trash collection, emergency services, and road maintenance, it costs a statewide average of 54 cents in expenditures per dollar of tax revenue collected for lands under agricultural production, compared to $1.13 for rural residential lands (Coupal et al. 2002).

Limited coordinated, statewide Geographic Information System (GIS) mapping capacity.
Currently, Wyoming lacks statewide tracking of subdivisions and rural residential developments to quantify land use changes and guide habitat conservation planning. Some counties in Wyoming have GIS departments and websites, but coordination among all 23 counties is limited and data is not uniformly available. GIS maps for wildlife and crucial habitats often lack specificity and are limited in the number and diversity of wildlife species incorporated.

Difficulty of land conservation and growth planning efforts keeping pace with development rates.
Limited staff for municipal and county land planners as well as for land trusts can make it difficult for the development review process and habitat conservation efforts to keep pace with high rates of rural subdivisions.

Recommended Conservation Actions

Increase funding for habitat conservation projects.
Organizations that conserve private wildlife habitat frequently have more interest from landowners than project funding will support. It can be difficult for many of Wyoming's land trusts to achieve the matching funding required to access state and federal conservation dollars, which are available through sources such as the Wyoming Wildlife and Natural Resource Trust Fund and the Natural Resource Conservation Service's Agricultural Conservation Easement Program. Mechanisms that other states have used to increase funding for land conservation include lodging and recreational user fees, bonding initiatives, state lottery funds, and a real estate transfer tax, which applies when land is sold and changes from an agricultural use to another use. Energy development mitigation money should continue to be available for habitat conservation projects. It is recommended that the Wyoming Wildlife and Natural Resource Trust be fully funded to its $200 million limit.

Wildlife habitat conservation efforts should be linked to maintaining ranching and other sustainable land uses.
The majority of privately-owned, crucial wildlife habitat in Wyoming is found on working ranches. Polls have shown that the loss of working family farms and ranches is of high concern for Wyoming voters (Hulme et al. 2009). Linking habitat conservation efforts to retaining agricultural operations may increase landowner involvement and public support.

Because the value of ranchland for development vastly exceeds the land's agricultural productive value, efforts that enhance the economic viability of agricultural operations may diminish incentives for ranchers to sell their land for alternative uses. Such initiatives may be popular with landowners and are not constrained by government budgets if they are linked to free markets. Examples of efforts that have been used to increase and diversify financial returns from agriculture include direct marketing, niche marketing, food cooperatives, and new product development. Many landowners have also established businesses that capitalize on the natural amenities of their land including outfitting for wildlife viewing, hunting, and fishing.

Similarly, increased regulation may also discourage landowners from remaining in agriculture. Continued access to grazing leases on federal land is central to the economic sustainability of many Wyoming ranching operations.

Future monitoring and stewardship expenses should be eligible for habitat conservation grant funding.
Wyoming land trusts are acquiring an ever-increasing number of conservation easements. Money to monitor and enforce conservation easements is a growing percentage of a land trust's operating budget. Most conservation easements are perpetual agreements. Research has shown that conservation easement violations typically occur after the land transfers from the original landowner who entered into the conservation easement agreement to a new owner (Danskin 2000). A portion of grants for habitat conservation projects should be eligible for long-term conservation easement stewardship expenses.

Enhanced coordination, consistency, and accessibility of GIS mapping efforts should be a state priority.
Mapping information regarding the size and location of rural subdivisions and crucial wildlife habitat in Wyoming is often incomplete and not compatible between sources. Similarly, even for state agencies, requirements for mapping data storage at a central location is lacking.

Currently, SGCN monitoring and inventory work is scattered among agencies, consultants, conservation organizations, and natural resource industries. Among other benefits, compiling data would help to identify data gaps.

Electronic maps which have been enhanced and made available through the Natural Resource and Energy Explorer (NREX) application as part of the 2017 SWAP revision (SWAP Habitat Section pages Page III – i - 10-13), should aid in conservation planning. Available maps display SGCN richness, habitat intactness, landownership, and the SWAP terrestrial habitat types.

Vulnerability analysis research completed by the Wyoming Nature Conservancy, Wyoming Natural Diversity Database, and WGFD shows projected interaction between rural development, energy development, and climate change on Wyoming SGCN and terrestrial habitats http://www.nature.org/media/wyoming/wyoming-wildlife-vulnerability-assessment-June-2014.pdf.

Some private landowners may be reluctant to reveal the locations of sensitive species and habitats on their property because of the fear of being the target of future regulations, which could result in the loss of land values and land uses. To reduce these concerns, investigations should be made into methods of providing safe-guards for future access and use of this information.

Increase awareness about the potential negative impacts of wildlife habitat fragmentation and the benefits of habitat conservation and growth planning.
Rural development and subdivision can reduce both the quantity and quality of wildlife habitat. Some impacts such as the spread of invasive species, increased wildlife conflicts including vehicle collisions and damage to crops and landscaping, and decreasing water quality may not be anticipated or well understood by those designing and reviewing rural subdivision plans.

Accordingly, knowledge levels should be improved about the benefits and relationship between wildlife habitat conservation and maintaining agriculture and other traditional land uses, attracting businesses, preserving clean air and water, providing outdoor recreational opportunities, and reducing the cost of providing community services. Proactive, incentive-based habitat conservation efforts can be effective in reducing the need for future listing of species under the Endangered Species Act.

Training workshops on habitat conservation and rural development issues should be enhanced and made available to larger audiences. Important stakeholder groups include landowners, developers, realtors, businesses, county and community land-use planners, county commissioners, mayors, town councils, planning and zoning commission members, and the general public. The Wyoming County Commissioners Association, The Sonoran Institute, University of Wyoming Department of Agriculture Cooperative Extension Service, and Wyoming Planning Association currently offer training and facilitation on development issues and growth planning.

A common terminology for discussing growth planning and land conservation issues should be developed.
For some, terms like "open space" can conjure images of beautiful vistas of natural areas and pastoral scenes; for others "open space" may mean urban greenways or even shopping center parking lots. Similarly, terms such as "conservation easements," "land use planning," and "zoning" carry with them considerable historically negative stigma and may elicit strong emotional reactions. Effort should be made to develop terms or clarify existing terms to discuss growth planning and habitat conservation issues that are broadly understood and facilitate discussions about both opportunities and limitations of various conservation options.

Clearly identify high priority wildlife habitat.
Habitat priority areas, including wildlife corridors, need to be clearly identified in order to be effectively incorporated into development design and growth planning efforts. High density SGCN areas identified in the Habitat Section of this State Wildlife Action Plan and available electronically through NREX should assist in achieving this objective. It is important to address all species, including SGCN and big game animals. Greater incentives and assurance should be provided to landowners who voluntarily participate in habitat GIS mapping projects that data will not be used in future regulatory actions. Attention should be given to creating policies and programs that encourage landowners to view designation of their land as a wildlife priority area as an opportunity rather than a potential threat to its traditional uses.

Improve the knowledge of first-time landowners about wildlife and rural living issues and increase efforts to mitigate the negative impacts of rural subdivisions.
Many rural subdivisions exist in Wyoming and many more will be developed in the future. Programs that increase first-time landowners' knowledge of wildlife and rural living issues, such as Barnyards & Backyards - Rural Living in Wyoming headed by the University of Wyoming's Cooperative Extension Services, should be continued and expanded. Additionally, there are numerous opportunities including landscaping choices, grazing practices, pesticide use, and garbage storage to mitigate the negative wildlife impacts of rural subdivisions and even increase habitat quality. More attention can be placed on wildlife-friendly fencing. The Wyoming Wildlife Foundation has a publication on wildlife-friendly fencing (http://wyomingwildlifefoundation.org/wp-content/uploads/2016/06/Fencing-Guide.pdf). Federal, state, and private landowner fence-design often lacks consistency. Landowners have the option to specify what type of fencing they prefer along Wyoming Department of Transportation rights-of-way. The state should assume a leadership role in providing examples of wildlife-friendly fencing for state projects.

Evaluating/monitoring Success

Continue to build GIS capabilities to track rural subdivision and land conservation efforts in Wyoming.
Many Wyoming counties do not have the ability to electronically map subdivisions, so that rural subdivisions are not being mapped on a statewide basis. Establishing a statewide electronic database of rural subdivisions would help to guide future development and conservation efforts to minimize impacts to important wildlife habitats. This database would also be helpful in enhancing existing research that monitors cumulative impacts of rural subdivisions in relation to other habitat threats such as energy development or invasive species, assuming that these threats are also mapped. The location of conserved properties, including lands upon which conservation easements or management agreements exist, should continue to be tracked to assist in planning. This information could be used in evaluating success in reaching habitat conservation targets.

The availability of funding and technical information resources for addressing rural subdivision and development should be monitored and made accessible to land conservation organizations, private landowners, local governments, and developers.
There are diverse funding and technical information resources for completing land conservation projects and enhancing development planning. Keeping updated on all resources can be difficult. Increasing land values and fluctuating fund availability will likely require increased resources for completing habitat conservation projects in the future.

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Additional Resources

Ducks Unlimited
Colorado/Wyoming Program
2926 East Mulberry Street
Fort Collins, CO 80524
Phone: (970) 221-9861
www.ducks.org

Jackson Hole Land Trust
P.O. Box 2897
555 East Broadway, Suite 228
Jackson, WY 83001
Phone (307) 733-4707
http://jhlandtrust.org/

National Turkey Foundation
1376 Harding Road
Burns, WY
Phone: (307) 547-3556
http://www.nwtf.org/

Rocky Mountain Elk Foundation
Southern Wyoming
1291 Jones Road
Thermopolis, WY 82443
Phone: (307) 867-2613

Northern Wyoming
53 Albright Drive
Buffalo, WY 82834
Phone: (307) 684-5285
http://www.rmef.org/Conservation/WhereWeWork/Wyoming/

Sheridan County Land Trust
P. O. Box 7185
Sheridan, WY 82801
Phone: (307) 673-4702
https://sheridanclt.org/

The Sonoran Institute
100 N. Stone Ave., Suite 400
Tucson, AZ 85701
Phone: 520-290-0828
http://www.sonoraninstitute.org/

The Conservation Fund
P.O. Box 4441
Jackson, Wyoming 83001
Phone: (307) 733-2360
http://www.conservationfund.org/

The Nature Conservancy in Wyoming
258 Main Street, Suite 200
Lander, WY 82520
Phone: (307) 332-2971
Fax: (307) 332-2974
http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/wyoming/

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1000 East University Avenue
Laramie, WY 82071
Phone: (307) 766-5080
Email: ienr@uwyo.edu
http://www.uwyo.edu/enr/ienr/

University of Wyoming Cooperative Extension Services
Dept 3354
100 East University Avenue
Laramie, WY 82071
Phone: (307) 766-5124
http://ces.uwyo.edu

Wyoming Assoc. of County Commissioners
P.O. Box 86
409 West 24th Street
Cheyenne, WY 82003
Phone: (307) 632-5409
www.wyo-wcca.org

Wyoming Business Council – Agribusiness
214 Wes15th Street
Cheyenne, WY 82002
Phone: (307) 777-6589
http://www.wyomingbusiness.org/business/agri

Wyoming Game and Fish Department – Lands Division
5400 Bishop Boulevard
Phone: (307) 777-4653
https://wgfd.wyo.gov/

Wyoming Planning Association
1001 Donegal Street
Casper, WY 82609
Phone: (307) 234-9442
http://www.wyopass.org/

Wyoming Stock Growers Land Trust
P.O. Box 206
Cheyenne, WY 82003
Phone: (307) 772-8751
http://www.wsgalt.org/

Energy Development

Wind energy development in Wyoming (Tony Hoch)

Bottom two photos courtesy of WGFD

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Background

Wyoming is a top U.S. domestic exporter of energy, supplying the nation with more than 10 quadrillion (thousand million million or 10^{15}) BTUs of energy per year (Surdam 2008). Wyoming domestic energy exports account for half of all energy exported by states within the U.S. and surpasses the exports of many major energy exporting nations (Surdam 2008). Specifically, Wyoming is a leading producer of coal, natural gas, crude oil, and wind-power (National Mining Association 2008, U.S. Energy Information Administration 2010, Elliott et al. 1991, Lawrence 2007). The minerals industry is by far the largest single contributor to Wyoming's economy.

Wyoming's role in supplying the nation's energy will likely increase in the future, although with recent declines in prices, energy development has slowed. Still, Wyoming has some of the largest untapped energy resources in the country, with the most significant constraint on enhanced energy production being a lack of adequate transportation options, transmission lines, and pipeline capacity.

Hundreds of thousands of acres of federal minerals are currently leased for coal extraction in Wyoming, and oil and gas leases total many millions more (Bureau of Land Management 2008). The Department of Interior (DOI) has suspended coal leasing until the DOI has a chance to review current rules regarding leasing. Concurrently, the DOI is also reviewing the leasing of federal fluid minerals. It is uncertain what the impact will be on development in the future.

Wind energy development has also increased. Wyoming has a high potential for on-shore wind energy sites (Bureau of Land Management 2010). Wind energy is an important focus of efforts to reduce national dependence on foreign oil and federal energy policy that emphasizes reductions in carbon emissions. The Wyoming Infrastructure Authority, in conjunction with transmission developers, is currently studying a conceptual design capable of collecting as much as 12,000 megawatts (MWs) of new electric generation within the state. The majority of this new generation is expected to come from wind turbines.

Increasing energy demands, diminishing fossil fuel reserves, and concerns over carbon emissions may lead to an increase in nuclear energy. Wyoming has the nation's largest uranium reserves (Department of Energy 2003). The World Nuclear Association estimates a substantial increase in uranium demand over the next 20 years.

Wyoming also has vast reserves of unconventional energy resources. It is estimated that oil shale found in the Green River Formation, located in northwest Colorado, southwest Wyoming, and northeast Utah, contains over two trillion barrels of oil, which is equivalent to one to two times the total world oil reserves (Bureau of Land Management 2010a). The Bureau of Land Management (BLM) instituted a moratorium on oil-shale development in the early 1980s, largely because the technology to extract the oil economically was lacking. Congress directed the BLM in 2006 to lift the moratorium and began accepting nominations for oil-shale research projects. In 2013, the BLM signed a Record of Decision (ROD) for the Allocation of Oil Shale and Tar Sands Resources on Land Administered by the BLM in Colorado, Utah, and Wyoming. The ROD opened approximately 292,000 acres in Wyoming for commercial oil shale leasing.

The state also has enormous potential to develop shale gas, deep gas, bypassed under-pressure gas, coal gasification, and coal-to-liquid energy sources (Surdam 2008) although this potential has been largely undeveloped despite existing technologies. Wyoming also has excellent geologic features to sequester carbon dioxide in the form of structural traps with saline reservoirs, depleted compartmentalized gas accumulations, and deep coal deposits (Surdam 2008).

Wyoming has geothermal resources which could be commercially developed for energy production in a number of locations in the state, including the northwest, central, and southwest portions of the state. Wyoming's solar energy development potential is also strong statewide, although both solar and geothermal energy sources remain largely undeveloped in the state at this time (Nielsen et al. 2002). A helium production facility has been built near Big Piney. The plant is designed to produce 200 million standard cubic feet of helium per year initially, with expectations for future expansion to 400 million standard cubic feet per year (Gasworld 2014). The Wyoming State Geological Survey has conducted an inventory and prioritization of all Wyoming geologic sites capable of sequestering commercial quantities of CO_2. The research identified the Rock Springs Uplift as the most promising geological CO_2 sequestration site in Wyoming. A CO_2 sequestration project is also underway at Rands Buttes by Big Piney.

Figure 4.

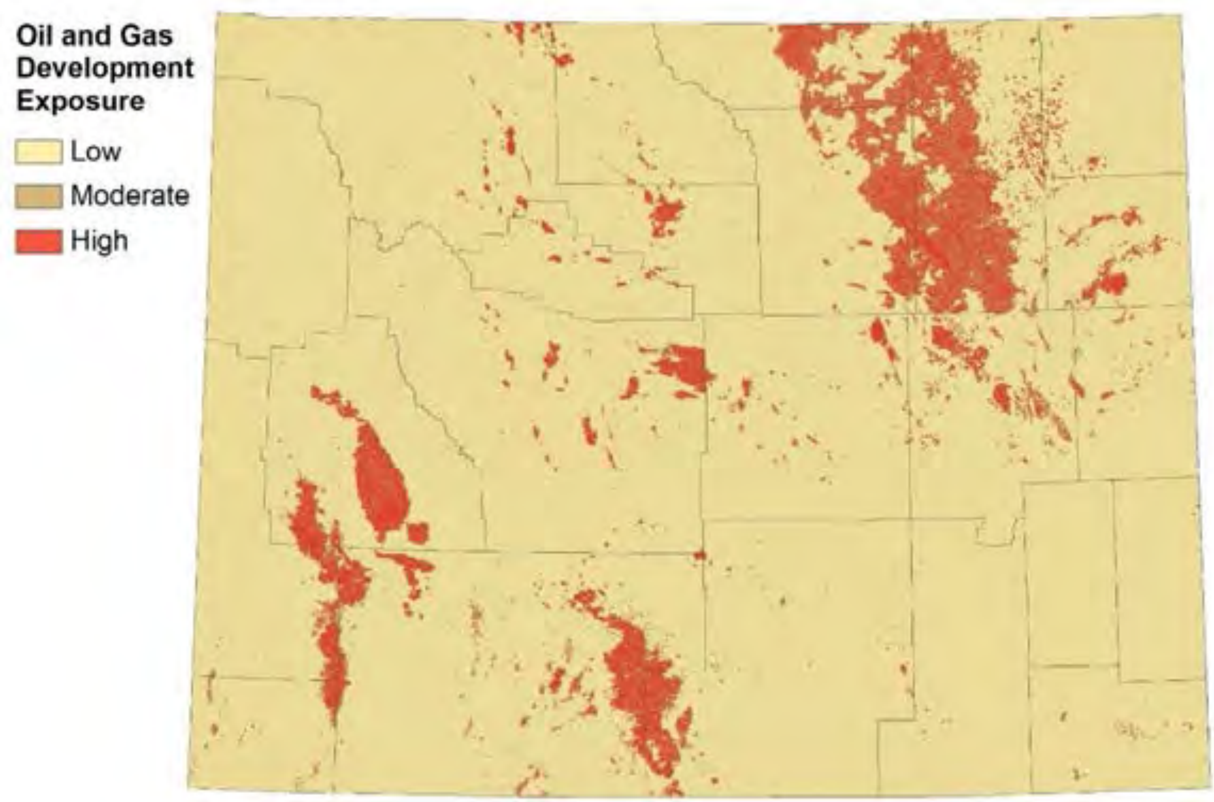
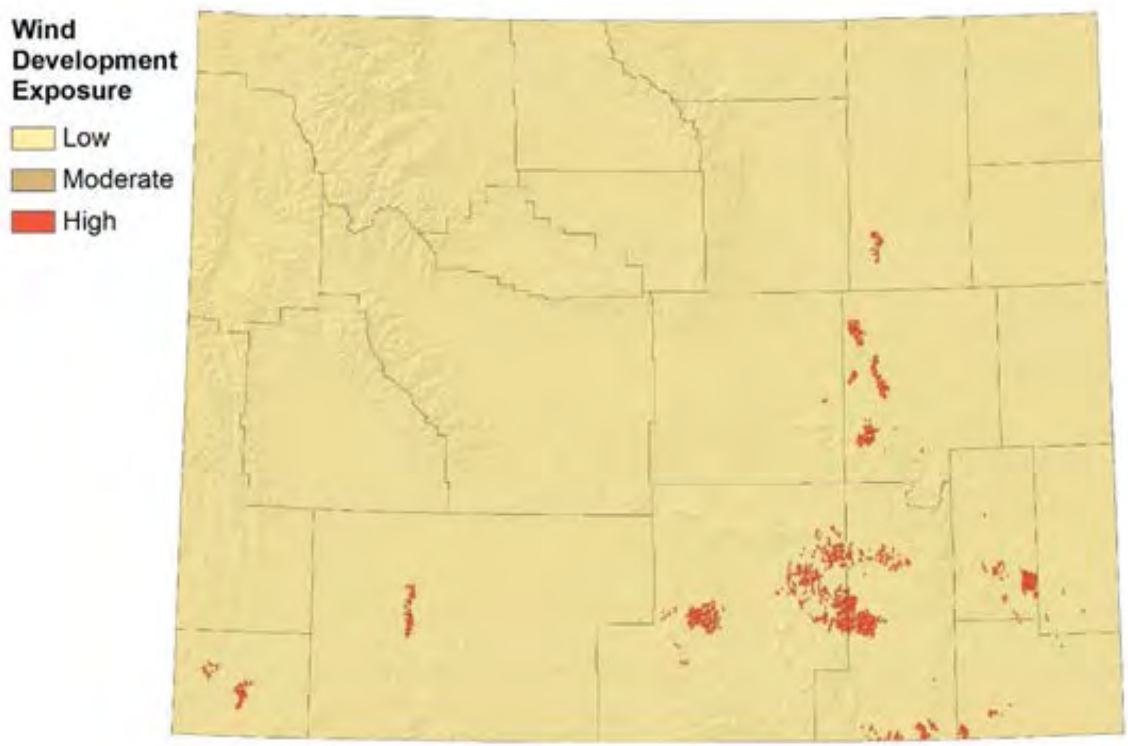


Figure. 5



Exposure to oil and gas or wind energy development represents the relative impact of energy development on the landscape and was calculated for all 30-meter raster cells across Wyoming. Cell values ranged from 0, which reflects minimal potential for impact, to 1, which reflects complete conversion of native habitat. The scores ranging from 0 to 1 were assigned to categories as follows: low (<0.33), moderate (0.34-0.66), and high (>0.67) (Pocewicz et al. 2014). Exposure to energy development includes existing wells or turbines (2010), as well as projected development (2030). Existing development was represented using point datasets of oil and gas wells (Wyoming Oil and Gas Conservation Commission 2010) and wind turbines (O'Donnell and Fancher 2010). Future development projections were based on spatial models representing the likelihood of potential development, combined with published growth projections used to populate the highest probability locations with oil and gas well or wind turbine points, while excluding those areas where each development type would be legally prohibited (Copeland et al. 2013). The energy development exposure raster datasets were created from the well or turbine points by assigning a maximum disturbance (value=1) at existing or projected points and applying a logistical decay to zero over a distance of 1 km (Pocewicz et al. 2014).

References cited:
Copeland,et al. 2013, O'Donnell and Fancher. 2010, Pocewicz, et al. 2014, . Wyoming Oil and Gas Conservation Commission. 2010.

Scope and Challenges of Energy Development and Wildlife Conservation

Access to affordable and reliable power is important to our nation's economy and security and contributes to the prosperity and quality of life of its citizens. Energy development is Wyoming's leading source of revenue and is responsible for thousands of jobs in the state (Wyoming Department of Employment 2010). Continued, well-planned energy development will play a central role in the futures of both Wyoming and the nation.

Like nearly all forms of disturbance, energy development, particularly during certain stages, has some level of impact on wildlife. The significance of the impact depends upon the amount, intensity, and duration of the disturbance; the specific locations and arrangements of the disturbance; and the ecological importance of the habitats affected (Wyoming Game and Fish Department 2010a). Small, isolated disturbances within less important habitats can often be of little consequence, but may have cumulative impacts. Larger-scale developments within habitats that are crucial to the survival or reproduction of wildlife can be significant if not mitigated.

Oil and gas development produces potential adverse effects. These include: direct loss of habitat, physiological stress to wildlife, disturbance and displacement of wildlife, habitat fragmentation and isolation, alteration of environmental functions and processes (e.g., stream hydrology, water quantity/quality), introduction of competitive and predatory organisms, and secondary effects created by work force assimilation and growth of service industries (Wyoming Game and Fish Department 2010b). Concerns over air quality have also arisen in areas of intense oil and gas development (Jacus and DiLuigi 2010).

The collective area of disturbance from oil and gas development may encompass a small percentage of the land; however, human disturbances associated with each facility (well pad, road, overhead power line, etc.,) can cause stress and avoidance by wildlife in surrounding areas (Wyoming Game and Fish Department 2010a). Zones of avoidance may extend over a mile for mule deer (Sawyer et al. 2008), over half a mile for elk on open winter range (Brekke 1988, Hayden-Wing Associates 1990; Hiatt and Baker 1981; Johnson and Lockman 1979), and up to several hundred yards for some raptor species during egg laying and early incubation (Fyfe and Olendorff 1976, White and Thurow 1985). Declines in the use of leks by male sage-grouse have been associated with decreasing distance to natural gas related disturbances, increasing levels of disturbance and noise, and greater levels of traffic (Holloran 2005). Similarly, nesting females avoided areas with high densities of producing gas wells and brooding females avoided producing wells (Holloran 2005).

As densities of wells, roads, and facilities increase, habitats within and near well fields can become progressively less suitable for some species of wildlife, until most animals no longer use the area or animals that do use the affected areas are subjected to increased physiological stress (Wyoming Game and Fish Department 2010a). Areas of intensive activity or construction may become barriers to animal movement, including inhibiting animals from reaching crucial winter ranges and habitats important for reproduction (Sawyer 2010). Animal numbers can increase in areas surrounding development which may raise the risk of density-dependent effects, such as range over-utilization or disease transmission, which can lower survival and reproduction (Sawyer et al. 2006). Greater road numbers and densities may also increase both the legal and illegal harvest of wildlife.

Aquatic habitats can be impacted by energy development if roads and development sites affect the infiltration rate of water, through increasing the velocity and quantity of water running across the landscape, and potentially increasing erosion and sediment deposition into nearby waterways (Wyoming Game and Fish Department. 2010b). These changes may result in decreased pool depths, decreased riffle area, less diversity in channel substrate, and increased bank erosion. These changes along with direct effects from increased sediment loading can affect macro invertebrate populations and diversity and decrease fish habitat (Wyoming Game and Fish Department 2010b). A common impact is a decrease in gravel and cobble used by spawning fish (Wyoming Game and Fish Department 2010b).

The overall health of an aquatic habitat is a reflection of the condition of the entire watershed including the uplands, riparian corridor, and the stream channel. Disturbances to upland plant communities can impact wildlife by influencing water quantity and quality as well as associated flow regimes (Wyoming and Game and Fish Department 2010b). Also, changed physical conditions, such as stabilized flow regimes and reduced sediment loads, can create environments favorable for the establishment and spread of nonnative species which may be detrimental to native wildlife.

Some researchers have proposed similar impacts on wildlife from wind energy to those possible with oil and gas development (Becker et al. 2009). Wind power requires an amount of space per unit of power that is second only to that required by bio fuels (Kiesecker et al. 2009, Surdam undated). Unlike oil and gas development, bird and bat strikes are commonly associated with wind energy facilities. For other species of wildlife that inhabit open landscapes, such as pronghorn and sage-grouse, the behavioral and resulting population responses to wind energy development are currently unknown but being studied.

Wind towers range from 212 feet to over 260 feet tall with blade sweeps of between 328 to more than 400 feet above ground level (Wyoming Game and Fish Department 2010b). Injury and mortality to birds is known to occur from strikes during flight with wind turbine rotor blades, monopoles, power lines, guy wires, and other related structures (Kunz et al. 2007, Winegrad 2004). Most species of birds are at risk of collision, although studies have shown that specific groups of birds in particular habitats, under certain weather conditions, or in large densities are more at risk than others, including raptors, migrating birds, wading birds, and waterfowl (Wyoming Game and Fish Department 2010b). Nearly 90% of bat fatalities occur in late summer and early fall, during the peak of fall migration (Keeley et al. 2001, Erickson et al. 2002, Johnson 2005). Migrating and commuting bats often follow linear features in the landscape, and may be drawn to ridges where wind energy facilities are commonly located (Erickson et al. 2002, Kunz 2004). The physical characteristics of wind turbines might also attract bats.

Energy booms are also often accompanied by human population growth in nearby towns and cities, which can lead to additional wildlife conservation challenges. These secondary effects arise from additional housing, service industries, transportation corridors, and other infrastructure (Wyoming Game and Fish Department 2010a). Private lands available for housing subdivisions are often located along valley bottoms and waterways that frequently provide crucial winter range, travel corridors, and reproductive sites for wildlife.

Further information about potential impact for energy development to wildlife, as well as mitigation and monitoring recommendations for individual and groups of wildlife species, can be found within the Wyoming Game and Fish Department's (WGFD) *Recommendations for Development of Oil and Gas Resources within Important Wildlife Habitats* and *Wildlife Protection Recommendations for Wind Energy Development in Wyoming*. Links to download copies of these documents are located in the Literature Cited section of this chapter.

Current Initiatives to Incorporate Wildlife Conservation into Energy Development

Sage-grouse Conservation

In Wyoming, a significant amount of the state's coal, natural gas, and oil production, as well as area that would support commercially developable wind energy (Class 4 or higher) exist within sage-grouse current range (Clark 2009). Greater sage-grouse have been petitioned to receive protection under the Endangered Species Act. In March 2010, the U.S. Fish and Wildlife Service (USFWS) ruled the species status warranted, but precluded; meaning that the greater sage-grouse meets the criteria to be listed as threatened, but there are other species that have higher priority. Most recently, in September 2015, the U.S. Fish and Wildlife Service determine the species not warranted for listing. The listing of the sage-grouse under the Endangered Species Act would have significant negative consequences for Wyoming's economy and future energy development within the state. Impacts to the energy sector alone could be greater than 22 billion (Stoellinger, T. Taylor, D. 2016). Efforts to conserve the sage-grouse are at the forefront of energy-development wildlife conservation planning and mitigation efforts and will likely have a positive impact on other sagebrush-associated wildlife species. Associated science and management innovations could likely be applied to other wildlife species and habitats in the future.

The following section lists some of the most significant sage-grouse conservation efforts in Wyoming related to energy development. Additional information about sage-grouse and sagebrush habitat conservation work can be found in the Sage-grouse Species Account and the Sagebrush Shrublands Habitat Type.

Sage-grouse Core Area Strategy

In 2007, in response to the possibility of listing the greater sage-grouse under the Endangered Species Act, Governor Freudenthal formed the Sage-grouse Implementation Team (SGIT). First among the SGIT's recommendations was extensive statewide mapping of sage-grouse habitats and habitat enhancement efforts. In 2008, Governor Freudenthal issued Executive Order 2008-2, which constituted Wyoming's Core Area Strategy. Governor Freudenthal reissued the Executive Order in 2010 (E.O. 2010-4). Governor Mead issued his Sage-Grouse Executive Order in 2011 (E.O. 2011-5) and updated it in 2015 (E.O. 2015-4). The subsequent orders were similar but improved on the previous orders. New development within Core Population Areas would only be authorized when it could be demonstrated the activity will not cause declines in greater sage-grouse populations. Incentives would be provided to encourage development outside Core Population Areas and to enhance reclamation in habitats adjacent to Core Population Areas. The Core Area Strategy was designed to demonstrate to the U.S. Fish and Wildlife Service that Wyoming had a mechanism in place to ensure the viability of the species across its range in Wyoming.

Bureau of Land Management Instructional Memorandums on Sage-grouse

In 2009, the Washington D.C. Office of the BLM issued Instruction Memorandum WO-2010-071 to ensure environmentally responsible development within the range of the Gunnison and greater sage-grouse. The memorandum instructed that nominated oil and gas, oil shale, and/or geothermal lease parcels would be withheld or deferred from sale as needed, pending additional land-use planning and/or further NEPA analysis. All new leases would include notices that more stringent restrictions may be required as future sage-grouse conservation needs are identified. Conditions of Approval (COAs) may be attached to new Applications for Permits to Drill (APD) that could be more stringent than restrictions identified in Resource Management Plans (RMPs) and existing lease stipulations if needed to protect sage-grouse habitats. In RMP revisions and amendments, areas could be excluded from energy development if they are identified as priority habitats necessary to support sage-grouse populations. New right-of-way applications for wind energy development would also be screened to alert applicants that authorization could be delayed until additional research on impacts for wind energy development on sage-grouse has been completed to demonstrate if development can occur without causing declines to affected populations. Lastly, transmission corridors would be rerouted to avoid high priority habitats necessary to support sage-grouse populations.

In September 2015, the BLM and U.S. Forest Service issued Records of Decision and Approved Resource Management Plan Amendments for Greater Sage-Grouse to confirm sage-grouse conservation in conjunction with Governor Mead's Sage-Grouse Executive Order.

Sage-Grouse Local Working Groups
Eight local working groups were established as a result of the 2003 Wyoming Greater Sage-Grouse Conservation Plan drafted by the Wyoming Sage-Grouse Working Group. The purpose of Local Sage-Grouse Working Groups (LWGs) is to develop and facilitate implementation of local conservation plans for the benefit of sage-grouse, their habitats, and whenever feasible, other species that use sagebrush habitats. The plans will identify management practices and the financial and personnel means to accomplish these practices, within an explicit time frame, for the purpose of improving sage-grouse numbers and precluding the need for listing under the Endangered Species Act.

Candidate Conservation Agreements (with Assurances)
Also, in response to a potential listing decision, the U.S. Fish and Wildlife Service in coordination with state and federal partners developed the Greater Sage-Grouse Candidate Conservation Agreement with Assurances for Ranch Management (CCAA). The Greater Sage-Grouse CCAA is a voluntary agreement between a private landowner and the U.S. Fish and Wildlife Service that utilizes a suite of habitat conservation measures to benefit both sage-grouse and the landowner's existing agricultural operation. The CCAA addresses the primary threat to sage-grouse identified by the U.S. Fish and Wildlife Service, which is loss of habitat. Subsequently, the BLM and U.S. Forest Service developed a Candidate Conservation Agreement (CCA) to apply to federal lands. As of June 2016, Wyoming has completed 40 CCAAs and 24 CCAs, enrolling over 1.5 million acres in these conservation agreements.

Federal Energy Development Permitting
Bureau of Land Management Wind Programmatic Environmental Impact Statement (PEIS)
The BLM initiated the development of a Wind Programmatic EIS (PEIS) in the fall of 2003 for BLM lands in the 11 western states, including Wyoming, as part of a renewable energy resource assessment. A Programmatic EIS evaluates the environmental impacts of broad federal agency actions such as the setting of national policies or the development of programs. The final Wind PEIS was completed in 2005. Among the outcomes of the Wind PEIS was the development of best management practices, which address wind energy siting, construction, and mitigation activities to reduce adverse environmental impacts. These best management practices are being incorporated into the BLM Wind Energy Development Policy as additional guidance for BLM field offices for wind project-specific Plans of Development (PODs) and/or as right-of-way (ROW) authorization stipulations. Copies of the final Wind PEIS can be found at http://windeis.anl.gov/documents/fpeis/index.cfm.

Bureau of Land Management Leasing Reform
In May 2010, the BLM issued Instruction Memorandum 2010-117, which made modifications to existing leasing policy in order to ensure environmental protection of important natural resources on BLM lands while also aiding in the orderly leasing and development of oil and gas resources. The BLM will develop Master Leasing and Development Plans that consider important natural resource values prior to leasing in areas where intensive new oil and gas development is

anticipated. Each potential lease sale will undergo increased internal and external coordination, public participation, and interdisciplinary review of available information. Appropriate mitigation measures will be identified. Additionally, there will be confirmation of Resource Management Plan (RMP) compliance. When needed, site visits will occur to supplement or validate existing data.

Furthermore, the BLM issued interim draft guidance to its field offices on the implementation of Section 390 of the Energy Policy Act of 2005. Under NEPA, federal agencies may use categorical exclusions to approve projects on federal land without conducting extensive environmental reviews if it is determined that the projects will not have significant environmental impacts. The draft guidance establishes a process for considering individual actions that normally would be categorically excluded, but are of a nature or intensity that they warrant further environmental analysis before permitting.

Best Management Practices and Development Guidelines

Wyoming Game and Fish Department Energy Development Recommendations

In 2004, the WGFD produced *Recommendations for Development of Oil and Gas Resources within Important Wildlife Habitats* to identify thresholds of oil and gas development that could impair important wildlife habitats, recommend planning and management considerations to avoid or minimize impacts, and recommend mitigation activities to offset or compensate adverse effects. This document has been revised and updated several times, most recently in April 2010. Recommendations are intended to be applied to important wildlife habitats including big game winter ranges, sage-grouse habitats, priority watersheds, and others identified on maps available from the WGFD website at: https://wgfd.wyo.gov/WGFD/media/content/PDF/Habitat/Habitat%20Information/Wind%20Energy%20Development/Wildlife-Protection-Recommendations-for-Wind-Energy-Development.pdf. A similar document, *Wildlife Protection Recommendations for Wind Energy Development in Wyoming*, was approved by the Wyoming Game and Fish Commission in 2010. Sage-grouse habitat protection recommendations for significant surface-disturbing activities are addressed in the Sage-grouse Core Area implementation recommendations available on the WGFD website.

U.S. Fish and Wildlife Service Land-Based Wind Energy Guidelines

Completed in 2014, the Land-Based Wind Energy Guidelines provide a structured, scientific process for addressing wildlife conservation concerns at all stages of land-based wind energy development. They also promote communication among wind energy developers and federal, state, and local conservation agencies and tribes. Copies of the guidelines can be obtained at: http://www.fws.gov/habitat conservation/wind.pdf. Wyoming-specific USFWS guidelines are also available http://wyia.org/wp-content/uploads/2011/01/usfws-guidance-wy-wind-energy-draft-11-09-2010.pdf/.

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Bureau of Land Management Wind Energy Program Policies and Best Management Practices (BMPs)

In June 2005, the BLM established policies and BMPs regarding the development of wind energy resources on BLM lands. The policies provide guidance for how wind energy development activities are administered and indicate required stipulations, best management practices, and mitigation measures that are to be incorporated into project-specific PODs and ROW authorizations. https://www.blm.gov/wo/st/en/prog/energy/wind_energy.html

Electric Transmission Line Guide for State Fish and Wildlife Agencies

The Association of Fish and Wildlife Agencies' Wind and Transmission Subcommittee created *Electric Transmission Line Guide for State Fish and Wildlife Agencies* (Association of Fish and

Wildlife Agencies 2010). The document includes information on how state wildlife agencies can become engaged in the transmission planning and citing process and how agency staff can best provide guidance for proposed projects. It also provides specific wildlife recommendations, an overview of the transmission industry, and web links to additional resources.

Bureau of Land Management Reclamation Policy
In 2009, the BLM established a Wyoming Reclamation Policy in coordination with BLM specialists, WO-310, the Wyoming Governor's Office, the University of Wyoming, local governments, and professionals from private industry. The policy provides guidance for the modification, preparation and/or review of all reclamation plans. The policy outlines 10 requirements for reclamation plans which are necessary as part of the permit process for federal actions authorized, conducted, or funded by the BLM that disturb vegetation and/or mineral/soil resources: (https://www.blm.gov/style/medialib/blm/wy/resources/efoia/IMs/2009.Par.54664.File.dat/wy2009-022.pdf).

Wyoming Wind Legislation
Recent increases in the amount and rate of wind energy development in Wyoming prompted the Wyoming Legislature in 2010 to enact new legislation. Legislation significant for wildlife conservation includes SEA0038 which expands the jurisdiction of the Industrial Siting Council (ISC) over facilities to include wind energy facilities which consist of 30 or more towers or which are expanded to include 30 or more towers. The legislation also requires the ISC to establish rules for decommissioning, site-reclamation standards, and bonds to ensure these standards are sufficiently met. Also, the potential development impacts to wildlife including threatened, endangered, rare, or other species identified in Wyoming's State Wildlife Action Plan must be disclosed.
HEA0048 places a moratorium on the exercise of eminent domain for the purpose of erecting collector systems associated with wind energy projects. The moratorium is effective until June 30, 2011, or until new legislation establishing additional conditions for the use of condemnation for collector systems associated with wind energy projects is enacted.
HEA0064 requires all facilities generating more than 0.5 megawatts of electricity from wind power to obtain a permit from every county in which the facility is located. This legislation also establishes the minimum standards that counties must apply when issuing the required permits. Permitting requirements include the development of waste management, site reclamation, and decommissioning plans, and descriptions of any environmental, social, or economic effects. Lastly, HEA0018 imposes upon the energy company a tax of one dollar per megawatt hour, which goes into effect three years after the turbine first produces electricity.

Energy Development Research, Planning, and Conservation Projects
State and Regional GIS Wildlife Decision Support Systems
The WGFD and the University of Wyoming's Wyoming Geographic Information Science Center (WyGISC) have finalized the Wyoming Interagency Spatial Database and Online Management (WISDOM) System for housing and disseminating GIS natural resource data. The project is focused on two key elements: 1) organizing and centralizing the storage of data from a variety of sources, and 2) establishing an Internet-based mapping system to provide access to this data to partners and the public. Wyoming's WISDOM will eliminate the need to contact multiple agencies and individuals for data and will provide data-quality assurances for conservation and development planning and analysis.

This effort is linked to the Western Governors' Wildlife Council's effort to establish a Western Regional Wildlife DSS to map crucial habitats across the West. In 2008, the Western Governors Association called for decision support systems to be established in each state that would compile information at scales useful for analyzing proposed energy, land use, and transportation projects, as well as support climate-change adaptation efforts. Presently, the Western Governors' Wildlife Council has developed definitions for crucial wildlife habitats and has presented states with guidelines to facilitate the establishment of regionally compatible systems.

In 2016, Wyoming released a new web-based GIS decision support tool called Natural Resource and Energy Explorer (NREX). NREX was developed through an agreement between the Governor Mead's Policy Office and WyGISC as a result of an objective from the administration's 2013 Energy Strategy.

The goal of NREX is to develop a web-mapping tool to enable discovery and assessment of energy, infrastructure, environmental, wildlife, cultural, and socioeconomic assets for user-defined, project-scale areas of interest in the state. This web-based tool incorporates interactive mapping and geographic information system query and analytical capabilities. The primary target audience for which the NREX tool will be designed is a group of end-users with basic fluency in the use and application of geographic information systems and geospatial data. End users represent developers, conservationists, natural resource managers, and/or local government planners with interests in assessing potential place-based resource allocation concerns. NREX will replace the external, public version of WISDOM.

Wyoming Wind Conflict Map

The Governor's Planning Office produced a wind energy development conflict map in 2009. Wind for power generation is ranked from Class 1 (the lowest) to Class 7 (the highest). In general, wind power Classes 4 or higher are considered viable for generating wind power from turbines. The wind power conflict map was produced by evaluating Class 4–7 winds in Wyoming, as modeled by the National Renewable Energy Laboratory (NREL), against areas where statute, regulation, or federal agency resource management plans would likely prohibit development activities[1] as well as where the protection of natural resource values are a high priority that require a very high mitigation standard that would need to be met prior to allowing development[2]. Location of sensitive species' priority habitats, Sage-grouse Core Population Areas, big game crucial winter ranges, national wildlife refuges, and state wildlife management areas were included in the evaluation in the mapping process.

Western Governors' Western Renewable Energy Zones Initiative

The Western Renewable Energy Zones Initiative (WREZI) is a collaborative effort between the Western Governors and the U.S. Departments of Energy, Interior, and Agriculture; the Federal Energy Regulatory Commission; Canadian provincial premiers; renewable energy developers; tribal interests; utility planners; environmental groups; and government policymakers. The focus area is the Western Interconnection electricity grid which covers 12 western states including Wyoming, as well as portions of Canada and Mexico. In its first phase, a report has been created that identifies areas with low environmental impacts for the development of large-scale renewable resources and associated high-voltage transmission lines. Additional refinements are planned which will identify crucial wildlife habitats. Future work will focus on facilitating the efficient delivery of energy from renewable resource areas to population centers throughout the Western Interconnection. http://www.westgov.org/rtep/219-western-renewable-energy-zones

[1] Included in this category are: state parks, National Park Service lands, National Forest System lands (including National Grasslands), National Wildlife Refuges, Wilderness Study and Visual Resource Management Class I areas, BLM lands with a no-surface occupancy stipulation for sage-grouse, and state wildlife habitat management areas.

[2] Included in this category are: sage-grouse core areas, BLM Visual Resource Management Class II areas, BLM Areas of Critical Environmental Concern, BLM Rawlins Resource Management Plan –Wind Avoidance Areas, and big game crucial winter ranges.

The Nature Conservancy's Development by Design
The Nature Conservancy's (TNC) Development by Design blends landscape-level conservation with the mitigation hierarchy—first avoid, then minimize/restore, and finally offset—to improve mitigation efforts. This is accomplished in a four-step process: 1) develop a landscape conservation plan (or use an existing conservation plan); 2) blend landscape conservation planning with mitigation hierarchy to evaluate conservation and development conflicts; 3) determine the residual impacts associated with development and select an optimal offset portfolio; and 4) estimate the offset contribution to conservation goals.
In Wyoming, TNC's Energy by Design has been used to prioritize project funding for the Jonah Interagency Mitigation and Reclamation Office and will similarly assist for mitigation planning for Continental Divide-Creston, Hiawatha, and Pinedale Anticline oil and gas fields.
http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/wyoming/howwework/energy-by-design-in-wyoming.xml

Wyoming Landscape Conservation Initiative
The Wyoming Landscape Conservation Initiative (WLCI) was created in 2007 as a multi-agency and stakeholder initiative designed to maintain and enhance wildlife habitat and other resource values in the face of intensive energy development and other changes. The WLCI has brought together diverse groups to work toward common goals across a 19-million-acre area. Through the WLCI, partners are conducting science-based research and monitoring, completing habitat enhancements and restoration, encouraging effective reclamation and mitigation practices, identifying and prioritizing landscape-scale conservation work, and promoting grazing practices which benefit wildlife, ranchers, and open-space conservation. Projects have included fence modifications and exclosure fencing, prescribed burns, riparian enhancements, invasive species treatments, river restoration, and conservation easements. Initial funding has come through federal appropriations. http://www.wlci.gov/

Offsite Reclamation Funds
The Jonah Interagency Mitigation and Reclamation Office (JIO) was created by the Jonah Project Record of Decision. Its purpose is to provide overall management of on-site monitoring and off-site mitigation activities primarily focusing on pronghorn and greater sage-grouse in the vicinity of natural gas developments near Pinedale, Wyoming. Encana Oil & Gas (USA) and BP America Production Company committed $24.5 million in compensatory (off-site) mitigation. Encana designated $16.5 million of the fund to be used to mitigate wildlife impacts, while the remaining $8 million could be used to mitigate other resource impacts, perform monitoring, or accomplish other activities. Similar mitigation activities are underway for other oil and gas fields, including the Continental Divide-Creston, Hiawatha, and Pinedale Anticline.
http://www.wy.blm.gov/jio-papo/

USFWS – Strategic Habitat Conservation – Adaptive Management Framework
Strategic Habitat Conservation (SHC) is an adaptive resource management framework used by the USFWS to determine how and where to apply conservation efforts to achieve desired outcomes. SHC incorporated elements of biological planning, conservation design and delivery, monitoring, and research. In response to a request by the WGFD and industry, the USFWS is applying SHC principles to develop an alternative to standard timing stipulations that would provide additional conservation benefits to raptors, while allowing industry to drill year-round. Along with industry, the USFWS is focusing survey efforts in a small pilot project area (~100 square miles) to record forage availability (i.e., to map white-tailed prairie dog towns, ground squirrel colonies) and raptor nest sites. Data collected in 2010, in conjunction with historic data and habitat models, will be used to convert standard timing stipulations into no-surface occupancy areas—where no activity (e.g., drilling) will be permitted. In exchange for not drilling in the areas designated as most important to raptors, the other areas will be open to year-round drilling with no development activity buffer

around active nest sites. Results from 2010 survey and mapping efforts may determine if this alternative is feasible and could be applied to other species and projects.

Assessment of Wildlife Vulnerability to Energy Development Project (AWVED)
The Wyoming Chapter of the Nature Conservancy, Wyoming Natural Diversity Database, and WGFD conducted research to evaluate the vulnerability of Wyoming terrestrial SGCN and habitats to oil, gas, and wind development. Vulnerability was determined by evaluating each species' potential exposure and sensitivity to energy development. Exposure was evaluated through a GIS analysis that overlayed distribution maps of SGCN with areas of known and projected energy development. Sensitivity was determined by examining habitat and behavioral attributes of SGCN, as well as reviewing existing impact studies. Research gives an indication of which species and taxonomic groups are potentially vulnerable to development, and also helps to direct future research to address information gaps. The AWVED project was funded jointly by the United States Geological Survey, Wyoming Landscape Conservation Initiative, and WGFD and can be viewed at: http://www.nature.org/media/wyoming/wyoming-wildlife-vulnerability-assessment-June-2014.pdf.

Interstate Agency-Industry-NGO Research Collaborative on Wind Energy Development Effects on Sage-grouse
State wildlife agencies from Wyoming, Idaho, California, and Oregon have convened the wind industry, academia, and NGOs to develop a focused research initiative. This initiative will work to maximize efficiencies and leverage funding that will focus specific research to better understand the potential impacts of wind development on sage-grouse across their range. This initiative has developed coordinated research questions and protocols and solicited study proposals to replicate studies across the sage-grouse range to foster predictability of impacts from wind development on sage-grouse. For the foreseeable future, the initiative will primarily address research gaps regarding the impacts of wind turbines and associated infrastructure[3]. Additional objectives include: coordinate study results into a comprehensive analysis of impacts across sage-grouse range, ensure peer review of studies is completed and outreach of results is conducted, and provide the science needed to inform wind developers of federal and state agency wind-development stipulations and mitigation strategies while accommodating the need for adaptive management as new science findings occur.

Thunder Basin Grasslands Prairie Ecosystem Association
Among the most notable partnerships between landowners, natural resource agencies, and non-profit organizations is the Thunder Basin Grasslands Prairie Ecosystem Association. The Association was established in 1999 as a landowner-driven effort to develop an ecosystem management plan for species of concern while balancing these needs with sustainable economic and social activities. Members in the Association include private property owners within a designated 931,192-acre landscape in eastern Wyoming. Areas of interest include management activities related to ranching, coal, coal-bed methane, oil, and gas production, and the conservation of wildlife.

Wyoming Game and Fish Department Industry Reclamation and Wildlife Stewardship Awards
The WGFD established the Industry Reclamation and Wildlife Stewardship Awards in 2006. The awards recognize companies and agencies whose primary mission is not wildlife-related, yet who have significantly contributed to the maintenance, restoration, or enhancement of wildlife, wildlife habitat, or recreation. Past recipients include Anadarko Petroleum Corporation, Encana Oil & Gas (USA) Inc., Yates Petroleum Corporation, Rio Tinto Energy America, Bridger Coal Company, Lower Valley Energy, PacifiCorp's M&M Ranch, Fidelity Exploration and Production

[3] Including turbines, meteorological towers, guyed wires, and short-haul transmission within the annual home range of sage-grouse being studied.

Company, Marathon Oil Company, North Antelope Rochelle Mine, Powder River Coal Company; Antelope Coal Mine, and Rio Tinto Energy America. Two consultants who work with energy companies on wildlife-related issues have also been honored: Jim Orpet, Intermountain Resources and Gwyn McGee, Jones and Stokes.

Examples of projects that have received recognition include using black-tailed prairie dogs as a tool for reestablishing mountain plover habitat, creative use of water produced as part of gas extraction for wildlife habitat enhancements, providing wildlife recreational opportunities on energy company-owned land and reservoirs, wildlife monitoring studies, reclamation work, and placing conservation easements on reclaimed mined lands.

Governor Mead's Energy Strategy
In 2013, Governor Mead introduced his administration's energy initiative, *Leading the Charge: Wyoming's Action Plan for Energy, Environment, and Economy*. The plan recognizes energy development as the state's top industry and seeks to balance energy, environment, and economic priorities in Wyoming through strategic initiatives and objectives. Strategies and objective were developed in conjunction with public stakeholders. Several of the specific objectives are directly or indirectly related to wildlife and habitat conservation including developing an Energy Atlas GIS Decision Support Tool; federal agency cooperation and coordination with the state of Wyoming and local governments in the NEPA process; review of state oil and natural gas environmental regulations; exerting state influence on Endangered Species Act issues; sage-grouse studies; Wyoming State Water Strategy and Management Plan; develop a state of Wyoming reclamation standard; develop a state of Wyoming off-site mitigation framework; and incentives for development in non-core sage-grouse habitat.

In 2015, Governor Mead began a similar public process to develop additional initiatives with plans to update the Energy Strategy in 2016.

Wyoming Cooperative Fish and Wildlife Research Unit
The Wyoming Cooperative Fish and Wildlife Research Unit is housed at the University of Wyoming and conducts ecological research to help better understand, manage, and conserve animal populations, including research related to energy development issues. Most recently, the coop unit has supported the founding of the Migration Initiative, whose goal is to advance the understanding, appreciation, and conservation of Wyoming's migratory ungulates. Migration corridors are impacted by energy development projects in some parts of the state, particularly western Wyoming.

BLM Powder River Basin Restoration Program
The Powder River Basin Restoration (PRBR) program is a collaborative partnership to restore and enhance sage-grouse habitat on a landscape level in the Powder River Basin (PRB).

The BLM High Plains District Office PRBR program was developed to form partnerships with local cooperators, federal and state agencies, private landowners, and industry to work collaboratively on sage-grouse habitat restoration. PRBR is focusing on areas affected by federal oil and gas leasing that has occurred over the past decade in the PRB in northeastern Wyoming. The goals of the PRBR are:

- Build partnerships to restore habitat for the greater sage-grouse on a large landscape or watershed level.
- Integrate habitat improvement programs and projects implemented by partners to leverage funding to enhance sage-grouse habitat reclamation.
- Facilitate the sharing of data/data collection methods, monitoring data/methods, and best management practices.

The strategy of this initiative requires a coordinated effort which includes forming a consortium of landowners, industry, and agency partners who can integrate their respective habitat improvement programs with BLM efforts focused on reclamation of abandoned coalbed natural gas (CBNG) wells. The partnership will provide funding sources and technical assistance for a community-based approach to restoration that goes above and beyond regulatory or industry requirements with minimal to no-cost to landowners. The result of this coordinated effort will be to restore a larger landscape or watershed area rather than the smaller areas the BLM requires through the plug and abandon process. Partners will contribute technical expertise and/or financial support focused on the long-term reclamation of abandoned CBNG wells and their infrastructure. There will be an emphasis on restoring and enhancing sage-grouse habitat. Conserving and enhancing sage-grouse habitat also benefits many other species, as well as livestock forage production. By integrating the implementation of these independent programs, there are opportunities to leverage both the technical expertise and financial contributions so that greater results are achieved.

Mitigation

WGFC MitigationPolicy

In 2012, the WGFC approved a mitigation policy to support the Department's commitment to early communication with project developers, permitting agencies, and land management agencies to avoid and minimize adverse impacts to wildlife during the course of project and land use planning. The mitigation approaches in the policy include: 1) resource maintenance and 2) resource compensation. Resource Maintenance is emphasized and may be achieved through avoiding, minimizing, rectifying, or reducing adverse impacts to wildlife through project planning. Compensation is achieved through the development and implementation of measures to replace or provide substitute resources to address impacts, which may include financial compensation.

The policy identifies and defines mitigation categories (irreplaceable, vital, high, or moderate) for specific wildlife and habitat resources and thereby provides direction to the Department in its project and land use planning recommendations. The policy was updated by the WGFC in 2016 to designate migration corridors as "vital" and add migration stopover areas and migration bottlenecks to the "vital" category, as well.

State of Wyoming Greater Sage-Grouse Compensatory Mitigation Framework

Executive Order 2015-4 Greater Sage-Grouse Core Area Protection issued by Governor Mead in July 2015 includes an attachment outlining basic requirements for compensatory mitigation related to unavoidable impacts in sage-grouse core areas. Subsequently, Governor Mead issued a more specific compensatory mitigation framework in late 2015 to further define compensatory mitigation as a strategy. The key components of the strategy, namely "credits" and "debits", took shape over several months of meetings and negotiations with state, federal, and private entities. The framework was finalized and went into full effect in June 2016. Accordingly, Governor Mead provided direction to 10 state agencies to implement the policy. The Governor also corresponded formally with the BLM, U.S. Forest Service, and U.S. Fish and Wildlife Service regarding the policy and the need for consistency across permitting agencies and land managers.

Pathfinder Ranches and the Sweetwater River Conservancy

In 2015, the U.S. Fish and Wildlife Service approved the nation's largest conservation bank and first bank for greater sage-grouse. The Sweetwater River Conservancy is the private operator of the bank, which is located on the Pathfinder Ranches located west of Casper, Wyoming. A conservation bank is a piece of property that is permanently protected and managed with regard to the natural resource values within that property. It functions to offset adverse impacts to a species which occurs elsewhere, and is often referred to as off-site compensatory mitigation. These lands are conserved and permanently managed for species that are listed under the Endangered Species Act, have been designated a candidate for listing, or are a species of conservation concern. The creation of conservation banks in Wyoming is guided by a review team comprised of representatives from state and federal agencies and private landowners. The Pathfinder Ranch initially contains approximately 55,000 deeded acres that may be sold as "credits" to offset development that occurs elsewhere. When a credit is sold, a permanent conservation easement is placed on that acreage precluding certain types of future development.

2015 Obama Presidential Memorandum
In November 2015, President Obama issued a *Presidential Memorandum: Mitigating Impacts from Development and Encouraging Related Private Investment*. The memo supports positive environmental outcomes in conjunction with economic development, infrastructure development, and national security through planning and emphasizing a hierarchy of avoidance, minimization, and compensation measures. President Obama directed the Departments of Defense, Interior, Agriculture, Environmental Protection , and the National Oceanic and Atmospheric Administration to follow the mitigation hierarchy and moreover to develop and adopt a mitigation plan. The memo supports the use of conservation banks to offset impacts in advance of development activities, as well promoting incentives for restoration and enhancement of natural resources on public lands.

Current Challenges for Improving Wildlife Conservation Efforts Associated with Energy Development

Incomplete understanding of the effects of energy development on wildlife species and habitats.
It can be difficult to fully understand the effects of energy development on both species and habitats especially given variations in the type, pace, and intensity of energy development; local site conditions; changes in energy development technologies; and the influence of other factors including weather and natural wildlife population fluctuations. Monitoring protocols have not been established for many wildlife species including SGCN. Immediate monitoring needs, such as responding to potential ESA listings, often drive monitoring efforts, diminishing resources directed toward understanding the larger effects of development on ecological systems and the success of mitigation efforts.

Difficulties in identifying specific goals and performance indicators by which to develop conservation plans and quantify the success of mitigation efforts.
It is difficult to establish performance indicators to evaluate the success of mitigation efforts given the diverse, changing, and incomplete understanding of the effects of energy development. There is also a lack of consensus on the timeframe or benchmarks by which success should be evaluated. Although improvements have been made, there can be a lack of standardization on how various variables are measured. A significant amount of wildlife mitigation and enhancement techniques pertain to riparian areas and wetlands, which tend to be geographically limited and defined. It can be more challenging to establish effective performance indicators in habitat types that occur on a landscape scale, such as sagebrush.

A diverse array of maps identifying important wildlife habitat are currently available to help guide energy development; however, they are often species-specific or wildlife-group-specific and can vary by organization. Further maps are needed that specify areas of multiple conservation values, including areas needed for sustaining populations of sensitive species, big game crucial winter ranges and migration corridors, and intact portions of representative habitat types.

Lack of understanding and investigation into cumulative impacts.
Currently, Environmental Assessments and Environmental Impact Statements are applied on a project-by-project basis. This results in potentially underestimating the cumulative impacts of multiple concurrent or sequential projects. To be effective, development planning and analysis should include more emphasis on

an evaluation of impacts for multiple forms of development as well as successive projects for a single type of energy development.

It is often difficult to keep Bureau of Land Management Resource Management Plans sufficiently updated and specific to meet the needs for effective mitigation and conservation planning.
BLM RMPs are often very general and do not typically evaluate site-specific impacts. Consequently, information provided to decision-makers can be inadequate for them to use in formulating effective mitigation plans, lease stipulations, or conservation areas. Once written, there can be limited flexibility to accommodate new information collected post-RMP development. Additionally, at this stage, energy development rights have often already been issued, typically making modifications difficult. Rapidly changing technologies and threats can also cause RMPs to quickly become outdated.

Lack of follow-up and enforcement in meeting monitoring and stipulation requirements.
The BLM often does not have the time or resources to monitor industry actions and compliance. State regulatory agencies also do not have adequate resources for follow-up or enforcement efforts where requirements or standards are not met. Kniola and Gil (2005) documented 84% of coal-bed methane wells and facilities in NE Wyoming that did not comply with reclamation standards and other conditions of approval.

Inadequate bonding system to ensure sufficient funds for the future decommissioning and reclamation of energy-development sites.
Lease development bonding is often tied to the original developer; however, leases may change hands multiple times. The type of company that secondarily acquires a lease may change over the lifetime of the lease, including companies that specialize in primary, secondary, and tertiary extraction, as well as salvage and scrap operations for energy-development equipment and infrastructure. Some of these companies go out of business or declare bankruptcy prior to the land being fully reclaimed, making accountability for reclamation difficult.

Recommended Conservation Actions

Advance efforts that identify important wildlife habitats and areas of potential energy development to guide development and conservation planning.
Careful, statewide planning will be critical in future development and minimizing its impacts on Wyoming's wildlife. Currently, multiple regional, statewide, and local habitat mapping efforts are ongoing including the Sage-grouse Core Area Strategy; TNC's Development by Design; WGFD's Strategic Habitat Plan Crucial Areas, and Wind Conflict Maps, among others. Continued attention should be directed toward involving federal and state agencies, industry, landowners, and conservation organizations on cooperatively refining and consolidating these maps. In addition to habitat identification, vulnerability assessments that identify areas of current and projected energy development, as well as other habitat stressors such as rural subdivision, invasive species, and climate change, should be incorporated into mapping efforts. These mapping activities will allow development planning to be conducted on a landscape or watershed scale so that wildlife conflicts can be identified early in the process to facilitate avoidance of impacts (high mitigation priority) and develop appropriate on- and off-site mitigation measures for unavoidable impacts.

Efforts should continue to support state and regional decision support systems to house and disseminate GIS data.
WyGISC's WISDOM, WGFD's internal analysis tool, and Natural Resource and Energy Explorer (NREX), which is an external, public tool, should be further established and associated data made easily accessible to

agencies, industry, government officials, and the public for energy development and wildlife conservation planning. These web-based GIS applications will facilitate the development and updating of maps identifying priority wildlife conservation and energy development areas described above. GIS analysis is also particularly effective for identifying and understanding the cumulative impacts of multiple development projects. Efforts should continue through the Western Governors' Western Regional Wildlife Support System to ensure Wyoming's web-based GIS tools are compatible with those of the surrounding states to facilitate planning multi-state energy transmission and infrastructure developments. Consideration should be given to the appointment of a Geographic Information Office who would oversee the collection, storage, and dissemination of GIS data for state or federal natural resource projects approved in Wyoming.

Monitoring efforts should be both designed to scientific standards, including having treatment and control sites, and formulated to answer specific questions.
The purpose of monitoring should be more clearly defined to evaluate the impacts of energy development and the success of mitigation efforts. The type and level of monitoring needs should be tailored to the specific attributes of the development project and the ecological sensitivity of the site. A framework for establishing this approach is found in the monitoring recommendations within the WGFD's *Recommendations for Development of Oil and Gas Resources within Important Wildlife Habitats* (Wyoming Game and Fish Department 2010a) and *Wildlife Protection Recommendations for Wind Energy Development in Wyoming* (Wyoming Game and Fish Department 2010b). WLCI has also begun compiling information to assist in the establishment of effective energy-development–wildlife-monitoring protocols and plans to serve as a clearing house for this information in the future. Increasing WLCI capacity in this role, or alternatively creating regional or statewide monitoring committees composed of agency personnel, industry, and scientists who have strong backgrounds in monitoring, should be considered. Monitoring plans could be voluntarily submitted to these committees for review. While accounting for the site-specific nature and purposes of monitoring, monitoring definitions should be standardized to the greatest degree possible to allow more accurate comparisons of WDS impacts on a landscape or watershed scale. It is particularly important to establish baseline data on wildlife and habitat conditions prior to energy development in order to be able to monitor future impacts.

Cumulative impact analyses should be used in decision making.
Environmental Assessments and Environmental Impact Statements are applied on a project-by-project basis. Cumulative impacts analyses of identified resource concerns are required as part of the NEPA process. The cumulative impacts analysis of a particular resource involves identifying an appropriate analysis area that typically extends beyond the area of the project itself. The impacts of existing, ongoing, and reasonably foreseeable activities within that analysis area are evaluated in conjunction with the proposed project. Energy development results in long-term direct and indirect impacts on the landscape, and the additive effects of multiple projects in the same region could lead to population level impacts on wildlife, including exhausting the carrying capacity of unimpacted habitat. Cumulative impacts analyses should be fully considered in land management agency project planning and decision making.

Habitat mitigation and monitoring requirements should be based on desired ecological outcomes.
Governor Mead finalized a greater sage-grouse compensatory mitigation framework in 2016, which developed "debit" and "credit" criteria for sage-grouse mitigation. Many of the concepts outlined in this document could be used for the conservation of other species, as well. The policy follows U.S. Fish and Wildlife Service and Bureau of Land Management compensatory mitigation guidance. The compensatory mitigation system is built on

conservation durability, accounting for indirect impacts, assessing current credit condition, assessing risk of development on the credit, potential threats to the credits, as well as other risk and habitat stability factors. A key component of the policy is to ensure the mitigation benefits are in place prior to the impact occurring on the landscape and for at least as long as the impacts exists on the landscape.

Developing a statewide mitigation framework to reclaim or maintain key habitat and natural resources has been identified as an objective for Wyoming Governor's Matthew Mead's Action Plan Energy, Environment, and Economy (2013). The focus will be on the reclamation, rehabilitation and conservation efforts in the places that are most likely to be adversely impacted by development. Measurable documentation of acres maintained or improved as habitat for species of concern could be tracked on an annual basis by the Wyoming Game and Fish Department.

Additional research and coordination should occur to maximize the benefits of on- and offsite mitigation.
The effectiveness of reclamation and mitigation efforts should be reviewed. Offsite mitigation should be used only in addition to, not as a replacement for, onsite mitigation. Attention needs to be placed on further refining goals for mitigation, as well as associated monitoring, in order to evaluate the effectiveness of habitat mitigation and enhancement programs. Offsite mitigation planning needs to consider landscape-level, cumulative impacts. Connectivity, both in terms of animals that migrate seasonally as well as corridors between localized population segments, should be incorporated into mitigation planning. The Nature Conservancy's Development by Design (see Current Initiatives) has been applied to establish prioritization processes to rank proposed mitigation projects for the Jonah Interagency Office and Pinedale Anticline Project Offices.

Efforts should be made to review and consolidate recommendations both within and between agencies to minimize conflicting or unnecessary regulations.
Research should be conducted on mechanisms to allow federal and non-federal minerals (oil and gas) to co-mingle, while retaining the ability to account for each separately. This would reduce the need for duplicating infrastructure to transport these materials. Currently, BLM regulations do not allow federal and non-federal mineral to co-mingle in order to allow for independent accounting. Additionally, single-point source regulations designed to limit pollution can reduce the amount of directional drilling occurring at one drilling site. This results in the construction of multiple drill sites as well as associated roads and infrastructure to extract the same amount of oil and gas while not reducing overall pollution rates.

There should be greater follow-up and enforcement regarding meeting monitoring and stipulation regulations.
The BLM and Forest Service have responsibility for monitoring development stipulations within their jurisdictions. The Wyoming Oil and Gas Conservation Commission assumes this responsibility on private and state-owned lands. The pace of energy development can overwhelm both agencies and industry with the permitting process, leaving few resources available for monitoring and enforcement. The pace of permitting should be reviewed if development is proceeding so quickly as to preclude adequate monitoring, or if mitigation measures cannot be instituted. Alternatively, industry could contribute financial resources for third-party monitoring if agency resources are inadequate.

Monitoring should be based on RMP development thresholds and stated desired future outcomes in lease agreements or on agency/private landowner goals if on private or state owned land. Protocols should be developed by field investigation to determine critical elements to be monitored. A clearinghouse for monitoring requirements based upon lease/APD language could be developed. Future permitting should be based on past performance.

Review reclamation bonds annually and ensure that when leases are transferred they are sufficient relative to reclamation needs.
Governor Mead's 2013 Energy Strategy identified state bonding review as a key initiative. To date, this initiative has not been completed.

Continued efforts should be made to develop and implement technologies and techniques to minimize energy-development impacts on wildlife.
Current technologies that have been used to reduce energy development wildlife impacts include using smaller rigs, directional drilling, oak mats, and purpose-built rigs. Whenever possible, supporting infrastructure, including power transmission lines and pipelines, should be placed in already existing corridors to reduce the cumulative impacts to wildlife.

More training opportunities should be provided for wildlife biologists and natural resource agency personnel to enhance their understanding of energy development techniques and issues. Conversely, energy industry personnel should have more educational opportunities regarding wildlife and biological issues on which agency personnel often base their recommendations.

Evaluating/Monitoring Success

Trends in wildlife populations should be monitored to learn more about the impacts of energy development and to ensure specified mitigation goals are met.
Continued effort needs to be made to conduct research to understand the potential impacts of energy development on species and habitats where little information exists. New forms of development will require additional research. Results of the AWVED project (see Current Initiatives, page II – 2 – 13) will provide guidance as to which species are likely to be impacted by energy development and where additional research is needed.

The long-term effectiveness of reclamation and mitigation measures should be monitored.
Long-term studies should be established to evaluate and compare the effectiveness of various mitigation techniques. Efforts should be made to continually integrate monitoring data into adaptive management strategies, including making individual and compiled results available to industry and agencies to improve energy-development and mitigation techniques. Opportunities to enable agencies, conservation organizations, and energy companies to collaboratively interact and contribute data should be identified.

The University of Wyoming's Reclamation and Restoration Center (WRRC) has provided the state with expertise and support on various projects and efforts.

The location, rate, and extent of energy development should continue to be tracked on a statewide basis to assist in identifying cumulative impacts, evaluating the integrity of wildlife priority areas, and updating conservation plans.
The establishment of a centralized GIS database for biological and energy development information should assist in achieving this goal.

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Additional Resources

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State and Federal Energy Development Regulations

Wyoming Statewide Rules

The Wyoming Oil and Gas Conservation Commission (WOGCC) issues state-wide rules and regulations to govern the development of oil and gas in Wyoming. Current WOGCC rules and regulations can be accessed through the links below or through the *Rules/Statutes* page on the WOGCC's website (http://wogcc.state.wy.us/). These rules and regulations apply to the drilling and mining of private, state, and federally owned minerals. The intent of WOGCC rules and regulations are to prevent waste and to conserve mineral resources, as well as to protect human health and the environment. This is accomplished through designating extraction methods which are designed to avoid soil or water contamination at drilling or producing locations. Compliance with state rules does not relieve the owner or operator of the obligation to comply with applicable federal, local or other state permits or regulatory requirements.

National Environmental Policy Act

National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. Under NEPA, there are three steps that can occur regarding energy development projects: 1) scoping, 2) developing an Environmental Assessment (EA), 3) and/or developing an Environmental Impact Statement (EIS). The scoping notice identifies issues and concerns that will need to be analyzed in an EA or EIS. A written EA analyzes how a proposed federal action might affect the environment. If no significant effects are determined, the agency issues a finding of no significant impact (FONSI). The FONSI may address measures which an agency will take to reduce (mitigate) potentially significant impacts to an insignificant level. In some circumstances, an EA does not need to be done prior to doing an EIS. If the federal agency or the project proponent already suspects that the environmental consequences may be significant, the EA process can be bypassed and the process goes directly to developing an EIS. In these circumstances significant time and money is saved by bypassing the EA step. An EIS is a more detailed evaluation of the proposed action and alternatives that discusses the potentially significant effects and consequences. The public, other federal agencies and outside parties may provide input into the preparation of an EIS and then comment on the draft EIS when it is completed. If a federal agency anticipates that an undertaking may significantly impact the environment, or if a project is environmentally controversial, a federal agency may choose to prepare an EIS without having to first prepare an EA. Additional information on NEPA can be found at: https://www.epa.gov/nepa

National Environmental Policy Act (NEPA) – Categorical Exclusion Reviews

Categorical exclusions are "a category of actions which do not individually or cumulatively have a significant effect on the human environment … and for which, therefore, neither an environmental assessment nor an environmental impact statement is required." The Council on Environmental Quality (CEQ) developed the categorical exclusion process to decrease the paperwork and time associated with NEPA compliance. The categorical exclusions for Mineral Management Services (MMS) activities are listed in the MMS Manual.

The CEQ acknowledges that occasionally exceptions to a categorical exclusion may be needed. As a result, the CEQ requires all agencies to develop procedures to determine whether a normally excluded action may have a significant environmental effect. The Categorical Exclusion Review (CER) determines whether a proposal that is categorically excluded may meet any of the Department's extraordinary circumstances criteria.

Federal Mineral Leasing

The Bureau of Land Management manages the nation's publicly owned mineral estate, including its leasing, and is also the federal agency responsible for conducting NEPA analyses for the mineral leasing activities that the agency approves. The Wyoming BLM State Office and WGFD entered into a memorandum of understanding (MOU) in 1990 to guide the cooperative input and consideration of wildlife resource values on BLM lands. Appendix 5G of that MOU deals specifically with coordination and cooperation related to oil and gas development activities.

Consideration of environmentally sensitive areas and other resources are addressed in two ways within the BLM federal leasing program: "no leasing" and "leasing with restrictive stipulations." "No leasing" is prescribed for specific areas only through a congressional mandate or through the BLM planning process when a determination on a given land-use plan is made not to lease in a specific area.

To limit conflicts with the variety of resources encountered on federal lands, the Wyoming BLM state office has developed Lease Notices and four standard types of stipulations that can be attached to a lease. Notices and stipulations are attached as part of a lease when the environmental and planning record demonstrates a necessity for them. The notices and stipulations are in addition to the terms of the lease as printed on the lease form, and once attached, become an integral part of the lease. The stipulation format includes the categories of: 1) no surface occupancy (NSO), 2) timing or seasonal restrictions, 3) controlled surface use, and 4) special administrative stipulations. In all cases, definitive use of the stipulations will require identification of specific resource values to be protected.

A Controlled Surface Use (CSU) stipulation is applied, on all or portions of a lease, where use and occupancy is allowed (unless restricted by another stipulation), but identified resource values require special operational constraints that may alter the lease terms. These could include prohibiting certain types of activities and/or occupancy unless suitable mitigation can be determined and agreed upon by the BLM and the operator. The CSU is different from the NSO, which totally prohibits surface occupancy, and from timing stipulations, which limit when operations may occur.

Special administrative stipulations are those stipulations provided by another agency or organization, such as the US Forest Service or Bureau of Reclamation. They are used in situations where standard stipulations do not adequately address a specific concern, surface management plan, or an agency regulation or policy.

"Exceptions" can be applied on a case-by-case basis. Exceptions are one-time exemptions from lease stipulations for a specified portion of a leasehold and for a specified period of time. Existing stipulations continue to apply to all other sites and time periods within the leasehold. Exceptions are approved by the BLM Area Manager in coordination with the WGFD.

"Modifications" fundamentally change the provisions of a lease stipulation, either temporarily or for the period of the lease. A modification may, therefore, include an exemption from, or alteration to, a stipulated requirement. Depending on the specific modification, the stipulation may or may not apply to all other sites within the leasehold. Modifications are approved by the BLM Deputy State Director for Minerals and Lands with consultation from the WGFD.

The Federal Onshore Oil and Gas Leasing Reform Act (FOOGLRA) of 1987 further provides for a 30-day public review opportunity before approving or substantially changing terms of a lease or varying lease stipulations. The level and intensity of public involvement is usually based on specific circumstances.

Federal Land Management Agency Planning Documents

The BLM's umbrella planning document for general resource and land use management direction for an administrative area unit is the Resource Management Plan (RMP). The RMP provides management direction for the BLM's oil and gas leasing, exploration, and development process and specific direction for the application of stipulations to oil and gas leases. The RMP also provides direction for conditions of approval (COAs) that are intended to guide the exploration and development stages of oil and gas activities. Similarly, each National Forest and Grassland is governed by a management plan in accordance with the National Forest Management Act (NFMA) http://www.fs.fed.us/emc/nfma/index.htm. These plans set management, protection, and use goals and guidelines. Monitoring conditions on a forest or grassland ensures projects are done in accordance with plan direction, and determines effects that might require a change in management. The US Forest Service determines where and under what conditions oil and gas leasing can occur on National Forest lands. The BLM then determines whether or not NEPA requirements have been met before the BLM offers the Forest Service oil and gas leases for sale at auction.

Mineral Activity on Wyoming State Lands
The State Board of Land Commissioners through the Mineral Leasing Section of the Office of State Lands and Investments is responsible for establishing rules and regulations for lands owned by the state of Wyoming. The Mineral Leasing Section is also responsible for providing information to the public and private sectors concerning state mineral lease availability and individual lease status.

U.S. Environmental Protection Agency and Wyoming Department of Environmental Quality
The U.S. Environmental Protection Agency (EPA) is a federal agency whose mission is to protect human health and the environment through regulation, research, and outreach related to pollutants in the environment. The Wyoming Department of Environmental Quality (DEQ) is a state agency, not directly affiliated with the EPA, which answers to the Governor and Legislature of the State of Wyoming. DEQ develops and implements regulations and policies in response to federal guidelines and in regards to direction from the Legislature and the Governor. Many DEQ programs have been designed to meet the EPA's requirements, so that DEQ is delegated the authority to enforce many of the EPA's environmental programs. By maintaining delegation, DEQ keeps the management of environmental programs within the state, allowing the development of regulations and policy to better meet the specific needs of Wyoming. The EPA retains oversight of any DEQ programs that implement federal requirements. DEQ is responsible for enforcing state and federal environmental laws, including the Clean Air Act, Clean Water Act, National Pollutant Discharge Elimination System (NPDES), Environmental Quality Act, Resource Conservation and Recovery Act (RCRA), Superfund Amendments and Title III Reauthorization Act (SARA), and Federal Surface Mining Reclamation and Control Act.

Wind Energy Development
Wind projects constructed in Wyoming, which consist of 30 or more towers or which expand to include 30 or more towers, regardless of land ownership, require a permit from the Wyoming Industrial Siting Council (WISC). W.S. 35-12-110 (b) requires WGFD to provide information and recommendations to the WISC regarding the impacts of industrial facilities including wind projects subject to WISC jurisdiction and a specific recommendation as to whether the WISC should issue a permit.

Like oil and gas, NEPA also applies to the development of wind energy and associated infrastructure on federal lands. A POD is a plan of development for individual wind energy development projects. Energy companies seeking to develop a wind power project on BLM-administered lands are required to develop a project-specific POD that incorporates best management practices and other appropriate existing BLM mitigation and guidance conditions developed to minimize or reduce environmental effects to other resources. PODs typically include a site plan showing the locations of turbines, roads, power lines, other infrastructure, and additional areas of short and long-term disturbance. ROW authorization can apply additional mitigation measures to address site- and species-specific issues for individual projects related to but not included in a wind energy development POD. Examples include meteorological test towers, connecting transmission lines, and support and maintenance facilities.

Invasive Species

Clockwise from the top: Russian olive removal project in eastern Wyoming (Dustin Hill); Quagga mussels on boat propeller (Utah Division of Wildlife Resources); Fish infected with whirling disease (The Whirling Disease Initiative); Rusty crayfish (USGS); Canada thistle (Danny Dalton, Wyoming Pest Detection Program); Leafy spurge (Danny Dalton, Wyoming Pest Detection Program); Cheatgrass (Richard Old, www.xidservices.com).

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Background

An invasive species is a species that is: "1) non-native to the ecosystem under consideration and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health" (Executive Order 13112, Appendix 1, 1999). Invasive species can include both terrestrial and aquatic plants and animals, and even pathogens such as West Nile virus. Not all non-native species become invasive; many, including agricultural crops and game animals, support human livelihoods and quality of life. However, some non-native species have the potential to cause significant environmental damage.

Terrestrial invasive plants can reduce forage production for wildlife and livestock; diminish breeding, escape, and thermal cover for wildlife; alter hydrologic cycles; change fire regimes; increase sedimentation and erosion rates; and change nutrient cycles and soil properties (Wyoming State Weed Team 2003). Invasive aquatic species can further affect aesthetics, drainage for agriculture and forestry, commercial and sport fishing, drinking water quality, flood control, human and animal health, hydropower generation, irrigation, recreational boating, swimming, water conservation and transport, and land values (Rockwell 2003). In the U.S. alone, damage and losses from invasive species are estimated at approximately $120 billion annually (Pimentel et al. 2005).

Most invasive species have been introduced into this country from abroad. As a result, they often do not have natural control agents or competitors and thus have the potential to dominate the native habitats they occupy. An increase in international trade and travel has worsened the intentional and unintentional introduction of invasive species. Ships are a common pathway for the unintentional introduction of invasive species, whether they travel by clinging to hulls, wrapping on propellers, or traveling within ballast water, or as cargo. Passengers traveling by ship, airline, train, motor vehicle, or even on foot are also common means of transport. Intentional pathways include pet, aquarium, aquaculture, and horticulture trades. In Wyoming, roads serve as conduits to spread invasive species through the creation of disturbed areas and vehicle traffic. Weeds frequently blow off hay being transported along the interstate, rural, and public lands roads.

Invasive species are a major cause of wildlife extinctions worldwide. For example, globally, invasive species have been identified as at least contributing to 48–62% of fish extinctions (68% of North American fish extinctions), 50% of bird extinctions, and 48% of mammal extinctions (U.S. Environmental Protection Agency 2008). In the United States, as many as 49% of all threatened and endangered species are adversely impacted by invasive species to some degree (Wilcove et al. 1998).

Scope and Challenges of Invasive Species and Wildlife Conservation

Terrestrial

Invasive terrestrial plants including noxious weeds inhabit about 1.3 million acres (~ 2%) in Wyoming (Wyoming State Weed Team 2003). The importance and impact of a particular weed species often vary by watershed. Additionally, the attention given to an individual species can shift with changing conservation issues and priorities as well as with the occurrence of new species.

Invasive terrestrial plant species are typically well suited to quickly colonize bare ground and disturbed sites resulting from both human and natural causes (Sheley et al. 1999). This attribute contributes to invasive species being a principal component of, or compounding, other negative effects associated with habitat impacts such as rural subdivision, energy development, disruption of natural disturbance regimes, overgrazing, and off-road vehicle use.

Increasing levels of outdoor recreation aid the spread of invasive species which are commonly transported on vehicles, boats, and felt-soled fishing boots. Invasive weeds have been transported to alpine areas in hay for recreational horseback riding, although the required use of certified weed-free forage has reduced this problem in some areas.

Climate change and associated changes in atmospheric carbon dioxide levels, modified precipitation regimes, increased ambient temperatures, and altered nitrogen distribution is expected to intensify problems associated with invasive species. While some species are anticipated to experience range reductions, the ranges of others will expand. Additionally, climate change may result in new habitat types or conditions favorable to nonnative species (U.S. Environmental Protection Agency 2008). Climate change may also increase the frequency and intensity of natural disturbances; including fire and drought which could benefit those invasive species that are tolerant of changing hydrologic conditions and easily regenerate after wildfire (see Wyoming Leading Wildlife Conservation Challenges – Climate Change).

Tamarisk (commonly known as *saltcedar*), Russian olive, and cheatgrass (downy brome) may be the terrestrial invasive plant species with the greatest statewide recognition. Tamarisk was introduced into the U.S. from the Mediterranean region and likely escaped cultivation in the 1870s. It is an aggressive colonizer that often forms monotypic stands, outcompeting willows, cottonwoods, and other native riparian vegetation. It received its common name of *saltcedar* from the ability of the stems and leaves of mature plants to secrete salt. This salt forms a crust above and below ground that inhibits other plant growth (Sudbrock 1993). Tamarisk has a long tap root and is an enormous water consumer, which leads to its propensity to lower ground water levels, drying up springs and marshy areas. Additionally, large stands of tamarisk with extensive roots systems can contribute to flooding by choking stream beds (Rush 1994). Infestations often have a detrimental impact on wildlife; however some recent studies suggest that the effects of tamarisk invasion on wildlife vary depending on the ratio of tamarisk to native vegetation, wildlife taxa, and the quality and type of adjacent habitat (Shafroth et al. 2010). Although it provides some shelter, its foliage and flowers provide little food value for native wildlife species. (Shafroth et al 2005).

Problems associated with Russian olive are similar to those associated with tamarisk. Russian olive is a native plant from Eurasia that was introduced to many Great Plains and southwestern states in the early 1900s. The trees were extensively planted to provide windbreaks at first, and then federal conservation programs promoted their use for wildlife habitat among other uses. The Natural Resources Conservation Service (NRCS) continued to subsidize Russian olive seedlings for conservation plantings until the 1990s (Wyoming Game and Fish Department 2010 a). Currently, Russian olive is present in every western state, and occurs in most drainages across Wyoming except for portions in the far west and at higher elevations. In 2007, Wyoming joined other states (CO, CT, NM, and UT) with its listing of Russian olive as a noxious weed by the Wyoming Department of Agriculture. In addition, United States Congress passed the Saltcedar and Russian Olive Control Demonstration Act in 2006, which directs the Secretary of Interior to assess and develop programs to control these two plant species, and to provide a comprehensive scientific assessment of the distribution, abundance, and impacts of the two plant species (Shafroth et al. 2010).

Russian olives can out compete native riparian vegetation, interfere with natural plant succession and nutrient cycling, and tax water reserves. The spread and establishment of Russian olives has been accelerated by water development projects. Controlling, minimizing, or eliminating flushing flows and the formation of gravel bars is detrimental to the regeneration and establishment to native vegetation such as willows and cottonwoods, but has little effect on Russian olive or tamarisk reproduction. Cottonwood declines have been associated with flow alterations on the North Platte (Miller et al.

1995) and Bighorn (Akashi 1988, Bray 1996) Rivers in Wyoming. Although Russian olives can provide food and cover, they typically replace native vegetation favored by many wildlife species. Cottonwoods in particular are important to birds by providing structural diversity for foraging and nesting as well as suitable dead and dying trees for cavity nesters. Some studies have found that Russian olives harbor fewer bird species than native vegetation (Brown 1990, Knopf and Olson 1984), but more recent research generally finds that some species prefer habitat created by Russian olives and some do not, depending in part on the density of the nonnative trees and the surrounding habitat (Shafroth et al. 2010).

Cheatgrass is an annual brome grass from Eurasia that has the capacity to reduce the productivity of desirable forage plants as well as decrease plant species diversity. Cheatgrass has become a particular problem in large areas within the Great Basin, including western Utah, Nevada, and southern Idaho. High densities of cheatgrass increase fire severity by increasing fine fuel loads and shorten the time period between fires due to rapid regrowth. This altered fire regime can change entire plant communities. In some locations cheatgrass-fueled wildfires have converted native grasses and sagebrush habitats to cheatgrass-dominated landscapes. Of special concern are the loss of crucial sage-grouse habitat and other wildlife habitat along with secondary weed invasions from species such as rush skeletonweed and Medusa-head wild rye (Smith and Enloe 2006). Cheatgrass is adapted to surviving continuous years of drought and may grow vigorously when water becomes available. Its adaptation to fire and drought tolerance may make it well suited to thrive in a climate that is warmer and has more variability in precipitation which is commonly predicted for Wyoming in many climate change models (Bradley et al. 2008).

Aquatic

Aquatic invasive species (AIS), including fish, amphibians, mollusks, crustaceans, plants, and pathogens, are currently present in Wyoming. While a number of species cause problems and need to be prevented and controlled, the most significant threat to Wyoming is from zebra and quagga mussels (Wyoming Game and Fish Department 2009).

Zebra and quagga mussels have not been documented in Wyoming's waters, but as of 2008, instances of zebra and quagga mussels have occurred in Colorado, Utah, Nebraska, Kansas, Nevada, Arizona, and California (Benson 2009b, Benson 2009c). Zebra and quagga mussels have high reproductive potentials and spread rapidly. They negatively impact water delivery systems and power generation facilities by clogging pipes, pumps, turbines, and filtration systems. They have harmful impacts on fisheries by removing plankton from the water, reducing the productivity of waters. There are high economic and social costs once these mussels become established, including decreased boating and angling and increased water delivery and electricity costs (Wyoming Game and Fish Department 2009). Both species naturally disperse through water currents, but human transport via recreational watercrafts trailered from infested waters is the primary vector for movement to new aquatic systems (O'Neill 1996). As a headwater state, Wyoming's control activities are important in preventing the spread of these organisms and other invasive species to downstream locations.

Wyoming will likely continue to experience energy development, rural subdivision, and recreational use in the future. Additionally, climate change may alter existing habitats as well as create new ones favorable for invasive species. New species are likely to arrive as world trade and travel becomes more commonplace. All these factors suggest that threats from invasive species to Wyoming's native wildlife will increase in the future and continue to present new challenges to wildlife and natural resource managers.

Current Initiatives to Control Invasive Species

Federal

Most federal land management agencies have invasive species programs. Invasive species management is addressed in US Forest Service and Bureau of Land Management Forest and Resource Management Plans. Executive Order 13112, issued in 1999, mandated the establishment of the National Invasive Species Council to help ensure a coordinated, cost-efficient, and effective federal response to invasive species. Part of the Council's work included the creation of an Early Detection and Rapid Response (EDRR) strategy to prevent the establishment of invasive species.

State and Local

Twenty-three Weed and Pest Control Districts have been established in Wyoming as a result of the Wyoming Weed and Pest Control Act of 1973. Weed and Pest Control Districts provide cost-sharing assistance to landowners to eradicate or slow the spread of invasive species. Districts also have crews who treat weed outbreaks along county, state, and federal roads and in the backcountry. Public and professional training and education on weed identification, treatment, and prevention are important components of their work. Weed and Pest Control Districts are funded by mill levies on property.

Wyoming's Weed and Pest Council is comprised of one representative from each Weed and Pest District. The purpose of the council is to encourage the exchange of information and cooperation between districts and other agencies relative to the control of weeds and pests. The council also plays an educational role for the public and professionals in serving as a clearing house for information on weeds and invasive species. When needed, the Weed and Pest Council sponsors appropriate weed and pest laws. It receives funding from a pesticide registration fee, US Forest Service and state private forestry grants, the Wyoming Department of Transportation, and the Wyoming Office of State Lands and Investments for weed control on state highways and state lands, respectively. The Council has previously received a bi-annual legislative grant from special management program funds for leafy spurge control.

Growing problems with invasive species and increasing numbers of private individuals and professionals with interests or responsibilities associated with weed control have led to the formation of the Wyoming Weed Management Association (WWMA) in 2006. The WWMA's purpose is to promote collaboration and education on weed management issues among interested parties.

Wyoming has a list of Designated Noxious Weeds (S. 11-5-102 (a)(xi)) and Prohibited Noxious Weeds W.S. (11-12-104). There are currently 26 species on this list, the composition of which usually determines how resources and money are allocated for weed management at the county and state level. Species are added to the list through a joint resolution by the Weed and Pest Council and the Wyoming Board of Agriculture. The process is initiated at the request of one or more Weed and Pest Control Districts. Public hearings are held at the county level and by the Board of Agriculture. Wyoming counties often have independent ranked lists of weed species which guide the allocation of local resources.

Cooperative efforts comprised of multiple agencies and/or counties are becoming increasingly common for invasive species control. Examples include the North Platte Weed Initiative, the Big Horn Exotic Plant Group, Greater Yellowstone Coordinating Committee Invasive Species Program, and the Wyoming Green River Basin Healthy Lands Initiative. Coordinated Resource Management (CRM) teams have used a collaborative, stakeholder-based model to address land management issues in Wyoming since 1975. Currently, there are approximately 40 CRM teams in Wyoming, most of which have a weed management component. The CRM process works well with the Weed and Pest's Weed

Management Area designation. CRMs help to identify the ecological needs of the area, to address monitoring and any needed reclamation to ensure success of the control method being used, and to keep control of future invader through good management practices.

The Wyoming Game and Fish Department (WGFD) has actively participated on a statewide basis with almost all 40 CRMs and additional smaller groups which deal with invasive species within specific watersheds, basins, or sub-basins. WGFD habitat biologists and land managers are well trained on invasive species issues and provide input for coordinated management efforts. The WGFD has also substantially increased invasive species control efforts on department-managed lands during the last five years.

Presently, the Wyoming Weed and Pest Council is tracking of the location and spread of terrestrial invasive species beyond county-level presence and absence through a coordinated effort lead by their GIS/Mapping committee. Data from the effort is housed within the Fremont County Weed and Pest Control District. There is; however, no annual reporting requirements on statewide weed and pest activities. All though the mapping effort is coordinated and centralized, there are data-sharing limitations, particularly for data about invasive species located on private lands, as approval from the landowner is required to share this information. The Bureau of Land Management, National Park Service, and US Forest Service have programs to map and track invasive species on their lands. However their data is not readily shared nor do their mapping standards always parallel the district's standards. The WGFD has taken several actions to prevent the spread of AIS across state borders into Wyoming and within Wyoming's borders. The WGFD has used funds from the Wyoming Legislature to renovate hatcheries to effectively manage and control the spread of whirling disease (Beers1999). Additional efforts include regulations to combat illegal fish introductions, chemical removal of rusty crayfish, Hazard Analysis and Critical Control Point efforts for department activities, and education and outreach (Wyoming Game and Fish Department 2009). The Department has also been involved in regional and national coordination on AIS issues. The best source for current information on AIS in Wyoming and other states is the Nonindigenous Aquatic Species database housed by the USGS (http://nas.er.usgs.gov/).

The Wyoming AIS Management Plan was developed by the WGFD in response to the invasive species threats that are currently impacting Wyoming's waters and the imminent threats that are afflicting the waters of neighboring states. The management plan is meant to help coordinate all levels of efforts to prevent, control, monitor, and, whenever possible, eradicate AIS populations that are threatening Wyoming's waters. Specific plan objectives to achieve this goal are: 1. To coordinate and implement a comprehensive management program, 2. To prevent the introduction of new AIS into Wyoming, 3. To detect, monitor, and eradicate AIS in Wyoming, 4. To control and eradicate established AIS that have significant impacts on Wyoming waters, 5. To educate resource user groups about the risks and impacts of AIS and how to reduce their harmful impacts, and 6. To support research on AIS in Wyoming and develop efficient systems to disseminate information to research and management communities (Wyoming Game and Fish Department 2010 b).

In order to achieve the aforementioned goals, the WGFD is undertaking extensive efforts to inspect and decontaminate watercrafts that are being launched on Wyoming's waters, as well as monitor those waters for AIS. It is also carrying out public outreach and awareness campaigns including educating boaters on how to perform an AIS self-check on their watercraft and evaluating potential control methods. The management strategies that are included in the AIS Management Plan are proactive and realistic and are intended to be implemented in coordination with federal, state, tribal, and local entities. To date, WGFD outreach efforts have been intensive with the hope that generating public awareness will be the most effective way to prevent additional AIS from becoming established in Wyoming's waters.

The plan ranks AIS into one of four priority classes, which indicate varying levels of urgency regarding addressing these threats. Priority Class 1 and 2 species are the main focus of the management plan, with special focus on the mussels that are currently impacting the waterways of neighboring states and are easily transported on watercrafts to other bodies of water. The AIS Management Plan is designed to be adaptable in order to address future AIS threats and to coordinate with other agency/organization programs that are already established to address this issue. In November 2011, Wyoming's AIS Management Plan was approved by the national Aquatic Nuisance Species Task Force, making it eligible for funding through the National Invasive Species Act.

The Wyoming Aquatic Invasive Species Act was passed in 2010 by the Wyoming Legislature. WGFD has a permanent AIS coordinator position to facilitate the development, coordination, and implementation of the AIS program.

Current Challenges for Effectively Controlling Invasive Species

Need for greater coordination for invasive species control efforts at the regional and state level.
While coordination on invasive species control activities is effective at the county level, greater coordination is needed between state and federal agencies. The Wyoming Governors Task Force on Forests recommendation 4.2 identified the need to expand multi-jurisdictional cooperation for mapping, monitoring, and controlling non-native invasive species (Governor's Task Force on Forests 2015). Areas where coordination can be improved include the sharing of goals and priorities; coordinating educational initiatives; and enhancing understanding of individual agency regulations, policies, and guidelines. Federal land management agencies are required to follow state directives; however, at times there is insufficient coordination with federal land management agencies on invasive species issues to achieve this requirement.

Lack of the necessary consistent, multi-year funding required for establishing and implementing effective invasive species control efforts.
Most invasive species funding in Wyoming is allocated annually which makes it difficult to develop long-term programs needed for the effective treatment and monitoring of invasive species. Additionally, funds are often allocated based upon acres treated and less directed toward efforts preventing the spread of invasive species or by the success of past control efforts. Anticipated federal and state budget cuts, due to weak economies and federal deficits, will likely reduce funding for invasive species control in the near future.

Increasing subdivision.
Soil disturbance from construction, the year-round grazing of horses and other hobby livestock, and the use of nonnative plants as ornamentals can facilitate the establishment of invasive species (Maestas et al. 2002). As the number of property owners increases, it becomes more likely that at least some will not adopt invasive species control efforts. This in turn creates source areas for future infestation making it more difficult for surrounding neighbors to control weeds. One study of 162 ranchers in the Sierra Nevada foothills of California found that 25% of interviewees reported that neighbors with weed sources on their properties reduced their investment in control efforts, because of the cost associated with continual reinvasion (Epanchin-Niell et al. 2010).

Inflexible or inconsistent monitoring and enforcement of existing invasive species regulations.
Monitoring and enforcement of invasive species management regulations and contracts on

public and private lands are inconsistently enforced. These regulations often pertain to surface disturbance from sources such as road building.

Inadequate statutory authority or invasive species regulations.
Through the Aquatic Invasive Species Act, the WGFD received the statutory authority to inspect and decontaminate boats that are being launched on Wyoming waters. However, there is not adequate control regarding the importation and sale of plants that are not on the list of Designated Noxious Weeds. Stronger education, recognition, and regulatory response to the importation and sale of plants recognized as an invasive species is encouraged

Need to increase public and professional knowledge about invasive species and invasive species management.
Knowledge levels about invasive species control and monitoring techniques vary considerably among land management and wildlife agency employees. The same is true for construction personnel, including those associated within the oil, gas, and wind development industries, who are responsible for preventing the spread of invasive species. Frequent employee turnover can diminish local knowledge, momentum, and follow-through for invasive species management programs.

In addition to educating land management and natural resource professionals, there is a need to increase invasive species knowledge levels among suburban residents and those engaging in outdoor recreation. Increasing awareness about the impacts of invasive species is necessary to encourage activities to limit the spread of invasive species and to build public support for control efforts. It is often difficult to get the public to attend workshops or other types of training. In addition to increasing general awareness, educational efforts should include information on where to get further technical assistance on controlling invasive species.

Difficulties in keeping pace with the increasing numbers of invasive species as well as the intensification of the causes accelerating their spread.
Control efforts are not growing at the rate necessary to meet the challenges posed by the increasing numbers of invasive species, greater development pressures, higher levels of outdoor recreation and international trade, and mounting influences from climate change. Frequently, there is only time and money for treatment, and little attention is directed toward monitoring or subsequent efforts to re-establish native species.

Recommended Conservation Actions

Establish a statewide inter-agency working group to coordinate invasive species control efforts.
A statewide inter-agency invasive species working group should be established to facilitate coordination among invasive species control efforts. Responsibilities of the working group could encompass serving as a clearing house for information about invasive species including current treatment efforts and their level of success, increasing awareness about technical and financial assistance available for invasive species management, identifying common conservation goals among agencies, and coordinating educational efforts. Coordinating activities, especially for educational efforts, can reduce costs for individual organizations. The Wyoming State Weed Team, which created Wyoming's Weed Management Strategic Plan, has expressed interest in assuming some of these responsibilities.

Increase consistent, long-term funding for invasive species control efforts.
To effectively control invasive species, funding should be multi-year and consistent. This would enable not only adequate treatments, but also the necessary follow-through including post-treatment monitoring and the re-establishment of desired species. Invasive species funds should be line items in federal and

state agency budgets and not subject to annual appropriations. Pesticide registration fees should continue to be directed toward invasive species management. The Wyoming Legislature provided for the use of pesticide registration fees to be used for special projects through a grant process. This enabled the Weed and Pest Districts to utilize a source of funds for targeted invasive species management. Grant-writing training should be provided to weed management coordinators to enhance funding opportunities.

Federal funding available to implement State AIS Plans through the USFWS Aquatic Nuisance Species Task Force should be increased. This funding is currently available through the National Invasive Species Act of 1996, but funds are limited to around $30,000 annually for each state with an approved AIS plan.

Better prioritization systems should be established for the allocation of invasive species funding.
Invasive species funding efforts are not always consistent within or between organizations. Additionally, grants are often not allocated according to need or treatment effectiveness. Invasive species control efforts should be focused on the watershed/basin level, and where appropriate, treatment should begin at the top of the watershed to ensure invasive species are not re-established from upstream sources in treated areas. Efforts should be made to involve multiple landowners in coordinated, watershed-level invasive species management plans.

Unify and increase invasive species educational efforts.
The Wyoming Governors Task Force on Forests recommendation 4.1 identifies the need for a statewide plan for public education on the threat of non-native species. Such a plan would facilitate coordination among federal, state, and local governments and funding mechanism to prevent, mitigate, and manage non-native species (Governor's Task Force on Forests, 2015).

Education material needs to be provided at points of entry including road accesses to public lands; trailheads for off-road vehicles, hiking, and horseback riding; walk-in fishing and hunting areas; boat launches; and visitor information centers for tourists. The number and type of educational opportunities should be increased for developers and contractors who are required to treat invasive species, or who have an impact on their ability to spread. General invasive species awareness should increase among land managers and wildlife personnel, including increasing the number and diversity of employees attending trainings. Educational efforts should be designed for specific audiences with regard to how the group best receives and applies information.

Educational programs should be working cohesively to ensure a broad spectrum of the public is reached. A unified message would also be cost-effective, by minimizing the amount of time and effort needed to create individual messages.

Increase Early Detection and Rapid Response (EDRR) capabilities.
Funding should be provided for the creation of an invasive species EDRR program in Wyoming. Reducing the spread of invasive species is less expensive and more effective than control efforts after the species is established. Projected costs for a Wyoming EDRR program are $3 million and $2 million annually for terrestrial and aquatic species, respectively. EDRR funding should be accompanied by increased coordination between the Weed and Pest Council, WGFD, and all other state and federal agencies for both terrestrial and aquatic species.

Coordinate the development of consistent invasive species monitoring protocols among local, state, and federal agencies.
Different land management and wildlife agencies presently use different methods to monitor the spread of invasive species and the effectiveness of control techniques. This lack of

consistency makes quantifying and compiling data from different agencies on a regional or statewide basis difficult or impossible. The incorporation of basic protocols with a limited number of standardized descriptive fields into the monitoring protocols of each agency or organization would facilitate data sharing and enhance future invasive species control efforts. Such standardization of basic nomenclature, including units and rating, could facilitate data sharing without limiting each organization in pursuing its individual mission and monitoring needs.

Evaluating/monitoring Success

Increased attention should be given to monitoring the effectiveness of control efforts.
The level of invasive species monitoring among agencies and landowners varies according to funding, time availability, and the priority placed upon monitoring. Currently, federal land management agencies have little financial or personnel capacity to establish comprehensive invasive species monitoring programs. Demands to address immediate treatment needs and respond to public requests prevent Weed and Pest Control Districts from putting significant resources into monitoring. However, only through monitoring can the cost effectiveness of treatments be evaluated and treatment techniques improved. The cost of monitoring programs can be reduced through multi-organizational cooperative efforts.

Monitoring efforts should be designed to evaluate habitat goals rather than just the success of killing targeted species.
Invasive species should not be monitored in isolation, but as part of overall integrated habitat plans. Current monitoring often examines only the effectiveness of treatments. Which species replace treated invasive species is equally as important as both evaluating the success of eliminating the targeted plant or animal and equating that change to impact on the habitat, positive or negative. The success of efforts to prevent the spread of invasive species should also be monitored and quantified.

Greater attention should be placed on monitoring the long-term effects of invasive species management activities on wildlife.
Many past invasive species monitoring efforts have largely focused on evaluating changes in forage production for livestock. When possible, monitoring efforts should include components to determine benefits to wildlife.

It is important that monitoring plans are tailored to the resources level, expertise, and degree of interest of the intended user.
No monitoring technique is effective if it is not actively applied. Invasive species monitoring techniques should be customized not only for the specific species, but also for the intended monitoring personnel. SamplePoint monitoring, created by USDA Agriculture Research Services, is an easy, quick, and effective monitoring method without the need for extensive expertise or training. Free SamplePoint Software can be downloaded at http://www.samplepoint.org/. The University of Wyoming Cooperative Extension Service and Society for Range Management make available terrestrial invasive plant species monitoring protocols. The WGFD developed AIS monitoring protocols in 2010 as part of its Wyoming AIS Plan.

The following individuals reviewed or contributed information to the Invasive Species section of the SWAP:

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Additional Resources

Bureau of Land Management – Wyoming State Office
5353 Yellowstone Road,
Cheyenne WY 82009
PO Box 1828
Cheyenne, WY 82003-1828
Phone: (307) 775-6256
http://www.blm.gov/wy/st/en.html

Center for Invasive Plant Management
Montana State University, Dept. LRES
333 Leon Johnson Hall
PO Box 173120
Bozeman, MT 59717-3120
Phone: (406) 994-5557
Email: weedcenter@montana.edu

Nonindigenous Aquatic Species Database
http://nas.er.usgs.gov/

University of Wyoming Cooperative Extension Service
Dept 3354
100 E. University Avenue
Laramie, WY 82071
Phone: (307) 766-5124

U.S. Forest Service R2/R4
Wyoming Capitol City Coordinator
Herschler Building 3 West, Room 3603
122 W. 25th St.
Cheyenne, WY 82002-0600
Phone: (307) 777-60870

USDA Natural Resource Conservation Service
Exotic Plant Database
http://plants.usda.gov/java/noxiousDriver

Wyoming Association of Conservation Districts
517 E. 19th Street
Cheyenne, WY 82001
Phone: (307) 632-5716
http://www.conservewy.com/index.htm

Wyoming Cooperative Agricultural Pest Survey (CAPS) / Pest Detection Program
University of Wyoming
Renewable Resources
Department 3354
1000 E University Avenue
Laramie, WY 82071
Phone: (307) 766-5278
http://www.uwyo.edu/capsweb/

Wyoming Game and Fish Department
5400 Bishop Boulevard
Cheyenne, WY 82006
Fish Division
Phone: (307) 777-4559
Aquatic Invasive Species hotline: 1-877-WGFD-AIS
Terrestrial Habitat Division
Phone: (307) 777-4565

Wyoming Natural Diversity Database
1000 E. University Ave.
Dept. 3381
2nd Floor, Wyoming Hall
Laramie, WY 82071
Phone: (307) 766-3023
http://www.uwyo.edu/wyndd/

Wyoming Weed and Pest Control Districts
http://www.wyoweed.org/about/district-offices

Wyoming Weed and Pest Coordinator
Wyoming Department of Agriculture
1510 E. 5th Street
Cheyenne, WY 82002
Phone: (307) 777-6585

Wyoming Weed Council
http://www.wyoweed.org/

Climate Change

Clockwise from the top left: Sudden Aspen Decline (SAD) in an aspen stand (U.S. Forest Service). Mountain pine beetle between Dubois and Grand Teton National Park (National Parks Traveler). Wood River near Meteetsee (WGFD). Greyrocks Reservoir during the height of the recent drought (WGFD).

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Background

Climate is a compilation of many meteorological features occurring over a long period of time. Primary elements include temperature, humidity, atmospheric pressure, air flow, and precipitation. "Weather" refers to short-term variation in these elements (i.e., two weeks or less), while "climate" refers to these dynamics over months, years, decades, centuries, and longer (NOAA 2008). Climate is controlled by many factors. It is influenced by Earth's orbit and tilt, which determine interannual changes such as the seasons. Latitude, elevation, terrain, ground cover, and presence or absence of water bodies also impact climate. These factors may affect atmospheric composition, temperature, precipitation patterns, and the many other elements mentioned previously. Climate is also affected by variables such as dust, aerosols, solar output and absorption, and concentrations of greenhouse gases in the atmosphere, namely water vapor, carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

Paleoclimatology, the study of ancient climates using proxy climate records (e.g., tree rings, ice cores, sediment cores), demonstrates that climate varies naturally over long periods of time. Climate is subject to natural variability from decade to decade primarily as a result of cyclical phenomena such as El Niño-Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), and North Atlantic Oscillation (NAO), which highlights the importance of long-term data when considering anthropogenic, or human-influenced, impacts to the climate system (Wiens and Bachelet 2009). The study of climate in the 20th century adds to scientific data pertaining to climate dating back thousands of years, painting a historical picture that shows both the warming and cooling of Earth's surface temperatures, as well as various drought and pluvial periods. Simply stated, historical records indicate that Earth's climate is variable and changes over time. Any scientifically recognizable, long-term variability in the aforementioned climatic elements (e.g., temperature, precipitation) is described as "climate change."

The Intergovernmental Panel on Climate Change (IPCC) was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 as the leading body for the review and assessment of worldwide scientific, technical, and socio-economic information on climate change. This scientific body *does not* perform research or monitor the earth's climate. The IPCC is charged with reviewing voluntary scientific contributions in the field of climate change and translating and conveying to the public the presently documented and potential future consequences of this global phenomenon.

Scope and Challenges of Climate Change and Wildlife Conservation and Management

Global to Local

While climate change is a global phenomenon with broad-scale ramifications at the global level, the ecological impacts are more readily observed, experienced, and addressed at the local level. The western United States has a more diverse landscape with climate variations that are difficult to model on a fine scale, areas that are remote and inaccessible for climate research and monitoring, and a patchwork of publicly and privately owned land that influences management strategies and policy making (Joyce et al. 2007). Wyoming is a unique mixture of mountain and plains landscapes, causing the state's climate to be varied from east to west and north to south. Wyoming is also faced with several unique challenges relating both directly and indirectly to climate and climate change.

According to paleoclimatic records dating back thousands of years, drought—a period of unusually low precipitation—is a defining feature of Wyoming's climate (Gray and Andersen 2009). Examination of western climates over centuries, which is established primarily by lake sediments, tree ring cores, and packrat middens (McWethy et al. 2010), demonstrates that severe drought is a natural part of Wyoming's climate (Gray and Andersen 2009). However, the baseline for state climate is established using records of climate variability throughout the past century (Gray and Andersen 2009). Most importantly, climate records over the past 30 years are most often used to establish resource management practices. A longer historical record indicates that the 20th century was an unusually wet time period in Wyoming relative to the past several millennia (Gray and Andersen 2009).

In addition to frequent drought, Wyoming is also challenged by the regional semi-arid climate. In other words, even in non-drought periods Wyoming is a rather dry area. Wyoming is the fifth driest state in the U.S.—over 70% of the state receives less than 16 inches of precipitation annually (Gray and Andersen 2009, Water Resources Data System undated). The state also relies almost exclusively on mountain snowpack as its major water source, with 70–80% of precipitation arriving as snow (Hays 2008). A majority of the snowpack is concentrated in a relatively small area (Gray and Andersen 2009), namely the higher elevations in the northwestern and southeastern mountain ranges. Ninety percent of Wyoming's runoff is snowmelt from these areas (Hays 2008). Wyoming is clearly a headwaters state, as its mountains form the headwaters of many major rivers, including the Snake-Columbia, Green-Colorado, Yellowstone-Missouri, and Platte systems (Gray and Andersen 2009). Consequently, water that originates within the state's political boundaries is allocated to downstream states, which means that Wyoming has important water-management responsibilities and also that water availability in this state has the potential to significantly impact other states.

Warming has shifted the periodicity and intensity of snowfall and subsequent runoff in much of North America (Mote et al. 2005, Regonda et al. 2005, Stewart et al. 2005, Wilcox 2010). April 1st snowpack in western watersheds has decreased between the middle of the 20th century and the end of the century (Joyce et al. 2007). The hydrological impacts of potential warmer surface temperatures and subsequently changing snow regimes in areas of high elevation are vast and may have countless secondary implications over time. Snowpack melt will occur earlier and, consequently spring runoff will come earlier and occur faster (Backlund et al. 2008, Wilcox 2010, Gray and Andersen 2009). As a result, late-season water flows will decrease (Joyce et al. 2007), which could exacerbate drought stress and contribute to increasing water temperatures (Wilcox 2010, The National Academies 2009). Overall warmer temperatures will likely lead to increased water loss due to evaporation and plant water use and decreased water yield to lakes, streams, and wetlands (Hoerling and Eischeid 2007).

Warmer winter temperatures might also cause seasonal precipitation to fall as rain instead of snow, subsequently decreasing annual snowpack and inhibiting the recharge of ground water reservoirs (Field et al. 2007). In the western mountain region of North America, the amount of annual precipitation in the form of rain that would normally fall as snow has been significantly increasing since the middle of the 20th century (Knowles et al. 2006), and spring and summer snow cover has been decreasing (Groisman et al. 2004). The West will become more vulnerable to shifts from snow to rain if winter temperatures continue to increase (Joyce et al. 2007). Warmer surface temperatures also will likely intensify drought events, much like those on historical record (Gray and Andersen 2009). Even a small increase in average temperatures with no decrease in annual precipitation would greatly impact Wyoming's water resources (Gray and Andersen 2009). The increase in water evaporation resulting from warmer temperatures would likely offset any increase in total precipitation (Joyce et al. 2000); it would also exacerbate the drought effects of decreasing amounts of total precipitation (Stonefelt et al. 2000, Pulwarty et al. 2005). In other words, conditions that currently define drought could become more of the norm in a future climate for Wyoming (Hoerling and Eischeid 2007, Seager et al. 2007).

Water and drought are a challenge for Wyoming regardless of climate change. Future projections for the western U.S. depict an increasingly warm and consequently drier climate that would alter regional and local hydrology and further strain limited water resources. Wyoming's resource managers, who are already familiar with drought planning and allocating scarce water resources for multiple uses and users, will continue to deal with these challenges in perpetuity. Good water management and planning are strong policies for the state of Wyoming under any realistic climatic scenario, and current projections of a drier climate emphasize this point.

Potential Impacts of Climate Change on Terrestrial and Aquatic Species

Species have evolved according to certain regional and local climate norms and much of their individual phenology and range is directly influenced by climate (Walther et al. 2002, Parmesan and Yohe 2003, Root et al. 2003, Parmesan and Galbraith 2004). Species respond to environmental change based on habitat needs, competitive ability, and physiological tolerances (Manley 2008). Climate change has the potential to alter species' fundamental interactions with other species, organisms, and the physical environment, which could lead to a cascade of impacts throughout the entire ecosystem (The National Academies 2009). The effects of climate change will impact both Species of Greatest Conservation Need (SGCN) and species that are not classified in this category (non-SGCN), including many invertebrates, plants, fungi, and microbes that are typically not directly addressed by state agencies.

Phenology[1]

Many species operate on seasonal cues that are directly related to climate and so changes in climate may lead to shifts in the phenologic trends of some species, impacting breeding and migration patterns and the timing of germination or flowering of plants (Parmesan 2006, Root et al. 2003). The onset of spring, as measured by the timing of a variety of natural phenomena, has been occurring earlier since the 1960s (Walther et al. 2002), which in turn has been impacting some species' observable climate-sensitive behaviors such as breeding, hibernation, migration, productivity, and range (Joyce et al. 2007). Species movement patterns may change according to the duration of the seasons, food availability, and altered migratory routes (Backlund et al. 2008). Migratory species may begin arriving at seasonal and transitional feeding grounds earlier and leaving later in reaction to climate change, or continue arriving and leaving on time even though climate has altered the seasonal processes of stop-over and breeding grounds (Visser and Both 2005).

Not all species are expected to alter their behavior in response to changing climate factors in the same way or at the same rate (Visser and Both 2005, Visser et al. 2004), and there is no guarantee that species responses will be synchronized to the responses of their forage resources. Such mistiming could have significant impacts on the structure of the ecosystem and the relationships of the species within that system. Changing species relationships will have a more significant impact on ecosystem structure and function than changes to any one particular species (Harrington et al. 1999, Visser and Both 2005).

Abundance and Biodiversity

The mis-timing of specific species' behaviors and forage resources to climate change and subsequent impacts to species relationships

[1] Phenology is the study of plant and animal life-cycle events that are influenced by variations in climate on an annual or interannual timescale. See Cayan et al. 2001 and Inouye et al. 2000 in the Literature Cited section for specific examples of studies that have documented phenologic changes in species in the western U.S.

such as competition and pollination could result in complex changes to population sizes and densities. For instance, population size may decline if breeding is mis-timed with a seasonal food source that peaks at a different time than historically observed, but may increase if forage is available earlier and lasts longer. More directly, populations and species may be affected by changing climate extremes. Changes in species abundance can lead to shifts in community make-up, changing interactions among species and the environment, and the emergence of new, novel communities and species interactions (Walther et al. 2002). Overall biodiversity may be altered by changing climate conditions as some species manage to adapt, some species move, and some become extirpated or extinct.

Genetic Diversity and Morphology

Climate change may also impact genetic diversity and species' morphology (Root et al. 2003). Genetic diversity fluctuates with population size and connectivity, and for many species the transition to a warmer and drier environment will translate to a rapid fragmentation of suitable habitat. Habitat fragmentation and landscapes that are increasingly being altered by human activities severely hinder species mobility and dispersal capacity (Pitelka and The Plant Migration Working Group 1997). Furthermore, warmer and drier conditions may select for individuals with smaller body sizes or other morphological adaptations, eventually resulting in populations with substantially different physical or physiological characteristics than today (Koopman 2008, Root et al. 2003).

Range

Not all species have the same level of plasticity in the face of environmental change, and many may not evolve quickly enough to adapt to changing climate conditions in situ (Parmesan 2006). Some species may shift their range in order to track the physical and biological conditions to which they are already adapted (Root et al. 2003). Climate change may cause species' ranges to expand, contract, or fragment (Ruggiero et al. 2008, Koopman 2008). Warming temperatures are expected to result in a general movement of species' ranges up in both elevation and latitude as a result of physiological tolerances and/or specific habitat needs. Populations of species currently persisting only at high elevations may fragment, forming small isolated populations on mountaintop islands. For example, some low-elevation pika (Ochotona princeps) populations that have been studied in the Great Basin have reportedly gone extinct since the 1930s, while populations inhabiting higher elevations remain intact (Beever et al. 2003, Parmesan and Galbraith 2004).

Similarly, warming water temperatures may drive cold- and cool-water fish species to new ranges or lead to local extirpation or extinction, while high-elevation fisheries may become more productive as temperatures warm. Ranges of cold-water species may contract, while species that are tolerant of warmer water temperatures may continue to expand their range (Stefan et al. 2001). The range of some plant species may also be affected by climate change, and vegetation redistributions may occur as a result of climate factors such as temperature tolerances, water limitations, pollinator interactions, and seed dispersal ability.

Both native terrestrial and aquatic species may increasingly be impacted by nonnative species that cross political boundaries in an effort to disperse and capitalize on opportunities for range expansion resulting from the decline of native species (Walther et al. 2002). Invasive species may contribute to the loss of biodiversity, changes in the abundance and distribution of native species, and alteration of species community structure, and may even cause local population extinctions (Joyce et al. 2000) (see Wyoming Leading Wildlife Conservation Challenges – Invasive Species). Some species will be successful in fulfilling habitat needs in more favorable climate and some, which are less mobile or adaptable, will not (Midgley et al. 2002).

Species with specific trophic relationships likely will not respond to climate changes in the same way or at the same rate, which may lead to local extirpations, extinctions, community breakdown, and structural reorganization (Root and Schneider 2002, Schmitz et al. 2003). Research indicates that species have responded to rapid climate change in the past, and some have already begun responding to the warming and other changing climate conditions that have occurred in the 20th century. Natural resource managers need to begin considering how both the direct and indirect effects of climate change may unfold across the landscape (Joyce et al. 2007). However, resource managers must also take into consideration a variety of non-climate drivers that impact species distribution (McWethy et al. 2010).

Other Stressors
Many of the potential effects of climate change on wildlife may occur as a result of the exacerbation of other challenges and stressors that affect species irrespective of climatic conditions. Other stressors include habitat fragmentation, loss, and disturbance; limited and declining quality of water resources; invasive species and disease; and declining species populations; among other things.

In particular, warmer surface temperatures could alter the survival and reproduction rates of some pathogens and vectors, which may currently be constrained by temperature minimums and maximums, potentially affecting the virulence and incidence of wildlife diseases like brucellosis, chronic wasting disease, whirling disease, West Nile virus, and bluetongue disease, as well as important plant pathogens such as white pine blister rust and mountain pine beetle.

Although all species will be affected by changing climate conditions, not all species will experience the same effects—some will benefit, while others will struggle. The species that may be at highest risk for dramatic impacts from climate change are those with limited ability to adapt. Species that are endemic to a particular area may be at greater risk than those that are geographically widespread. Similarly, species with an ability to move and adjust their range with changing conditions may have more success adapting than those that are unable to disperse or are relatively sedentary. Boreo-alpine taxa, which are already restricted to high elevations, will have limited options for population migration/dispersal as the climate warms and becomes more arid. Species that are habitat specialists or rely on specific interactions with other species, organisms, or physical aspects of the environment may be at greater risk of adverse effects of climate change than species that are more generalist in nature. Additionally, climate change has the potential to negatively impact species with low physiological tolerances to changing atmospheric, local weather, or environmental quality conditions. Finally, populations of species that have low genetic diversity or that have experienced recent or ongoing declines in population size may be more vulnerable to the effects of climate change than those species that have populations that are both rich and abundant (Midgley et al. 2002).

Potential Impacts of Climate Change on Habitat
Species survival depends largely on sufficient and healthy habitat; intact critical areas, such as breeding grounds or spawning beds; and connectivity among these areas (Joyce et al. 2000). Here again, non-climate stressors and natural ecological occurrences that are exacerbated by climate change may have the biggest impacts on habitat quantity and quality.

Terrestrial Habitat
The 11 terrestrial habitat types that are described in this SWAP include various types of forested land, shrublands, and grasslands; riparian areas and wetlands; and rocky areas with little vegetation (see Wyoming Habitat Descriptions – Terrestrial Habitat types). Wyoming's diverse terrestrial habitats are home to SGCN and non-SGCN alike, and all are influenced by regional climate and will be affected in some way by changing climate conditions. The structural components of an ecosystem may be significantly altered by changing interactions among species, which can impact the quality and quantity of habitat. Natural landscape disturbances, which may be

compounded by changing climate factors, will likely have profound effects on Wyoming's terrestrial habitat.

Wildfire is increasingly causing stress to mid-elevation forests as both the length of the fire season and the average area burned each year increases in the U.S. The length of the fire season has increased 78 days over the past 3 decades (Westerling et al. 2006), and is expected to grow by an additional 2–3 weeks by 2070 (Barnett et al. 2004). Over the past 20 years, the average area burned in the West has increased six-fold (Westerling et al. 2006). Climate is one factor among many that may influence the frequency and severity of wildfire (see Wyoming Leading Wildlife Conservation Challenges – Disruption of Historic Disturbance Regimes). Wildfire is a natural occurrence that regularly alters vast expanses of wildlife habitat. Coupled with the effects of climate change—namely warming temperatures, drought, and vegetation changes—wildfire may lead to more major ecosystem changes in the future. Water limitations resulting from the increased intensity of regional drought could hinder forest regeneration, causing meadow and grassland ecosystems to permanently replace current woodlands and forests (Joyce et al. 2007). Frequent fire also discourages the recovery of shrublands, and thus some of Wyoming's sagebrush habitat could be permanently converted to grassland (Bureau of Land Management undated).

Forests are natural water filters and flow regulators. The general loss of forested land predicted under a warmer and drier climate may compound water-quality issues and irregular hydrological flows, which are also being impacted more directly by rising surface temperatures. Overall declines in vegetative cover as a result of increased intensity and severity of wildfire may lead to further habitat alteration by damaging organic soils and causing increased soil erosion (Spigel and Robichaud 2007). Erosion can lead to increased runoff, sedimentation, and debris flow in streams and rivers, which can negatively impact aquatic habitat and associated species (Rieman and Clayton 1997, Dunham et al. 2003).

Bark beetle outbreaks are a natural part of forest ecology; however, researchers suggest that warmer winters in recent decades coupled with drought have caused forests to become more susceptible to the prolonged and more intense epidemics (Hicke et al. 2006, Romme et al. 2006). Warmer temperatures may be allowing for enhanced beetle population growth and range expansion to higher-elevation forests (Joyce et al. 2007). Large, contiguous tracts of dead and fallen trees as a result of beetle kill also increases the risk for high intensity fires, as well as impacts on local and regional hydrology including changes in annual water yields, peak flows, and low flows. Research also suggests that the loss of large numbers of trees in concentrated areas impacts local weather and atmospheric conditions by causing changes in precipitation, temperature, and air quality, which may further impact wildlife by leading to more vegetative restructuring (ScienceDaily 2008). Wildlife managers may also encounter difficulty with maintaining hunter access to public lands resulting from increasingly hazardous forest conditions.

Climate change has the potential to intensify periodic drought. Prolonged and more severe drought will significantly alter terrestrial habitat, affecting a range of species that rely on these habitats and associated resources. The combination of drought and increased evaporation from surface water and terrestrial ecosystems as a result of warming surface temperatures may have severe effects on wetlands and riparian areas. These areas could become increasingly sparse and/or less connected, or may dry up completely. Wetlands and riparian habitat are vitally important to aquatic and terrestrial species in Wyoming, providing both shelter and forage. A vast majority of species use these areas either daily or seasonally as part of their lifecycle, and many of Wyoming's bird species are wetland or riparian obligates (Nicholoff et al. 2003, Copeland et al. 2010). These habitats also serve as migration and dispersal corridors. The alteration of wetlands and riparian areas may also compound other hydrological effects of climate change by contributing to a decrease in surface water storage, less flood control, decreased filtration of sedimentation, and uncontrolled stream flow (Copeland et al. 2010), all of which impact the quality of species' habitat.

Long periods of drought may cause a decline in forested area as the land becomes too arid to support forest ecosystems (Joyce et al. 2007, The National Academies 2009), and may further increase the susceptibility of forests to insect epidemics (Logan et al. 2003). Decreasing soil moisture could also kill trees planted for shelterbelts and cottonwood galleries, both of which provide important habitat for numerous terrestrial species. Finally, drought may cause terrestrial habitats such as shrublands, sagebrush, and perennial grasses and forbs to decline due to water limitations (Bureau of Land Management undated). Such habitats may convert to other types or may simply become more barren of vegetation, consequently decreasing the forage value of the land, increasing susceptibility to the invasion of drought-tolerant species and wildfire, and leading to the decline of associated wildlife species.

As ecosystems and landscapes are altered by changing climate conditions and other disturbances, the opportunity for exotic and invasive species to establish populations in Wyoming may increase. Terrestrial habitat may be increasingly affected by invasive flora that can outcompete native flora in a warmer climate and in a landscape that is more frequently being disturbed by wildfire, insect outbreaks, and drought (Bureau of Land Management undated). Increasing amounts of valuable and structurally diverse habitat may be altered by invasive plant species, which in some cases may result in a naturally diverse mosaic of native communities being converted into a more monotypic habitat (see Wyoming Leading Wildlife Conservation Challenges – Invasive Species).

The viability of riparian areas, which are highly productive and provide critical habitat for species (see Wyoming Habitat Descriptions – Riparian Areas), is also being affected by invasive species such as Russian olive and tamarisk (Bureau of Land Management undated, Archer and Predick 2008, Wilcox 2010), and the impacts of these invasive species may be exacerbated by the effects of climate change (see Wyoming Leading Wildlife Conservation Challenges – Invasive Species). As changing climate conditions alter average seasonal temperatures and the hydrology of the West, riparian areas may become increasingly important as corridors for species movement to more suitable habitat, refuge, and also important areas for terrestrial grazers (Western Governors' Association 2008).

Figure 1.

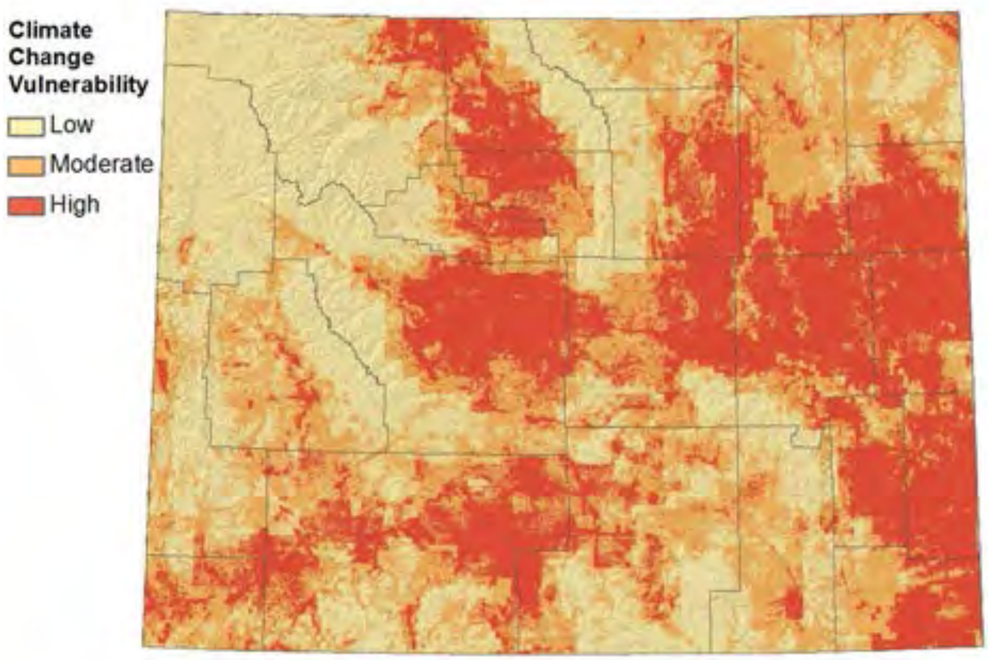


Figure 2.

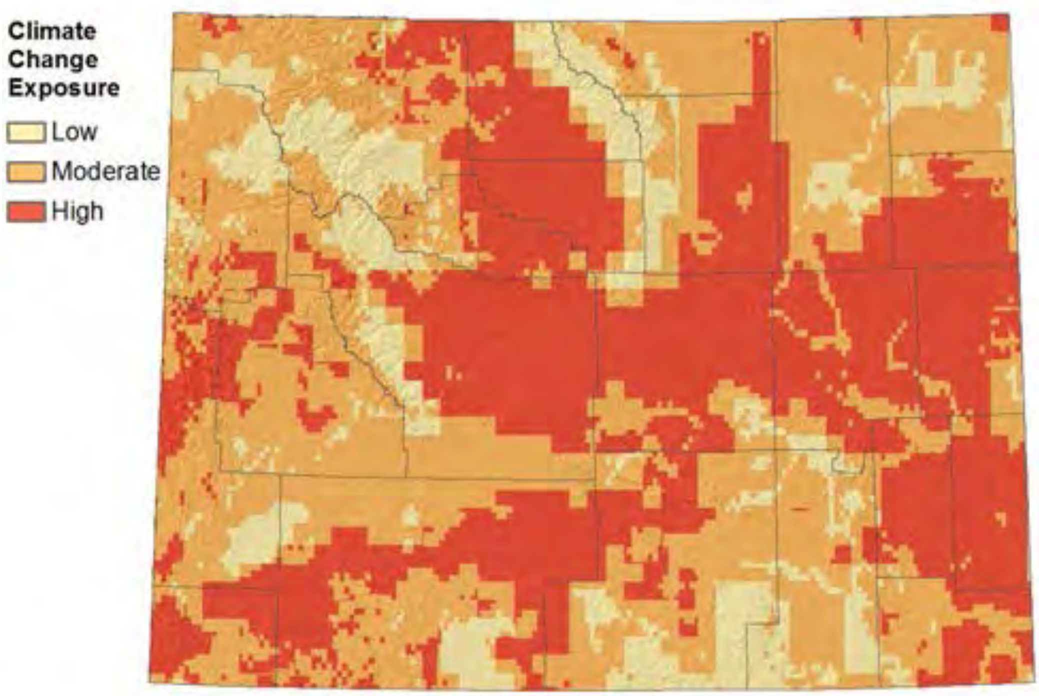
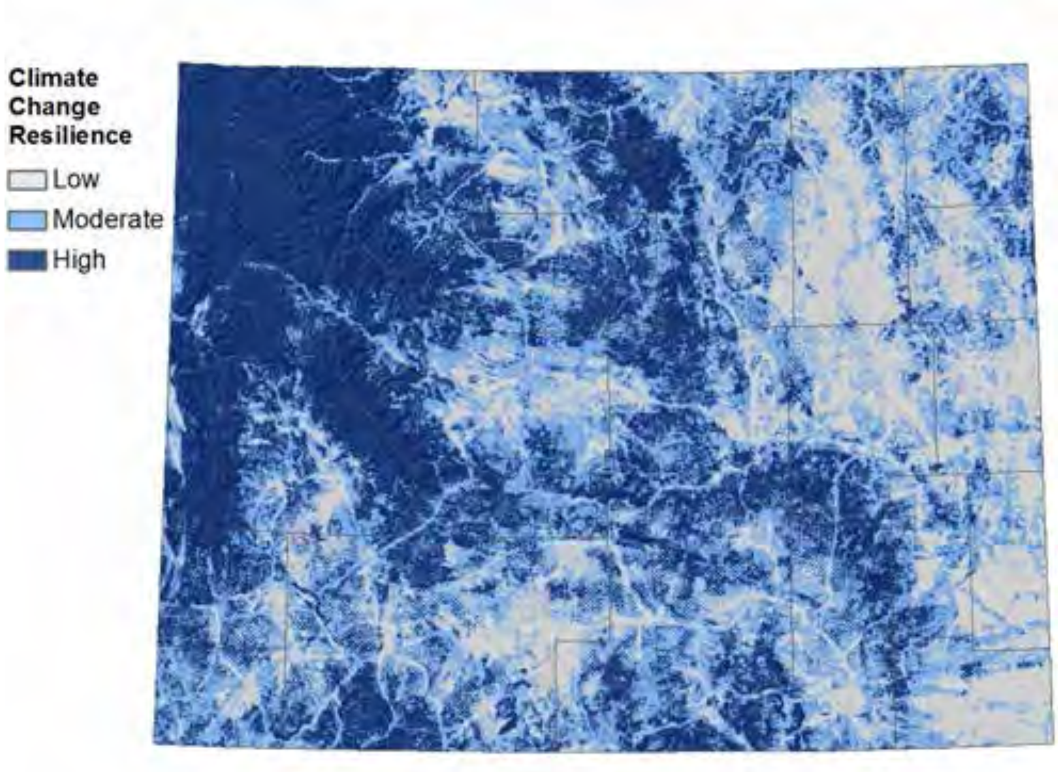


Figure 3.



Climate change vulnerability was calculated as exposure to climate change minus resilience to climate change, for 30-m raster cells across Wyoming (Pocewicz et al. 2014). Exposure to climate change represents the relative impact of changes in temperature and moisture on the landscape. Cell values ranged from 0, which reflects minimal potential for change, to 1, which reflects a maximum change in climate conditions. Two metrics were combined to represent climate change exposure, annual mean temperature change rate (°C/yr) from 1951-2006 and projected moisture deficit (Pocewicz et al. 2014). Resilience represents the relative ability of habitats within a landscape to survive or recover from a change. Cell values ranged from 0, which reflects minimal resilience, to 1, which reflects maximal resilience. Resilience was calculated from three datasets: topographic diversity and water availability, land management status, and landscape integrity or intactness (Pocewicz et al. 2014). For each climate change raster dataset, the scores ranging from 0 to 1 were assigned to categories as follows: low (<0.33), moderate (0.34-0.66), and high (>0.67).

Aquatic Habitat
The State Wildlife Action Plan (SWAP) identifies six aquatic basins in Wyoming (see Wyoming Habitat Descriptions – Aquatic Basin types). The potential impacts of climate change on water resources in Wyoming may significantly affect aquatic habitats and, like terrestrial habitats, exacerbate existing stressors to these ecosystems and the species they support.

Climate change may significantly impact hydrology in terms of both water quality and quantity, which could have far reaching impacts on aquatic habitat and the species that rely on that habitat. Warmer water temperatures resulting from increasing average surface temperatures decrease the oxygen saturation of the water and may negatively affect the viability of the habitat for some native aquatic species (Ficke et al. 2007, Western Governors' Association 2008). Increased air temperature, combined with changing atmospheric composition may also change water chemistry and the primary productivity of aquatic habitat (e.g., algal blooms).

Climate change has been causing mountain snowpack to melt earlier and run off faster in recent decades. Coupled with more severe storms in the future, this could cause more incidents of flooding (Backlund et al. 2008), especially when the previously discussed landscape changes are taken into consideration. Flooding has the potential to alter water quality by modifying aquatic root systems that filter sediments (Manci and Schneller-McDonald 1989), alter geomorphic features of streams and rivers, change riffle and pool distributions, and scour spawning beds (Joyce et al. 2007, Western Governors Association 2008). Decreasing late-season water flows resulting from early runoff and increased evaporation may cause the disappearance of isolated pools, contribute to warming water temperatures, and further lead to aquatic habitat fragmentation and fish mortality (Rahel et al. 1996, Field et al. 2007).

Wyoming's waters are already home to many nonnative species (e.g., walleye), some of which are deliberately promoted by managers, and some which are threatened to be spread from neighboring states (e.g., zebra and quagga mussels) (see Wyoming Wildlife Conservation Challenges – Invasive Species). As aquatic habitat continues to be altered by climate change and non-climate stressors, rivers, streams, lakes, and other bodies of water may become increasingly susceptible to invasive flora and fauna that are more tolerant of and/or adaptable to changes in water quality and quantity.

Climate Change and Uncertainty Regarding Impacts on Species and Species Interactions

The potential impacts of climate change on fish and wildlife and alterations to habitat in Wyoming are uncertain. While a high probability for change exists, the changes may play out in a variety of ways that, at times, will be unpredictable. Examining the ecological and biological impacts of long-term changing climate conditions may be confounded by the natural short-term and interdecadal cycles of changing trophic relationships (Schmitz et al. 2003). Peaks in the populations of some species and declines in others are often a natural part of the ecological narrative in relationships among species. Determining which changes are related to long-term climate trends may prove difficult depending on monitoring protocols and the availability of long-term data.

Modeling can be a useful tool to evaluate regional climate changes and to determine potential future critical habitat locations and species distributions that may result from climate changes. Regional climate modeling may help resource managers identify ecosystems at risk of transformative change. Bioclimatic models, also called envelope models or ecological niche models, may be used for predicting the future range and distribution of native and invasive species (Jeschke and Strayer 2008). Resource managers may be able to use these models to help target management strategies on focal areas where plant or animal species are most likely to survive in the future given climate constraints on the landscape (Bradley 2010). However, these models may also oversimplify estimates of suitable range and habitat by not accounting for non-climate drivers of species distribution, and so while these models may help paint a broad picture of future conditions, management actions should not be based solely on one model and should consider or address change at the appropriate level (e.g., regional or basin level, as opposed to sub-basin level).

Current Initiatives to Understand the Implications of Climate Change[2]

Strategies developed by government agencies and conservation organization to address climate change range from international monitoring and modeling efforts, to federal legislation, to efforts of national and regional

[2] The majority of the information in this section was obtained from the specific website of each initiative, unless otherwise noted.

conservation organizations, to state and local working groups holding public forums for discussion and completion of on-the-ground projects. The initiatives that follow do not constitute an all-inclusive list of climate change initiatives relevant to Wyoming, but are meant to paint a picture of the various agencies, organizations, and institutions that are providing leadership in the field of climate change science, mitigation, and adaptation.

International

The North American Regional Climate Change Assessment Program (NARCCAP) (http://www.narccap.ucar.edu/) is an international partnership using regional climate models (RCMs), atmosphere-ocean general circulation models (AOGCMs), and special report emissions scenarios (SRES) to generate future climate change scenarios for the purpose of analysis, impact studies, or further downscaling. The climate scenarios that are generated model historical climate trends (1971–2000) and project future climate trends (2041–2070) for the conterminous U.S., northern Mexico, and most of Canada. NARCCAP evaluates and estimates the uncertainty associated with the regional-scale climate change scenarios and aims to produce high-resolution (50 kilometers) climate change scenarios, which will aid resource managers in performing impact assessments on the resources that they are charged with protecting.

NatureServe (http://www.natureserve.org/) is a nonprofit conservation organization established in 1994 with guidance and resources from The Nature Conservancy. The organization is an association of natural heritage programs in the U.S., Canada, Latin America, and the Caribbean. These programs are widely drawn on by resource managers because they are the best source of information on rare and endangered species and sensitive ecosystems. The goal of NatureServe is to provide a clearinghouse for information on biodiversity that is easily accessible to resource managers and policymakers. NatureServe is responsible for the development of the Climate Change Vulnerability Index (CCVI), which is a tool that can be used to rank the level of vulnerability of individual species to climate change. The Wyoming Natural Diversity Database (WYNDD) is the state's natural heritage program, which is located at the University of Wyoming.

National

At the federal level, the U.S. Fish and Wildlife Service (USFWS) is at the forefront of developing strategies and evaluating the potential impacts of climate change on wildlife and habitat. In 2009, the USFWS released a revised draft of its strategic plan for responding to climate change (U.S. Fish and Wildlife Service 2009). The strategy emphasizes the need to move forward with decisive conservation action to address climate impacts despite the uncertainty that surrounds climate change in the future. The document is focused on three main strategies: adaptation, mitigation, and engaging partners. The USFWS also emphasizes landscape-scale approaches as part of the agency's National Fish and Wildlife Climate Adaptation Strategy (http://www.fws.gov/home/climatechange/). Twenty-one Landscape Conservation Cooperatives (LCCs) have formed that encompass all regions of the U.S. and some areas in Canada and Mexico. The purpose of the LCCs is to coordinate regional science and resources to address climate change and provide conservation delivery. Wyoming is divided unevenly by five LCCs, but the majority of the state's land area is covered by two cooperatives, the Plains and Prairie Potholes LCC and the Great Northern LCC.

The U.S. Geological Survey (USGS) established the National Climate Change and Wildlife Science Center (NCCWSC) (http://nccwsc.usgs.gov/) in response to the climate change science gaps that exist that may prohibit the development of sound management strategies for wildlife adaptation. Working with various partners at all levels, including eight regional Climate Science Centers (CSCs) established by the Department of the Interior, the NCCWSC is focusing on using scientific data and modeling to make predictions about future species response to climate change and habitat and ecosystem changes that may occur. The CSCs will work in coordination with LCCs to gather information and make resources and management tools accessible to resource managers. The USGS also supports research that explores ecosystem responses to climate change, including a project called Exploring Future Flora, Environments, and Climate through Simulations (EFFECTS).

In 1990, the U.S. Congress passed the Global Change Research Act (P.L. 101-606), which established the U.S. Global Change Research Program (USGCRP) (http://www.globalchange.gov/). The USGCRP is comprised of 13 federal departments and agencies and is charged with leading the nation in understanding global changes (e.g., climate, ozone, land cover) and making assessments and predictions to aid decision-making regarding the potential outcomes of these global changes. The USGCRP produces an annual report for Congress, *Our Changing Planet*, documenting its findings and recommending response actions.

The National Wildlife Federation (http://www.nwf.org/) and the National Fish Habitat Action Plan (http://fishhabitat.org/) are examples of wildlife conservation organizations and protection and restoration initiatives that are addressing the issue of climate change through research, mitigation, partnerships, and public education efforts. See Additional Resources within this section for more information on these organizations and relevant publications.

Regional

The Northern Rocky Mountain Science Center (NOROCK) (https://www.usgs.gov/centers/norock) has stations located in western Montana and Wyoming. The goal of NOROCK scientists and staff is to research and disseminate information specific to species and ecosystems in the northern Rocky Mountain region to aid federal, state, and local resource managers in developing effective management strategies. One of the center's projects focuses is on climate change in mountain ecosystems, including research on glaciers, snow and avalanches, and the structure and function of mountain ecosystems.

The Western Governors' Association (WGA) (http://www.westgov.org/) is a coalition of governors from 19 states and 3 U.S.-flag Pacific islands. The WGA focuses on issues that challenge western resources and economies. In addition to a policy resolution on climate change mitigation measures, the WGA has adopted a policy resolution that supports research into adaption measures. The association has developed a number of initiatives and internal working groups to address natural resource issues facing the West including water, forest and rangeland health, wildlife corridors, renewable energy, carbon sequestration, and alternative transportation fuels.

State and Local

In 2009, Wyoming passed a trio of laws clarifying the regulatory framework for geologic sequestration of carbon. The Wyoming State Climate Office oversees studies and research on climate change impacts to wetlands and water resources in the state. Their work includes developing drought-monitoring products for the online dissemination of water and climate data. They also support a number of stake-holder groups by assisting the development of the State Water Plan and helping to coordinate long-term climate and hydrologic monitoring efforts throughout Wyoming. The WGFD published its Wetlands Conservation Strategy in September 2010, which includes a section on climate change impacts and adaptation planning. Wyoming Wetlands Conservation Strategy

The University of Wyoming houses and supports many different research organizations whose research may directly or indirectly involve climate and the impacts of climate change. The Wyoming Cooperative Fish and Wildlife Research Unit (http://wyocoopunit.org/) is a partnership between the U.S. Geological Survey, U.S. Fish and Wildlife Service, University of Wyoming, Wyoming Game and Fish Department, and the Wildlife Management Institute. The research unit is located at the University of Wyoming in the Zoology and Physiology Department. Recently, the research unit has started to examine the past effects and potential future impacts of climate change on ungulates in the Rocky Mountain region.

The Water Resources Data System (WRDS) (http://www.wrds.uwyo.edu/) and the Wyoming State Climate Office (SCO) (http://www.wrds.uwyo.edu/sco/climate_office.html) provide Wyoming citizens, managers, and policymakers with comprehensive hydrological and climatological data from throughout the state. The offices are funded by the Wyoming Water Development Office and are located at the University of Wyoming. The WRDS and SCO compile information on hydrologic and climatic conditions from various resource managers and monitoring sources such as the Bureau of Reclamation and the National Weather Service, and develop the information into usable formats such as maps that depict climate trends over multiple decades. The offices are Wyoming's leading sources on drought information for the state, and the data products they develop help resource managers to identify climate trends and extremes.

Current Challenges for Effectively Managing Climate Change

Climate Change Certainties and Uncertainties

The study of climate over the past century has provided scientists with information about recent climate trends resulting from a combination of natural forces and anthropogenic influences. Studies indicate that Earth's surface temperatures gradually increase and decline over periods of time spanning hundreds of years as a result of solar activity, volcano eruptions, sea surface temperature, and pressure anomalies (McWethy et al. 2010). An examination of temperature records over the past two centuries demonstrates that surface temperatures generally have been increasing worldwide (International Panel on Climate change 2013). Many uncertainties also exist with regard to the science of modeling and projecting future climate variability and associated ecosystem outcomes. However, uncertainty does not necessarily mean that historical observations and future projections are wrong or inaccurate, but they maybe qualified as inexact due to many uncontrollable variables.

The general scientific consensus on temperature change is that average global temperatures will continue to increase, as will temperatures in North America and the Rocky Mountain West, including Wyoming (Christensen et al. 2007). Temperature records over the past 100 years indicate that the West is already experiencing warming trends, particularly in winter and spring (Joyce et al. 2007). Recent research efforts have put forth a range of projections regarding temperature increases over various spatial (e.g., global, regional, national, statewide) and temporal (e.g., mid-century, late-century) scales, but the rate and magnitude of changes may depend on a suite of factors including global economic growth, adoption of climate change mitigation measures, and interactions between natural variability and the consequences of changing greenhouse gas concentrations.

Consensus on precipitation is more elusive than consensus on temperature. The IPCC projects that overall global precipitation will increase as a result of warmer ocean temperatures (Christensen et al. 2007). However, precipitation is not expected to increase everywhere: currently wet regions are expected to get wetter and dry areas drier. The western United States, including Wyoming, is likely to become drier (Backlund et al. 2008). The past 100 years of precipitation records do not demonstrate any definitive precipitation trends in the West but do indicate a high level of variability (Joyce et al. 2007). Additionally, certain climatic events are expected to intensify. Storms may become more severe with more precipitation in a shorter amount of time, and droughts may extend over longer periods of time much like the megadroughts identified in the historical record (Gray and Andersen 2009).

Climate and Ecosystems

The fact that climate affects biological systems is well established, but how rapid or transformative climate change will impact these systems is less certain. Climate may alter the physical structure of the ecosystem, which includes living organisms (i.e., aquatic and terrestrial wildlife) and non-living, chemical, and physical environmental attributes (Westerling et al. 2006, Rosenzweig et al. 2008). Climate change may also lead to changes in core ecosystem functions such as energy exchange, nutrient cycling, and primary productivity, which form the basis of the ecosystem services (e.g., clean air and water) on which human populations depend.

Large and rapid changes have the potential to place a greater amount of stress on components of the system than long-term gradual changes, which is a concern for many species and ecosystems (Schneider and Root 1998). "Abrupt" climate change is defined as a rapid change in climate over a relatively short period of time, which causes significant disturbance to ecosystems (U.S. Climate Change Science Program undated). Currently, the rate of change is likely a greater threat to ecosystem viability than the actual amount of projected change. Ecosystem change may occur in step-like transitions involving long periods of time with minimal change, followed by a relatively rapid development when conditions are right (Jackson et al. 2009, Gray et al. 2006, Lyford et al. 2003).

Climate may directly or indirectly impact ecosystem structure and function in many ways. Climate impacts average seasonal temperatures and temperature extremes. In turn, temperatures have profound effects on hydrology, including the spatial and temporal patterns of snowpack accumulation and ablation, runoff, water storage and recharge (e.g., glaciers and aquifers), evaporation, and soil moisture (Gray and Andersen 2009, Barnett et al. 2004, Christensen et al. 2007). Climate influences the frequency and intensity of disturbances such as drought, insect and disease outbreaks, storm severity, flash flooding, erosion, and wildfire, and may promote the establishment of invasive and/or exotic species in arid landscapes (Backlund et al. 2008). It may extend or curtail the growing season and impact primary production (Backlund et al. 2008). Climate influences plant and animal migration, distribution, and interaction patterns, and also the survival and proliferation of pathogens and parasites (Backlund et al. 2008, Harvell et al. 2002).

The physical manifestations of climate change have been observed and documented throughout the 20th century and up to present day (e.g., Parmesan 2006). Since 1901, the average surface temperature across the contiguous 48 states has risen at an average rate of 0.14°F per decade. Average temperatures have risen more quickly since the late 1970s (0.29 to 0.46°F per decade since 1979) (U.S. Environmental Protection Agency's Website). Global sea levels have risen by 15–20cm and global overland precipitation has risen by about 2% since the beginning of the 20th century (Backlund et al. 2008). Most of the continental United States experienced increased precipitation, stream flow, stream temperatures, and glacial retreat (Backlund et al. 2008, Wilcox 2010).

The ecological manifestations of climate change have been similarly documented. Increased vegetation growth, vegetation redistribution, and changes in flora phenologic trends have been observed (Backlund et al. 2008, Cayan et al. 2001). Net primary production (NPP) increased approximately 10% from 1982–1998 (Boisvenue and Running 2006). The advance of the spring season has caused earlier blooming and onset of spring greenness; warming temperatures, which are more pronounced at high elevations and latitudes, may be contributing to the infilling of sub-alpine conifers in alpine tundra; and increasingly limited water resources may be causing drought-tolerant vegetation to shift its range (Myneni et al. 2001, Lucht et al. 2002, Joyce et al. 2007). Changes in the migration and phenologic patterns of some terrestrial species and the displacement of native high-latitude species also have been observed (Walther et al. 2002). Research on the direct and indirect impacts of climate change will likely increase in the future as changes continue to materialize or become more apparent.

Climate change may present human populations and fish and wildlife populations with various tradeoffs. Seasonal changes, such as an earlier spring and a later fall, will increase the length of the growing season resulting in increased agricultural production and extended foraging time for wildlife. However, if warmer temperatures are not coupled with increased precipitation, summer and late-season drought stress will likely adversely impact primary production. Forage quality may be negatively impacted by changing CO2 concentrations (Joyce et al. 2000), and invasive species, which may be more tolerant of changing climate conditions (Joyce et al. 2007). Warmer and milder winters may entail less wildlife winter mortality, but increasingly severe storms, changing temperature extremes, wildfires, and drought may adversely affect reproduction and the survival of young. Climate change is not inherently good or bad, but it is a shift from a previously managed state or structural organization, which will entail tradeoffs, new management goals and strategies, and winners and losers.

As long as global surface temperatures continue to increase and precipitation patterns become more variable, biological systems will be in a constant state of transition. Consequently, using a historic range of variation, formally or informally, to guide future management strategies may be insufficient and even inappropriate for facing the additional challenges that rapid climate change will bring to wildlife and habitat management (Wiens and Bachelet 2009, Joyce et al. 2007). Using 100 years or less of past climate data to inform future management strategies does not capture the variability that long-term proxy data can depict (McWethy et al. 2010) and likely will not accurately account for the ecosystem changes that will occur as a result of recent and future climate change. Goals and conservation strategies may need to be redefined in order to address the needs of wildlife in transitioning systems.

Climate Modeling

Climate change is a global phenomenon driven by large-scale dynamics that affect weather and climate conditions at the regional and local levels (Wiens and Bachelet 2009). At present, General Circulation Models (GCMs) use simplified representations of Earth's oceans, atmosphere, and land surface, and the interactions among these units to help paint a broad picture of general climate patterns and trends and to make projections regarding future possibilities. GCMs can also be run under various assumptions about future greenhouse gas emission levels to output projections about future climate across a variety of social and economic scenarios.

Unlike efforts aimed at short-term weather forecasting, the goal of most GCM-based research is to understand general patterns of climate variability and climate averages. As such, GCMs perform reasonably well in recreating both historical climates seen in instrumental observations and paleoclimates preserved in various proxy archives (e.g., tree rings). This, in turn, generates reasonable confidence in future climate projections, with the major caveat that economic and social variables that relate to greenhouse gas production are highly uncertain (Gray, personal communication, July 9, 2010). However, the usefulness of GCMs in applications related to wildlife management can be greatly limited by their course-scale output and the fact that they do not fully account for topography and ecosystem boundaries that often impact regional and local climate (Barnett et al. 2004).

Based on their ability to reproduce paleo and historical patterns, as well as the underlying chemistry and physics of climate change, scientists have much more confidence in the ability to predict future temperatures than they do for precipitation (Gray, personal communication, July 9, 2010). However, difficulty may still arise when attempting to distinguish between variations associated with climate change and variations driven by forces such as the El Niño-Southern Oscillation (Wiens and Bachelet 2009). Despite the noted uncertainties and shortcomings of climate modeling, the information produced by these models may be useful for predicting the potential vulnerability of an area to climate change, possible vegetation shifts, and future habitat suitability.

Given the uncertainty associated with global modeling, resource managers should avoid developing management strategies based on a single set of climate projections (Wiens and Bachelet 2009). Managers should instead take action by integrating a wide range of possible climate change scenarios into planning, conservation, and management efforts.

Recommended Conservation Actions

In light of the uncertainty regarding future climate conditions and the natural variability of climate in Wyoming, the overall goal of the WGFD is relatively simple and straightforward: continue to develop sound wildlife and habitat management policies and continue to employ sound wildlife and habitat conservation practices while evaluating a range of possibilities of future climate conditions and bringing climate into the planning and management processes as appropriate.
Projections of a warmer and drier climate in the western U.S. warrants the consideration of wildlife and habitat managers. Strategies that are practical across a range of possible future climate conditions will provide wildlife and habitat managers with the flexibility needed to adjust those strategies as appropriate and will not limit or inhibit future management options. Mitigating current threats to aquatic and terrestrial wildlife populations and habitat integrity; monitoring species and ecosystem health; and managing species populations, communities, and landscapes in accordance with what is known about natural disturbance regimes and ecosystem processes are good wildlife and habitat management strategies, as well as good climate change management strategies. Regardless of the accuracy of messages concerning climate change, it is important to maintain realistic and attainable management goals and objectives.

Scenario planning is a strategy that allows resource managers to evaluate current goals and objectives in light of climate change and to identify management actions that will address a range of issues facing aquatic and terrestrial wildlife populations.
Building scenarios involves the consideration of several likely directions and intensities of future climate change without requiring exact temperature and precipitation predictions. This type of planning acknowledges the uncertainty in climate projections and biotic response and provides resource managers a framework in which to better consider how various future climate conditions may impact the ecosystems, system components, and processes that they manage. Further, resource managers can evaluate how current goals may need to change and assess the future efficacy of current management strategies given a variety of climate scenarios.

In addition to scenario planning, adaptive management techniques may help wildlife and habitat managers deal with the uncertainty surrounding future climate conditions.
Adaptive management involves the continual reevaluation through monitoring and improvement of management strategies as climate change plays out and causes sometimes predictable and sometimes unpredictable impacts on ecosystems and species communities. Given what is known about historical climate variation in the West and the future climate projections for this region, the

coming decades may prove to be quite different than recent previous decades. Predictive models, flexibility, and adaptive management will be key to dealing with this uncertainty, as will a policy-making and management environment that supports creativity and moderate risk-taking.

Wildlife and habitat managers will likely pursue a combination of mitigation and adaptation measures as they employ strategies to maintain the health of aquatic and terrestrial flora and fauna and the integrity of the Wyoming landscapes that support these species.
Mitigation strategies that involve actions that lessen the input of greenhouse gases into the atmosphere are more likely to develop as state-level policy. Adaptation strategies, on the other hand, are not meant to resist inevitable changes or slow their occurrence, but are measures adopted to build the capacity of a species or ecosystem to deal with the impacts of climate change while maintaining stability and ultimately adapting and thriving under new conditions. An adaptation strategy may involve enhancing the quality, quantity, and connectivity of wildlife habitat so that wildlife populations are able to adjust their range according to physiological tolerances to changing climate conditions. Building and maintaining ecosystem health in order to accommodate change as opposed to resisting it is fast becoming the preferred method for wildlife management in the face of climate change.

Recommendations – General

Pursue financial, technical, and human resources to develop and implement a structure to coordinate the incorporation of climate change into WGFD activities at the agency level.
The WGFD will need a coordinated approach in order for climate change considerations to be effectively incorporated into WGFD planning and monitoring, and also to aid the timely development and implementation of projects and strategies addressing the impacts of changing climate conditions.

A point person from within the department could serve as a contact for communication with federal resource management agencies and the public, and would also aid with the intra-agency dissemination of information regarding climate change and the coordination of all other climate change-related efforts.

As wildlife and habitat managers begin to consider the potential impacts of climate change on the species and landscapes that they manage, it will be necessary to periodically evaluate the actual impacts of climate conditions on current management goals and strategies. The efficacy of some management techniques and the practicality/cost of some management goals may change with changing climate conditions. WGFD should take the appropriate steps to consider these impacts.

Identify and prioritize implementation actions that will benefit management targets by addressing a range of stressors given various future climate scenarios as an ongoing strategy.
After the potential impacts of several scenarios have been assessed and current management challenges considered in light of climate change, a range of no regret actions may be identified that address multiple issues and management challenges relating to both species and habitat. Adaptive management techniques supported by internal policies that encourage creativity and moderate risk-taking may aid wildlife and habitat managers in developing and implementing strategies that safeguard these resources against multiple stressors.

Partner with other agencies and organizations, and support initiatives related to climate change and wildlife and habitat management as an ongoing strategy.
Engaging in a variety of partnerships is an effective means of cost-sharing, compensating for limited human and technical resources, and avoiding the duplication of effort. Statewide

and regional interagency collaboration will facilitate information sharing, the assignment of appropriate roles to partner agencies, the request of appropriate data products from partner agencies, and the more efficient allocation of scarce resources for wildlife and landscape conservation. Additionally, partnerships may offer funding opportunities for climate-related research, mitigation, and adaptation projects. Coordinating efforts with federal, state, local, and non-profit partners should be an ongoing priority when dealing with climate issues.

Offer additional education opportunities for WGFD employees about climate change issues pertaining to wildlife and habitat management in Wyoming as an ongoing strategy.
The development of appropriate goals and the implementation of timely and successful strategies will require that agency employees are well-informed on how to integrate climate change into monitoring, planning, and management within the context of their current jobs. Fostering an environment of increased awareness about climate and wildlife/landscape-related issues through individual and group education opportunities is important. WGFD has organized climate change workshops in the past and should continue to organize workshops to discuss future climate projections and to specifically aid employees with the scenario building process, the enhancement of existing data-gathering programs to account for climate factors, and the development of adaptive management techniques.

Disseminate information to the public about climate change issues pertaining to wildlife and habitat management in Wyoming.
Hunters, anglers, and wildlife viewers are important stakeholder groups within the state. The dissemination of information to the public regarding the observed and future potential impacts of climate change on wildlife and habitat in Wyoming will be necessary. The use of existing forms of media provides an opportunity to convey climate-related issues to Wyomingites and to gain public feedback on proposed mitigation and adaptation measures. WGFD should consider using *Wyoming Wildlife* magazine and existing newsletters as forums for discussing appropriate and timely climate-related issues. Additionally, WGFD should consider developing future climate change workshops for public attendance and participation, and relate the topic of climate change to current and accepted wildlife management issues.

Work with regional organizations to evaluate existing laws and regulations and make recommendations in light of climate change as a long-term consideration.
Existing regulations and policies may need to be reexamined and/or modified to safeguard wildlife and habitat and to support reasonable conservation expectations as changes in climate occur. Dealing with certain laws will be a challenge if species become increasingly threatened by climate change and variability. Much like the development of strategies, policies should be flexible and should be revisited or revised more often to assess the need for changes and to avoid the use of scarce resources on hopeless causes. Timely recommendations on policy adjustments to either mitigate the effects of climate change or aid climate change adaptation should be welcomed and given due consideration. WGFD should work with regional organizations such as the Western Governors' Association and the Association of Fish and Wildlife Agencies to identify and recommend needed statutory and regulatory changes at the state and federal levels.

Recommendations – Species Management

Wildlife managers should continue to focus on good wildlife management techniques, including reducing non-climate stressors and promoting biological and genetic diversity.
Continuing to enhance efforts to minimize the impacts of non-climate stressors and continuing to manage for species and genetic diversity will help safeguard individual species populations

and species communities from any current or future threats (e.g., development pressures, natural disturbances, climate change) by increasing species' ability to adapt to environmental changes. WGFD should continue management practices that balance the abundance of wildlife populations with the carrying capacity of the land (e.g., big game management using harvest quotas), while also focusing on biodiversity (e.g., SGCN), and use existing knowledge about non-climate stressors affecting aquatic and terrestrial species to continue to enhance strategies to address these wildlife stressors (e.g., Aquatic Invasive Species program and initiatives to control invasive terrestrial flora).

Wildlife managers should build an understanding of past responses to climate change and climate as a driver of species behavior, range, and distribution.
Climate change and variability impacts species individually and may result in previously unforeseen vulnerabilities on Wyoming's wildlife. Climate change may have significant ecological and economic effects, including impacting hunter and angler recruitment and retention, causing the decline of SGCN, and leading to the establishment and continued proliferation of populations of nonnative species in the state.

Understanding how species have responded to stresses and disturbances in the past may provide wildlife managers with important insight about how species may respond in the future to climate change and stressors that are expected to be compounded by climate change. The use of existing research, literature, and experience, as well as utilizing historical data sets compiled by the USA National Phenology Network (http://www.usanpn.org/), may aid wildlife managers in building an understanding of climate as a driver of species behavior, range, and distribution. Wildlife and habitat managers should identify research and information needs and develop strategies to bridge knowledge gaps regarding the relationship of individual species and climate.

Assess the vulnerability of SGCN to climate change and evaluate the impacts of climate on select species.
The Wyoming Nature Conservancy, WYNDD, and WGFD completed research evaluating the vulnerability of Wyoming SGCN and the 11 SWAP terrestrial habitat types to climate change, residential and energy development, and wildlife disease, as well as cumulative vulnerability to all three of these stressors. Results for 2010 SGCN are listed in Appendix A. Vulnerability is a function of a species' or habitat's exposure to changes and its resilience to those changes. The vu

Research results give an indication of which species and taxonomic groups are potentially vulnerable to climate change, as well as helps to direct future research to address information gaps. The project was jointly funded jointly by the U. S. Geological Survey, Wyoming Landscape Conservation Initiative, and WGFD and can be found at: http://www.nature.org/media/wyoming/wyoming-wildlife-vulnerability-assessment-June-2014.pdf.

Since the 2010 SWAP revision, the WGFD also conducted research regarding the impacts of climate change on Colorado River cutthroat trout. Results will help to target priority conservation areas for these species and better understand interactions with populations of non-native fish (Roberts et al. 2013). The WGFD is also an active supporter of climate research being done by Forest Service researchers. The Climate Shield website hosts geospatial data and related information that describes specific locations of cold-water refuge streams for native cutthroat trout and bull trout across the American West. Predictions about the locations of refugia could enable the improve the odds of preserving native trout populations into the future http://www.fs.fed.us/rm/boise/AWAE/projects/ClimateShield.html.

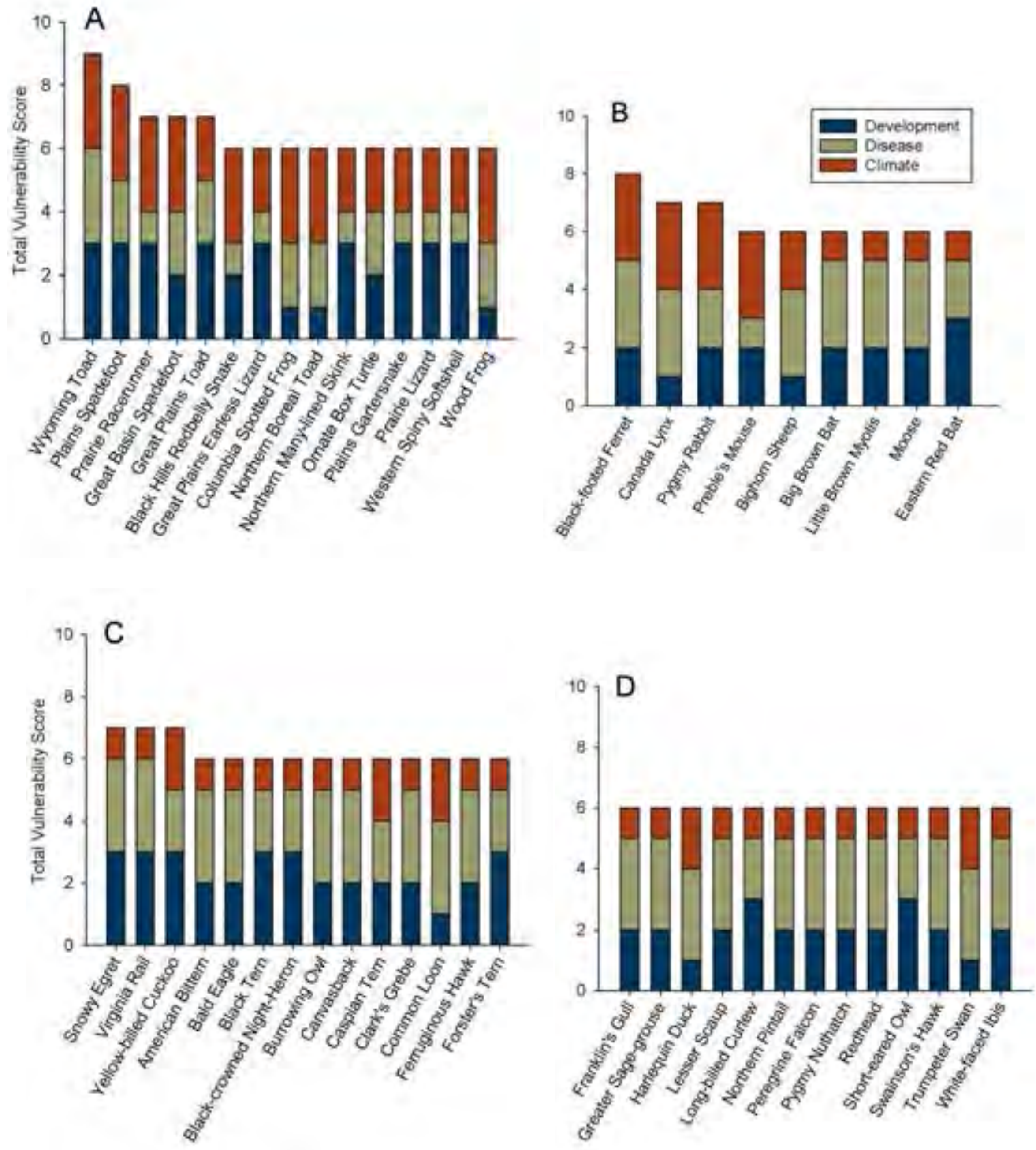


Figure 4.

The contribution of development, disease and climate change vulnerability to the overall vulnerability for the 51 species ranked as highly or very-highly vulnerable, for amphibians and reptiles (A), mammals (B), and birds (C, D). Categorical rankings for individual vulnerability components were assigned numeric values to illustrate relative contributions, where high =3, moderate = 2, and low =1 (Pocewicz et al. 2014).

Evaluate the feasibility of developing approaches to model future species distribution based on multiple drivers, including climate change. Build databases and produce maps depicting future species distribution including climate as a driver as a long-term consideration.
The SWAP includes current distribution maps for SGCN. Consideration should be given to developing maps of the potential future distribution of both SGCN and non-SGCN species based on key drivers of distribution, including climate factors. Evaluating the feasibility of using current species distribution maps to model the future distribution of species is a first step to understanding the potential impacts of climate change on individual species. Additional baseline information may be needed to produce maps that accurately depict future species distribution contingent upon multiple drivers, and knowledge gaps should be filled through continued research efforts or by obtaining data from the appropriate sources. Wildlife managers should identify the key drivers of SGCN and non-SGCN distribution and assess the feasibility, the quality, and the completeness of data for mapping the future distribution of SGCN and non-SGCN as a goal before the next SWAP revision. Producing maps for species with sufficient data and clear drivers of distribution may be a long-term consideration.

Downscaled climate data and finer-scale climate models may be necessary to make appropriate species management decisions in the future, and the availability of this data should be evaluated.
Modeling future species distributions and developing a clearer understanding about future climate scenarios across Wyoming will require more precise information about temperature and precipitation predictions. Through regional partnerships involving scientists and organization that are working on downscaling climate data to a relevant level for wildlife managers, asses the availability and quality of downscaled climate models for Wyoming and identify information gaps to guide development of finer scale models.

Assess the impacts of climate on disease dynamics. Incorporate this information in ongoing disease monitoring, and enhance disease distribution mapping, both current and projected
WGFD currently tracks and monitors diseases that are specific to certain species or populations, and has updated a wildlife disease manual that describes diseases that affect species in Wyoming. The Nature Conservancy, WYNDD, WGFD vulnerability analysis researched future potential changes in wildlife disease prevalence http://www.nature.org/media/wyoming/wyoming-wildlife-vulnerability-assessment-June-2014.pdf.

Additional research on the influence of climate factors on disease incidence and/or prevalence would complement existing knowledge and may benefit wildlife managers in the future by allowing them to establish a network of early detection sites where future cases of disease are likely to emerge given climate conditions and other factors. WGFD should continue to support research efforts to establish links between climate factors and the ecology of both aquatic and terrestrial wildlife diseases, including pathogens, vectors, and hosts. WGFD should also work with other agencies to understand the links between climate and mountain pine beetle, as the drastic alteration of Wyoming's conifer forests or precautionary closure of public lands will have significant implications for future wildlife and habitat management. WGFD should enhance wildlife disease monitoring efforts to describe the current distribution of diseases and predict potential future distribution or locations conducive to outbreaks based on known drivers as a long-term consideration.

Recommendations – Habitat Management

Habitat managers should continue to focus on sound conservation, restoration, and management practices as outlined in the WGFD Strategic Habitat Plan, which will help maintain the integrity of ecosystem structure and function in the face of many ecosystem stressors, including climate change.
Continuing to implement good aquatic and terrestrial habitat management practices will help maintain regular hydrological flows by regulating peak flows, increasing terrestrial water storage, and controlling late-season flows. WGFD should utilize existing data systems and tools to identify natural watershed storage features to aid in land management decision-making and continue to develop and execute wetland and riparian restoration projects, which will increase the distribution and function of the quantity of stored water.

Ecosystem restoration, or on a smaller scale habitat restoration, may be considered both a mitigation and adaptation strategy as intact systems store more CO_2 and positively feed into species health and biodiversity. Habitat managers may want to consider emphasizing ecosystem function and diversity over the maintenance of specific communities of species as climate change may cause managing for historic conditions to become increasingly costly, challenging, and impractical. WGFD should continue to work with private landowners, government agencies, and conservation organizations to manage landscapes to meet the needs of wildlife and to address access issues, and continue to support conservation programs, such as NRCS habitat extension programs, that aid landowners with the restoration and long-term protection of natural ecosystems.

Promote connectivity as outlined in the Strategic Habitat Plan as an ongoing strategy, and undertake additional mapping efforts that depict critical areas of wildlife movement, transition, and refuge as an ongoing strategy.

Increasing the overall amount and connectivity of habitat, including migration corridors, transitional areas, and refugia, is a strategy that will build ecosystem health and species resilience to a variety of stressors. Porous landscapes, or those that are easily traversed by fish and terrestrial wildlife, will allow some species to adjust to changing environmental conditions through population movement. Riparian areas may become particularly important as wildlife movement corridors and may require special focus. WGFD should continue to work with private landowners, government agencies, and conservation organizations to restore and maintain habitat connectivity and to connect core conservation areas by encouraging the development of solutions to help wildlife bypass obstructions, such as wildlife-friendly fencing and highway underpasses for terrestrial species and channels for aquatic species to move around waterway obstructions. WGFD should also continue to build the fish passage database to catalogue obstructions on Wyoming waters.

WGFD should use existing knowledge to map and prioritize wildlife corridors, transitional grounds, and refugia as an ongoing strategy to aid future management and land conservation efforts under changing climate conditions

Consideration should be given to conducting habitat vulnerability assessments as an ongoing strategy.
The Nature Conservancy, WYNDD, WGFD terrestrial and habitat vulnerability analysis should be updated as part of the 2027 SWAP revision.
http://www.nature.org/media/wyoming/wyoming-wildlife-vulnerability-assessment-June-2014.pdf

Evaluating/monitoring Success

After wildlife and habitat managers have developed an idea of how climate change may affect the species and landscapes that they manage and have ranked the relative vulnerability of species and/or habitats, incorporating the predicted impacts into species and land management plans will be the next step. Modifying existing protocols or developing new protocols and enhancing existing programs for monitoring the impacts of climate change on wildlife and ecosystems requires wildlife and habitat managers to determine what to monitor and to identify indicators of climate-driven change or early warning signs of climate-related stress.

WGFD should continue to identify species and climate-driven behaviors that may provide an early indication of climate-related environmental change. For instance, species that are particularly susceptible to hydrological changes or species that have observable phenology such as migration and breeding patterns may provide wildlife managers with indicators of ecosystem change resulting from changing climate conditions from which they can begin to anticipate other changes or start to re-evaluate management goals and strategies. Similarly, WGFD should identify and monitor climate-driven landscape changes that may impact the efficacy of current management strategies and provide insight on potential future conditions.

Develop standard monitoring protocols.
In order to effectively monitor the impacts of current and future climate conditions on wildlife and landscapes, the WGFD may need to modify existing protocols or develop new protocols to capture specific climate-related information that will be valuable for the future development of mitigation and/or adaptation strategies for wildlife and habitat. Standardizing these monitoring protocols across the WGFD should be an ongoing effort, and the department may want to consider investigating methods and assessment tools that have been developed and successfully implemented by other states or regular partner agencies/organizations. Factors that should be assessed in terms of climate trends and local impacts include habitat, physiology, phenology, and species interactions.

Establish a reasonable planning timeline as part of a long-term strategy.
It is not practical to carry out all strategies and recommendations at once. WGFD should continue to determine which actions are now feasible and which should be done in the future. A planning timeline could help in successfully evaluating the impacts of climate on species, ecosystems, and processes, as well as in implementing timely mitigation and adaptation strategies. WGFD should develop a planning timeline for developing and implementing new climate monitoring protocols and programs for the most sensitive species and the most vulnerable landscapes.

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Additional Resources

Assessments and Publications

Assessing the Future of Wyoming's Water Resources: Adding Climate Change to the Equation. An assessment conducted by the Ruckelshaus Institute of Environment and Natural Resources at the University of Wyoming, 2009. Available online at http://www.uwyo.edu/enr/.

Beyond Seasons' End: A Path Forward for Fish and Wildlife in the Era of Climate Change. A collaboration of Ducks Unlimited, Trout Unlimited, BASS/ESPN Outdoors, Izaak Walton League of America, Association of Fish & Wildlife Agencies, Coastal Conservation Association, American Sportfishing Association, Pheasants Forever, and Boone and Crockett Club. Published by the Bipartisan Policy Center, 2009.

Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment. By Patty Glick and Bruce A. Stein. Published by the National Wildlife Federation, 2010 (draft).

The State of the Birds: 2010 Report on Climate Change. An assessment conducted by the North American Bird Conservation Initiative, American Bird Conservancy, Association of Fish & Wildlife Agencies, Cornell Lab of Ornithology, Klamath Bird Observatory, National Audubon Society, National Fish and Wildlife Foundation, The Nature Conservancy, U.S. Fish and Wildlife Service, U.S. Forest Service, and U.S. Geological Survey.

Voluntary Guidance for States to Incorporate Climate Change into State Wildlife Action Plans & Other Management Plans. A collaboration of the Association of Fish & Wildlife Agencies and Teaming with Wildlife, 2009.

Government Departments and Organizations

Bureau of Reclamation
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Mills, WY 82644-1630
Phone: (307) 261-5671
http://www.usbr.gov/gp/wyao/

Great Northern Landscape Conservation Cooperative
http://greatnorthernlcc.org/

Greater Yellowstone Coalition
Climate Change in the Greater Yellowstone Ecosystem
http://www.greateryellowstone.org/issues/climate/index.php?category=climate

National Fish Habitat Action Plan
http://fishhabitat.org/

Western Native Trout Initiative
http://westernnativetrout.org/

Desert Fish Habitat Partnership
http://www.nature.nps.gov/water/DFH_partnership.cfm

Great Plains Fish Habitat Partnership
http://www.prairiefish.org/

NatureServe
Climate Change Vulnerability Index
http://www.natureserve.org/conservation-tools/climate-change-vulnerability-index

Plains and Prairie Pothole Landscape Conservation Cooperative
https://plainsandprairiepotholeslcc.org/

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USA National Phenology Network
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Wildlife Conservation Society
Corridor Conservation Initiative
http://www.wcs.org/conservation-challenges/climate-change.aspx

World Wildlife Fund
North Great Plains ecoregion
http://www.worldwildlife.org/what/wherewework/ngp/index.html

Wyoming Game and Fish Department Climate Change Workshop
http://gfi.state.wy.us/ClimateChangeWS/index.asp

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Appendix A

Table 1a. Vulnerability ranking results for 2010 SGCN bird species, sorted alphabetically within each overall vulnerability category (Pocewicz et al. 2014).

Name	Overall	Climate Change	Development	Disease	Landscape-based
American Bittern *(Botaurus lentiginosus)*	High	Low	Moderate	High	Moderate
Bald Eagle *(Haliaeetus leucocephalus)*	High	Low	Moderate	High	High
Black Tern *(Chlidonias niger)*	High	Low	High	Moderate	High
Black-crowned Night-Heron *(Nycticorax nycticorax)*	High	Low	High	Moderate	High
Burrowing Owl *(Athene cunicularia)*	High	Low	Moderate	High	High
Canvasback *(Aythya valisineria)*	High	Low	Moderate	High	Moderate
Caspian Tern *(Sterna caspia)*	High	Moderate	Moderate	Moderate	Moderate
Clark's Grebe *(Aechmophorus clarkii)*	High	Low	Moderate	High	Moderate
Common Loon *(Gavia immer)*	High	Moderate	Low	High	Moderate
Ferruginous Hawk *(Buteo regalis)*	High	Low	Moderate	High	High
Forster's Tern *(Sterna forsteri)*	High	Low	High	Moderate	High
Franklin's Gull *(Larus pipixcan)*	High	Low	Moderate	High	Moderate
Greater Sage-grouse *(Centrocercus urophasianus)*	High	Low	Moderate	High	High
Harlequin Duck *(Histrionicus histrionicus)*	High	Moderate	Low	High	Low
Lesser Scaup *(Aythya affinis)*	High	Low	Moderate	High	Moderate
Long-billed Curlew *(Numenius americanus)*	High	Low	High	Moderate	High
Northern Pintail *(Anas acuta)*	High	Low	Moderate	High	Moderate
Peregrine Falcon *(Falco peregrinus)*	High	Low	Moderate	High	Low
Pygmy Nuthatch *(Sitta pygmaea)*	High	Low	Moderate	High	Low
Redhead *(Aythya americana)*	High	Low	Moderate	High	High
Short-eared Owl *(Asio flammeus)*	High	Low	High	Moderate	High
Snowy Egret *(Egretta thula)*	High	Low	High	High	High
Swainson's Hawk *(Buteo swainsoni)*	High	Low	Moderate	High	High
Trumpeter Swan *(Cygnus buccinator)*	High	Moderate	Low	High	Low
Virginia Rail *(Rallus limicola)*	High	Low	High	High	High
White-faced Ibis *(Plegadis chihi)*	High	Low	Moderate	High	High
Yellow-billed Cuckoo *(Coccyzus americanus)*	High	Moderate	High	Moderate	Moderate
Barrow's Goldeneye *(Bucephala islandica)*	Moderate	Low	Low	High	Low
Bobolink *(Dolichonyx oryzivorus)*	Moderate	Low	High	Low	High
Brewer's Sparrow *(Spizella breweri)*	Moderate	Low	Moderate	Moderate	Moderate
Bushtit *(Psaltriparus minimus)*	Moderate	Low	Moderate	Moderate	Moderate
Chestnut-collared Longspur *(Calcarius ornatus)*	Moderate	Low	High	Low	High
Columbian Sharp-tailed Grouse *(Tympanuchus phasianellus columbianus)*	Moderate	Low	Moderate	Moderate	Low
Dickcissel *(Spiza americana)*	Moderate	Low	High	Low	High
Grasshopper Sparrow *(Ammodramus savannarum)*	Moderate	Low	High	Low	High

Name	Overall	Climate Change	Development	Disease	Landscape-based
McCown's Longspur *(Calcarius mccownii)*	Moderate	Low	High	Low	High
Merlin *(Falco columbarius)*	Moderate	Low	Moderate	Moderate	Moderate
Upland Sandpiper *(Bartramia longicauda)*	Moderate	Low	High	Low	High
American Three-toed Woodpecker *(Picoides dorsalis)*	Low	Low	Low	Low	Low
Ash-throated Flycatcher *(Myiarchus cinerascens)*	Low	Low	Moderate	Low	Moderate
Black Rosy-Finch *(Leucosticte atrata)*	Low	Moderate	Low	Low	Low
Black-backed Woodpecker *(Picoides arcticus)*	Low	Low	Low	Low	Low
Boreal Owl *(Aegolius funereus)*	Low	Low	Low	Low	Low
Brown-capped Rosy Finch *(Leucosticte australis)*	Low	Low	Low	Low	Low
Great Gray Owl *(Strix nebulosa)*	Low	Low	Low	Moderate	Low
Greater Sandhill Crane *(Grus canadensis)*	Low	Low	Moderate	Low	Moderate
Juniper Titmouse *(Baeolophus ridgwayi)*	Low	Moderate	Low	Low	Moderate
Lark Bunting *(Calamospiza melanocorys)*	Low	Low	Moderate	Low	High
Lewis' Woodpecker *(Melanerpes lewis)*	Low	Low	Moderate	Low	Moderate
Mountain Plover *(Charadrius montanus)*	Low	Low	Moderate	Low	High
Northern Goshawk *(Accipiter gentilis)*	Low	Low	Low	Moderate	Low
Northern Pygmy-Owl *(Glaucidium gnoma)*	Low	Low	Low	Moderate	Low
Sage Sparrow *(Amphispiza belli)*	Low	Low	Moderate	Low	Moderate
Sage Thrasher *(Oreoscoptes montanus)*	Low	Low	Moderate	Low	Moderate
Western Scrub-Jay *(Aphelocoma californica)*	Low	Low	Low	Moderate	Moderate
Willow Flycatcher *(Empidonax traillii)*	Low	Low	Moderate	Low	Moderate

Table 1b. Vulnerability ranking results for 2010 SGCN amphibian species, sorted alphabetically within each overall vulnerability category (Pocewicz et al. 2014)

Name	Overall	Climate Change	Development	Disease	Landscape-based
Plains Spadefoot *(Spea bombifrons)*	Very High	High	High	Moderate	High
Wyoming Toad *(Anaxyrus baxteri)*	Very High	High	High	High	High
Columbia Spotted Frog *(Rana luteiventris)*	High	High	Low	Moderate	Low
Great Basin Spadefoot *(Spea intermontana)*	High	High	Moderate	Moderate	Moderate
Great Plains Toad *(Anaxyrus cognatus)*	High	Moderate	High	Moderate	High
Northern Boreal Toad *(Anaxyrus boreas boreas)*	High	High	Low	Moderate	Low
Wood Frog *(Lithobates sylvatica)*	High	High	Low	Moderate	Low
Northern Leopard Frog *(Lithobates pipiens)*	Moderate	Low	Moderate	Moderate	Moderate

Table 1c. Vulnerability ranking results for 2010 SGCN reptile species, sorted alphabetically within each overall vulnerability category (Pocewicz et al. 2014)

Name	Overall	Climate Change	Development	Disease	Landscape-based
Prairie Racerunner *(Aspidoscelis sexlineatus viridis)*	High	High	High	Low	High
Black Hills Redbelly Snake *(Storeria occipitomaculata pahasapae)*	High	High	Moderate	Low	Moderate
Great Plains Earless Lizard *(Holbrookia maculata)*	High	Moderate	High	Low	High
Northern Many-lined Skink *(Eumeces multivirgatus)*	High	Moderate	High	Low	High
Plains Gartersnake *(Thamnophis radix)*	High	Moderate	High	Low	High
Prairie Lizard *(Sceloporus consobrinus)*	High	Moderate	High	Low	High
Western Spiny Softshell *(Apalone spinifera hartwegi)*	High	Moderate	High	Low	High
Great Basin Skink *(Plestiodon multivirgatus ultivirgatus)*	Moderate	Moderate	Moderate	Low	Low
Midget Faded Rattlesnake *(Crotalus oreganus concolor)*	Moderate	High	Low	Low	Moderate
Northern Tree Lizard *(Urosaurus ornatus wrighti)*	Moderate	High	Low	Low	Moderate
Ornate Box Turtle *(Terrapene ornata ornata)*	Moderate	Moderate	Moderate	Moderate	High
Pale Milksnake *(Lampropeltis triangulum multistriata)*	Moderate	Low	High	Low	High
Plains Hog-nosed Snake *(Heterodon nasicus)*	Moderate	Low	High	Low	High
Rubber Boa *(Charina bottae)*	Moderate	High	Low	Low	Low
Smooth Green Snake *(Opheodrys vernalis)*	Moderate	Moderate	Moderate	Low	Low
Valley Gartersnake *(Thamnophis sirtalis fitchi)*	Moderate	Moderate	Moderate	Low	Moderate
Western Painted Turtle *(Chrysemys picta bellii)*	Moderate	Low	High	Low	High
Great Basin Gophersnake *(Pituophis catenifer deserticola)*	Low	Low	Moderate	Low	Moderate
Greater Short-horned Lizard *(Phrynosoma hernandesi)*	Low	Low	Moderate	Low	Moderate
Plains Black-headed Snake *(Tantilla nigriceps)*	Low	Low	Moderate	Low	High
Red-sided Gartersnake *(Thamnophis sirtalis parietalis)*	Low	Low	Moderate	Low	Moderate

Table 1d. Vulnerability ranking results for 2010 SGCN mammal species, sorted alphabetically within each overall vulnerability category (Pocewicz et al. 2014)

Name	Overall	Climate Change	Development	Disease	Landscape-based
Black-footed Ferret *(Mustela nigripes)*	Very High	High	Moderate	High	Moderate
Big Brown Bat *(Eptesicus fuscus)*	High	Low	Moderate	High	High
Bighorn Sheep *(Ovis canadensis)*	High	Moderate	Low	High	Low
Canada Lynx *(Lynx canadensis)*	High	High	Low	High	Low
Eastern Red Bat *(Lasiurus borealis)*	High	Low	High	Moderate	High
Little Brown Myotis *(Myotis lucifugus)*	High	Low	Moderate	High	Moderate
Moose *(Alces alces)*	High	Low	Moderate	High	Low
Preble's Meadow Jumping Mouse *(Zapus hudsonius preblei)*	High	High	Moderate	Low	Moderate
Pygmy Rabbit *(Brachylagus idahoensis)*	High	High	Moderate	Moderate	Moderate
Great Basin Pocket Mouse *(Perognathus parvus)*	Moderate	Moderate	Moderate	Low	Moderate
Idaho Pocket Gopher *(Thomomys idahoensis)*	Moderate	Low	High	Low	Moderate
Least Weasel *(Mustela nivalis)*	Moderate	Low	High	Low	Moderate
Northern Myotis *(Myotis septentrionalis)*	Moderate	Low	Moderate	Moderate	Low
Pallid Bat *(Antrozous pallidus)*	Moderate	Low	Moderate	Moderate	High
Piñon Mouse *(Peromyscus truei)*	Moderate	High	Low	Low	Low
Plains Harvest Mouse *(Reithrodontomys montanus)*	Moderate	Low	High	Low	High
Plains Pocket Mouse *(Perognathus flavescens)*	Moderate	Low	High	Low	High
Silky Pocket Mouse *(Perognathus flavus)*	Moderate	Moderate	Moderate	Low	High
Swift Fox *(Vulpes velox)*	Moderate	Low	High	Low	High
Wolverine *(Gulo gulo)*	Moderate	High	Low	Low	Low
Wyoming Pocket Gopher *(Thomomys clusius)*	Moderate	Moderate	Moderate	Low	High
American Pika *(Ochotona princeps)*	Low	Moderate	Low	Low	Low
Canyon Mouse *(Peromyscus crinitus)*	Low	Moderate	Low	Low	Low
Cliff Chipmunk *(Neotamias dorsalis)*	Low	Low	Moderate	Low	Moderate
Dwarf Shrew *(Sorex nanus)*	Low	Low	Moderate	Low	Low
Fisher *(Martes pennanti)*	Low	Low	Low	Low	Low
Fringed Myotis *(Myotis thysanodes)*	Low	Low	Moderate	Low	Moderate
Hayden's Shrew *(Sorex haydeni)*	Low	Low	Low	Low	Low
Hispid Pocket Mouse *(Chaetodipus hispidus)*	Low	Low	Moderate	Low	High
Long-eared Myotis *(Myotis evotis)*	Low	Low	Moderate	Low	Moderate
Long-legged Myotis *(Myotis volans)*	Low	Low	Moderate	Low	Moderate
Marten *(Martes americana)*	Low	Low	Low	Low	Low
Northern Flying Squirrel *(Glaucomys sabrinus)*	Low	Low	Low	Low	Low
Olive-backed Pocket Mouse *(Perognathus fasciatus)*	Low	Low	Moderate	Low	High

Name	Overall	Climate Change	Development	Disease	Landscape-based
Plains Pocket Gopher *(Geomys bursarius)*	Low	Low	Moderate	Low	High
Preble's Shrew *(Sorex preblei)*	Low	Low	Moderate	Low	Low
Pygmy Shrew *(Sorex hoyi)*	Low	Moderate	Low	Low	Low
River Otter *(Lontra canadensis)*	Low	Low	Moderate	Low	Moderate
Spotted Bat *(Euderma maculatum)*	Low	Low	Moderate	Low	Moderate
Spotted Ground Squirrel *(Spermophilus spilosoma)*	Low	Low	Moderate	Low	High
Townsend's Big-eared Bat *(Corynorhinus townsendii)*	Low	Low	Moderate	Low	Moderate
Uinta Chipmunk *(Neotamias umbrinus)*	Low	Low	Low	Low	Low
Vagrant Shrew *(Sorex vagrans)*	Low	Low	Moderate	Low	Low
Water Vole *(Microtus richardsoni)*	Low	Moderate	Low	Low	Low
Western Small-footed Myotis *(Myotis ciliolabrum)*	Low	Low	Moderate	Low	Moderate
Yellow-pine Chipmunk *(Neotamias amoenus)*	Low	Low	Moderate	Low	Low

Disruption of Historic Disturbance Regimes

Photos courtesy of WGFD

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Background

A disturbance is any event or series of events that alters ecosystems by affecting functions or processes, habitats, animal populations, or their physical environments, by either natural or human causes. Disturbances are natural components of virtually all ecosystems and can include fires, floods, droughts, storms, herbivory, and disease outbreaks. Humans are significant agents of habitat disturbance, and examples of human-induced disturbances range from pre-European settlement fires set by Native Americans to improve game habitat to modern-day mechanized logging and crop cultivation. Some human activities can mimic natural disturbances and are important in maintaining or enhancing wildlife diversity, while others can degrade habitat and may even lead to species extinctions.

A disturbance regime is distinguished from a single disturbance event by describing a pattern, frequency, and intensity of disturbances across the landscape or watershed. For terrestrial ecosystems, variations in these factors, along with changes in soil and topography as well as competitive interactions among plants, typically result in patches of vegetation in various stages of disturbance and recovery. Patches can be distinguished from each other by the height and structure of individual plants as well as the composition of plant species, both of which change over time as regeneration progresses. "Patch dynamics" and "shifting mosaic steady-state" are concepts used to describe this dynamic. The attributes of various disturbance regimes vary with the natural communities in which they occur.

Disturbances can act both singly and in concert with multiple other disturbances to determine plant and animal communities. The number and type of disturbances can change over time. Maintaining wildlife diversity as well as habitat for individual species often depends upon the availability of a patchwork of cover and habitat types throughout the landscape. In addition to wildlife habitat and plant regeneration, periodic disturbances are essential to maintaining the productivity of an ecosystem and its capacity to produce clean air and water through facilitating nutrient cycling.

The loss of "historic"[1] disturbances as well as interactions within and between various types of disturbances and associated habitats is a significant cause for the decline and extinction of many wildlife species. Flow alteration is the leading cause for reductions in native plant and animals populations in rivers worldwide (Poff et al. 1999). In the Rocky Mountain West, fire suppression and altered grazing patterns by wild and domestic ungulates have contributed to declines in aspen (Nicholoff 2003). In Wyoming, it is estimated that over half of the recent historic aspen acreage has converted to other community types (Nicholoff 2003). Aspen stands are second only to riparian areas in biodiversity (Kay 1998).

Disturbances such as fire, floods, and insect outbreaks can be detrimental to human health or destructive to human property. There have been efforts to limit natural fluctuations in abundance associated with disturbance cycles in favor of achieving consistent, sustained yields for plants and animals which have high economic or social values such as timber, livestock forage plants, and game animals. Disturbance regimes under which many native habitats and wildlife evolved may be lost, altered, or no longer possible as natural habitats become increasingly fragmented and modified through human development. Additionally, climate change will likely further alter the frequency, type, and intensity of disturbances as well as the local composition of plants and animals responding to these events.

The role of historic disturbances in maintaining native species and habitats has only recently

[1] "Historic" disturbance regime refers to environmental disturbances under which native species and habitats evolved. This term has been selected as opposed to "natural" disturbance regime since it is often not possible, or meaningful, to segregate the influence of pre-Columbian human-induced disturbances caused by Native Americans, such as fires intentionally lit to improve game habitat, from those caused by natural sources, such as lightning strikes.

become known and appreciated by habitat managers. In order to conserve native species and habitats, more effort is being placed on retaining historic disturbances where possible or mimicking their effects by active management where not. While Wyoming habitats are influenced by a diversity of historic disturbances, alterations to historic stream flow, fire, and herbivory regimes are considered the most significant and will be the focus of this chapter.

Scope and Challenges of Integrating Historic Disturbance Regimes into Wildlife Conservation

Disruption of Water Flow Regimes

Variation within and between seasons in the timing, duration, frequency, and magnitude of water flows are typical for rivers and streams in Wyoming. Seasonal spring floods move water and sediment through channels and onto floodplains, depositing or exposing alluvial soils necessary for the establishment of cottonwoods, willows, and other riparian plants (Friedman et al. 1997). High water flows move fine sediments and maintain gravel and cobble habitats, which support diverse aquatic insect communities and fish spawning sites. Spring runoff and high water events also bring woody material into stream channels, providing structure and food for aquatic species. Other important habitat features, such as cobble bars and scour-pools, are also formed and maintained by high flushing and channel-forming flows. The timing of high water events is important to the lifecycles of many aquatic and riparian species. For example, the seed release of riparian trees such as willows and cottonwoods is synchronized with the timing of spring flood recession to maximize dispersal efficiency and germination (Natural Resources Conservation Service 2006).

Natural flow regimes in many stream segments around the state have been severely altered by a number of human activities including irrigation diversions, hydroelectricity, waste disposal, and flood control. In the United States, only 2% of rivers remain in their natural, unmodified condition (Graf 1993). In Wyoming, the disruption of flow regimes is often a consequence of broad-scale changes in land use and management such as agriculture, grazing, timber harvest, and housing development. These activities can affect the amount and type of streamside vegetation and the quantity and rate at which precipitation flows over and through the land to streams and lakes, altering both ground water cycles and surface flow regimes.

Such flow regime changes can affect plants and animals by altering water quality (e.g., increasing sediment, organic material, and pollutants, raising water temperatures, and reducing dissolved oxygen) and changing physical stream characteristics. Secondary effects can include altered species interactions (e.g., a shift in competitive advantage for one species), increased disease transmission, and accelerated exotic species invasion. Communities may also be negatively impacted by flow alterations from land-use changes by ground water depletions, declines in water quality and flow availability, and more frequent and intense flooding (Natural Resources Conservation Service 2006).

Wyoming is an arid state, and considerable development of dams and water diversions has occurred to control, store, and deliver water, as well as to produce hydroelectric power. There are approximately 1,530 permitted dams in Wyoming which are subject to regulation under Wyoming Safety of Dams Statutes (W.S. 41-3-307 through 41-3-318)[2] and many smaller dams that are not subject to state or federal Safety of Dams regulations. Most of the dams in the state were constructed to provide water for irrigation, enhance the availability of domestic

[2] Section 41-3-307 defines the term dam as any artificial barrier, including appurtenant works, used to impound or divert water and which is or will be greater than twenty (20) feet in height or with an impounding capacity of fifty (50) acre-feet or greater. Dams with less than 15 acre-feet capacity regardless of height, or 6 feet or less in height regardless of capacity, are excluded provided that there are no habitable buildings immediately downstream.

water supplies, reduce the risk of flooding, and provide new boating and fishing opportunities on manmade reservoirs.

While water development can threaten native species, some coldwater fish species, such as trout, and warmwater species, such as walleye, have benefited from dam construction. The simplification of natural systems by human development tends to favor species with generalized and broad habitat requirements. For example, the walleye fisheries in the North Platte River reservoirs and Boysen Reservoir depend on the consistent deep water and forage production inherent in these man-made water bodies. Stable stream flow releases from dams, with relatively low peak flows and relatively high base flows, perpetuate productive sport fisheries. The famous "Miracle Mile" trout fishery below Kortes Dam and the "Grey Reef" fishery below Alcova Dam are examples.

Alternatively, dams and water diversions typically result in major alterations to natural flow regimes that negatively impact many species (Annear et al. 2004). Most notably, dams reduce peak flows commonly associated with spring runoff and change the quantity, timing, and consistency of base flows. The loss of high spring flushing flows on dammed rivers greatly reduces the natural cycle of sediment transport and deposition. Depending on a variety of factors, releases from dams can accelerate down-cutting of stream channels to the extent that side channels and shallow water habitats are depleted or eliminated. In other situations, releases can lead to the armoring of the stream channel by removing most of the fine materials from the streambed and leaving an almost impervious surface with diminished value for aquatic insects and fish. These and other changes in channel geomorphology also favor the replacement of native cottonwoods and willows, which are dependent upon seasonal flooding for seedling establishment, by Russian olive and tamarisk (commonly referred to as saltcedar), which are exotic invasive species. Reduction in the size and structural complexity of cottonwood stands, through lack of tree regeneration, has been associated with declines in riparian bird species diversity (Slater 2006). In Wyoming, cottonwood declines have been linked to flow alterations on the North Platte (Miller et al. 1995) and Bighorn Rivers (Akashi 1988, Bray 1996).

Dams and water diversions can also significantly limit connectivity in stream habitat and prevent seasonal migrations of aquatic species. Dams are a leading cause in the reduction of range-wide sauger numbers and significantly contributed to their extirpation from the North Platte River drainage in Wyoming (Nelson and Walburg 1977, Hesse 1994, Pegg et al. 1996, 1997, Maceina et al. 1998, McMahon and Gardner 2001). Dams and diversion structures have also isolated several Colorado cutthroat trout populations in headwater tributaries within the Little Snake River watershed (Cook 2009).

Reduction in the number and distribution of beaver is another major contributor to altered stream flows. Similar to man-made dams, beaver ponds accumulate sediment, improve water quality, reduce stream velocities, raise water tables, and increase the size of associated riparian zones. These effects create and maintain both terrestrial and aquatic habitats. Beaver ponds also control the timing and duration of flow in streams by slowing surface-water runoff and storing large amounts of water in the surrounding water table. Much of this stored water releases into streams throughout the year, which helps maintain late-season flow in many small streams with high beaver densities. In some active beaver habitats, bird densities have been shown to be three times that of adjacent riparian habitats (Collins 1993). Studies have also shown that trout size and biomass are greater in streams with beaver ponds (Olson and Hubert 1994). Over the centuries, beaver ponds have trapped tens to hundreds of billions of cubic meters of sediment that would otherwise been carried downstream (Naiman et al. 1988). Today, the physical character and vegetation of many meadowlands is the result of historic beaver activity.

Fur trapping in the 19th century greatly reduced beaver numbers and extirpated them from many areas. By the early 21st century, beavers have reoccupied most of their historic range, but at only approximately 10% of the pre–European-contact densities (Naiman et al. 1988). One study found that beavers had been extirpated from more than 25% of first, second, and third order streams in Wyoming, and concluded their historic ecological influence was absent from a far greater percentage (McKinstry et al. 2001).

Predicted future rises in mean temperature and greater variability in precipitation may lead to less snow accumulation, shorter and earlier spring runoffs, and higher evaporation rates (IPCC 2007). These changes will likely further compound the effects of current disruptions to historic flow regimes. Additionally, as the human population of the region grows, additional dams and diversions will likely be created to ease the growing demand for water resources by various user groups.

Notable Wyoming Species of Greatest Conservation Need (SGCN) negatively impacted by alterations to natural flow regimes in Wyoming include bluehead suckers, flannelmouth suckers, roundtail chubs, western silvery minnow, sauger, cutthroat trout (Bonneville, Yellowstone, Snake River, and Colorado River), Wyoming toad, and northern leopard frog.

Alterations to Fire Regimes

Historically, fires were common in Wyoming wherever sufficient fuel accumulated. Semiarid deserts and plains likely burned infrequently, but fires were a regular occurrence in riparian zones, montane forests, some grasslands and dense shrublands and woodlands (Knight 1994).

Fire frequency and severity vary by climatic conditions, site characteristics, and vegetation types. In turn, these variables influence the plants that re-colonize a site and the wildlife species that inhabit it during the vegetation successional stages that follow. Native Americans often started fires to facilitate hunting, either to attract animals to palatable re-growth or by using fire as a tool to drive game (Knight 1994). A review of historical accounts of fire in the Rocky Mountains concluded that fires set by Native Americans were common in lowlands and may even have occurred annually, though not likely in the same spot in consecutive years (Gruell 1985). In the foothills, prior to European settlement, fire may have occurred every 5 to 25 years (Knight 1994). Fire intervals in sagebrush habitats and forests in Wyoming were more variable and site-specific. In forested areas, fire intervals likely ranged from decades at lower elevations to several hundred years or more in high alpine forests, where fuel levels are low and required climatic conditions rare (Knight 1994). Estimates on historic fire intervals for sagebrush habitats range from every 10 to 400 years or longer depending upon species and site conditions (see Sagebrush Shrublands Habitat Type).

Fire releases nutrients and increases the amount of bare soil. Fire-blackened soils warm quickly, which increases microbial activity, furthering nutrient cycling and encouraging plant growth. In forests, fire can reduce canopy coverage favoring the growth of sun dependent plants. In prairies, fire can remove dead vegetation that hinders new growth, reduce invasive plants[3], and encourage native species. Due to variations in plant species tolerance levels, fire can have a significant influence on plant species composition. Because fires kill many young trees and some shrubs it can often create savannas by reducing tree densities. Ponderosa pine habitats in Wyoming were believed to be more savanna-like prior to European settlement as a result of frequent fires (see Xeric Forests Habitat Type).

Intensity has a strong influence on the ecological effects of fire. Extremely hot fires that burn through the forest canopy can kill most of the trees and significantly alter habitats.

[3] Fire can also promote the spread of cheatgrass and other invasive species under certain circumstance (Paige and Ritter 1999).

In contrast, surface fires often burn forest floor litter and kill few organisms. Perennial grasses, forbs, and some shrubs and trees have the ability to sprout from surviving roots, leading to recovery in several years (Knight 1994).

Beginning in the 20th century, fire suppression management techniques have been linked to increasing fire severity due to greater fuel load accumulations (Omi and Martinson 2004).

Ponderosa pine, limber pine, and Douglas-fir appear to be increasing in density and expanding their range in part as a result of fire suppression (Knight 1994). Many believe that juniper has expanded its range northward and to lower elevation grasslands and shrublands that previously had higher fire frequencies (Gillihan 2006).[4] Increasing tree densities and greater age uniformity among lodgepole and ponderosa pine stands have led to increased stress resulting from competition for water and soil nutrients, which may be causing trees to become more susceptible to mountain pine beetle infestations (Knight 1994).

Fire suppression and increased grazing by wild and domestic ungulates have led to notable declines in aspen, true mountain-mahogany, serviceberry, and skunkbush sumac. These species provide important food and cover for a diversity of wildlife. Throughout the West, aspen have declined between 50 to 96% (Bartos and Mitchell 2000).

Changes to historic fire regimes, both natural and prescribed, have also altered the interaction of fire with other disturbances, most notably grazing. Grazing animals are attracted to burned areas immediately following fires to feed on nutritious re-growth. In contrast, most current fire management strategies recommend growing season deferment from livestock grazing for one or more years following fires to facilitate native plant growth and reduce the establishment of invasive plant species (Bureau of Land Management 2005). Similarly, prescribed fires are often applied to entire pastures during the dormant growing season, whereas historical fires were likely patchy in distribution and occurred during mid to late summer when there is the highest incidence of lightning strikes. Over the past decade, the Wyoming Game and Fish Department's prescribed fire plans have been increasingly focused on promoting patchiness.

Cheatgrass is an increasing annual invasive from Eurasia. Cheatgrass is highly fire-adapted and fire prone and has the potential to increase fire frequency in areas where it becomes widely established (Whisenant 1990). Altered fire regimes can change an entire plant community by converting native grassland, sagebrush, and other plant communities to cheatgrass-dominated landscapes. Of special concern are the loss of crucial sage-grouse and other wildlife habitats along with secondary weed invasions from species such as rush skeletonweed and Medusa-head wild rye (Smith and Enloe 2006).

Climate change is expected to increase precipitation variability and drought frequency (Christensen et al. 2007). Both factors will likely further alter historic fire regimes in Wyoming. The length of the fire season in the U.S. has increased significantly over the past 30 years and is expected to continue to grow in coming years (Westerling et al. 2006, Barnett et al. 2004). Moreover, the amount of acres burned each year in the West over the past two decades has also increased (National Wildlife Federation 2010). Wildfire coupled with a combination of warming temperatures, drought, and vegetation changes resulting from changing climate factors may lead to drastic ecosystem changes in the future.

Alteration to Grazing Regimes

Herbivory has a long history of influencing habitats and associated plants and animals (Milchunas et al. 1988). Before the arrival of Europeans, bison, elk, deer, antelope, prairie dogs, as well as a diversity of other wildlife and

[4] Some researchers believe that historic climate change may have an equal or greater influence on juniper distribution in the West which has gone through a number of range expansions and contractions (Miller and Wigand 1994.)

insects, grazed and browsed Wyoming vegetation. Today, elk, deer, and antelope remain abundant, while domesticated livestock are the predominant grazers across Wyoming ecosystems.

Grazing is a keystone process in maintaining habitat diversity (Collins 1992, Knapp et al. 1999). Historically, the distribution of grazing ungulates was uneven across the landscape. Prior to European settlement, grazing and fire interacted closely to influence bison behavior. Bison were attracted to recently burned areas to graze on palatable, re-sprouting grasses. This localized high grazing pressure permitted vegetation in other areas to accumulate which in turn made these locations more prone to subsequent fire (Fuhlendorf and Engle 2001, Fuhlendorf et al. 2009). Prairie dogs, often thriving in areas recently grazed by bison, lived in large colonies, digging burrows and cropping vegetation. Burrows and open patches of ground created by bison and prairie dog colonies create habitat for other wildlife species including the black-footed ferret, burrowing owls, long-tailed weasel, mountain plover, and swift fox (Kotliar et al. 1999, Kotliar 2000). The resulting patchwork of variation in plant structure and composition shifted across the landscape.

Bison and prairie dogs have experienced substantial reductions in both numbers and range. Other pre-Columbian herbivores, like the Rocky Mountain locust, which likely had a very significant grazing impact during outbreaks, are believed to be extinct (Lockwood 2004).

Cattle and sheep were introduced in large numbers in Wyoming in the 1880s following the elimination of bison in most areas of the state outside Yellowstone National Park. Uncontrolled livestock grazing at the end of the 19th century and the beginning of the 20th century substantially altered some ecosystems (Belsky and Blumenthal 1997). In 1934, the federal Taylor Grazing Act was passed, which led to the creation of grazing districts in which grazing use was apportioned and regulated on public lands. Since this time, range conditions and grazing practices have improved although some habitats remained modified by this period of overuse through changes in plant composition as well as altered fire frequency (Laycock 1991).

Wildlife species often depend upon habitats produced by one grazing level while others require conditions supported by a diversity of grazing intensities (Derner et al. 2009, Toombs et al. 2010). For example, mountain plover and McCown's longspur prefer habitats that have been intensively grazed while Caspian sparrow thrives in more lightly grazed areas (Knopf 1996). In contrast, many modern rangeland management practices were developed to increase livestock production through evenly distributing livestock and enhancing vegetation use. This strategy emphasized uniform moderate grazing levels thereby eliminating grazing extremes (i.e., none, light, and heavy). Over time, such practices can lead to decreases in plant species and structural diversity (Fuhlendorf and Engle 2001). Although practices such as water placement can create grazing gradients by reducing grazing intensity at distances farther from water sources, such gradients tend to be static if water sources are not moved or altered. In such cases, repeated, heavy, localized grazing can lead to the initial stages of rangeland deterioration (National Research Council 1994).

Riparian areas are often the most diverse and productive habitats in Wyoming. Most riparian habitats evolved with some feeding and trampling from animals; however, repeated intensive use during the same season each year can have negative impacts. Impacts include a change, reduction, or elimination of bank vegetation; increased water temperatures; excessive sedimentation and upland erosion; channel widening and bank sloughing; and heightened coliform bacterial counts (Kauffman and Krueger 1984). Although livestock are often associated with riparian overuse, high concentrations of wild ungulates, particularly elk, have substantial impacts on riparian and aspen communities (Ripple and Beschta 2004).

There has been considerable improvement in conditions for many riparian areas through improvements in livestock management strategies (Smith et al. 1992).

In addition to being a natural component of many Wyoming habitats, grazing is the cornerstone of Wyoming's ranching industry. The continued function of a considerable amount of crucial wildlife habitat located on private land within the state is closely tied to the future sustainability of the state's ranches, which will continue to increase with increasing partnerships between ranchers, conservation organizations, and state and federal land management agencies (see Wyoming Leading Wildlife Conservation Challenges – Rural Subdivision and Development).

Current Initiatives to Maintain, Restore, or Duplicate Historic Disturbance Regimes

Hydrology

In 2001, several habitat types were identified in the WGFD Strategic Habitat Plan (SHP) that are considered particularly important to maintain or enhance. Among these were riparian and wetland habitats, prairie stream systems, and cutthroat trout streams. Declines in late season water flows, water quality, and loss of water flow and native fish due to water diversions are significant factors contributing to less than optimal prairie stream system habitat and adversely affecting cutthroat trout habitat. Updates to the SHP in 2009 and 2015 identified specific regional priority areas for conservation work. These areas included crucial areas, necessary for maintaining terrestrial and aquatic wildlife populations and enhancement areas where there is the potential to enhance or improve important wildlife habitats that have been degraded. Combined, these prioritization efforts will help guide conservation and restoration efforts for aquatic habitats.

In 2008, fish passage goals were added to the SHP and in July 2009, the WGFD designated fish passage as a department program with an associated budget. Projects completed and continuing around the state include reinstalling or replacing culverts that prevent passage, replacing or modifying diversion dams to provide upstream passage, installing bypass channels around diversion structures, and screening diversion ditches and canals. Fish movement studies continue to be used to evaluate upstream passage at existing diversion structures and fish mortality in various canal systems. The WGFD developed a fish passage database to document fish passage diversions around the state and prioritize projects to address passage issues.

The Bureau of Reclamation, State Engineer's Office, Wyoming Water Development Commission, and the WGFD have worked together to establish formal and informal water management strategies for some reservoirs. These agreements benefit aquatic wildlife, including sport fisheries, while still serving the reservoirs' legislatively authorized purposes. Examples include the Snake River below Jackson Lake Dam, Shoshone River below Buffalo Bill Dam, Green River below Fontenelle Reservoir, Bighorn River below Boysen Reservoir, and the North Platte River below Kortes, Pathfinder, Grey Reef, and Glendo Dams. Maintaining historic flow regimes is typically a secondary consideration compared to traditional focuses on flow releases to benefit agriculture, sport fisheries, and recreation.

Instream flow water rights provide the ability to manage natural flow regimes up to designated base levels for fisheries and, by association, may benefit nearby riparian corridors. The WGFD began evaluating various methods and quantifying instream flow needs for fish in 1979. In 1986, the Wyoming Legislature enacted a statute (41-3-1001 to 41-3-1014) that formally recognizes opportunities to maintain or improve instream flow as a beneficial use. Because water rights can only be issued for uses that have been officially recognized as "beneficial," this designation is of critical importance. Since the inception of the program, the WGFD has employed biologists to identify priority areas and quantify instream flow regime needs for fish habitat, and the WGFD has submitted applications for over 140 instream flow water rights. The program is reviewed on an annual basis and a water management plan is updated with explicit goals for upcoming efforts.

Wyoming has also undertaken a comprehensive water planning effort which has influence on the management of flow regimes. In 1999, the Wyoming Legislature approved a planning framework and authorized plans for the Bear and Green River Basins (Wyoming Water Development Office 2010). In the years that followed, the Legislature authorized funding for the five remaining river basins. The Platte River Basin Plan was the last plan completed, in May 2006. Anticipating completion of the individual river basin plans, the 2005 Legislature authorized funding for the Statewide Framework Water Plan. The purpose of this plan is to summarize the results of all seven river basin plans and to provide future water resource planning direction to the state. It includes an inventory of the state's water resources and related lands, a summary of the state's present water uses, a projection of future water needs, and potential options for meeting those needs. In early 2010, initial steps were taken to address the plan's environmental and recreational components, including riparian habitats. These needs still require additional consideration and specification in all basin planning documents.

Fire

In Wyoming, the Bureau of Land Management (BLM), US Forest Service (USFS), Wyoming State Forestry Division, and other cooperators utilize the National Fire Plan (NFP) as the overarching plan to guide all fire management activities. NFP primarily focuses on ensuring there is capacity to address wildfire prevention, fire preparedness and suppression, as well as post-fire stabilization and rehabilitation. As one of many objectives, NFP includes elements of both duplicating historic fire regimes and benefitting wildlife habitat.

NFP prioritizes fire suppression responses through District Fire Management Plans and activity level plans. These plans dictate what Fire Management Units receive for fire suppression resources upon the detection of a fire as well as, based on a lightning tracking system, the allocation of resources prior to a fire. Fire Management Units are tied to local USFS Forest Plans, BLM Resource Management Plans (RMP), and Fire Management Plans which incorporate goals of managing for historic fire regimes. The LANDFIRE GIS system and Fire Regime Condition Class methodology are two tools which are used to determine fire fuel loads and departures from historic fire regimes in order to guide management objectives and set priorities for habitat and fuel treatments.

The NFP also establishes an intensive, long-term hazardous fuels reduction program. In many areas fuel loads are unusually high as a result of decades of fire suppression, sustained drought, and increasing infestations by insects, disease, and invasive plants. Hazardous fuels reduction treatments are designed to lower the risks of catastrophic wildfire to people, communities, and natural resources while restoring forest and rangeland ecosystems to closely match their historical structure, function, diversity, and dynamics. Treatments are administered using prescribed fire, mechanical thinning, herbicides, grazing, or combinations of these and other methods. Treatments are being increasingly focused on the expanding wildland/urban interface. Fuels management treatments are developed by teams of natural resource specialists.

When catastrophic fires do occur, stabilization and restoration work begins immediately to restore lands that are unlikely to recover naturally from the effects of wildfires. This work, often implemented over the course of several years following a wildfire, includes reforestation, fence replacement, fish and wildlife habitat restoration, invasive plant treatments, and replanting and reseeding with native or other desirable vegetation.

As the human population grows, concerns for human safety and property loss will diminish the viability of natural and prescribed fire in habitat management. In many locations in Wyoming, commercial timber harvest is also economically important and will continue to be a leading forest management objective (Wyoming State Forestry Division 2009). Under these circumstances, efforts have been placed on duplicating the effects of fire in forest management activities including commercial timber harvest (North and Keeton 2008). Silviculture practices designed to duplicate the effects of historic disturbance regimes typically include increasing forest structural complexity, plant species diversity, and spatial patterns of timber removal and thinning (North and Keeton 2008). Accomplishing these goals may require lengthening tree harvest rotations and retaining large green trees, snags, and logs in harvested areas (Swanson and Franklin 1992, Franklin et al. 1997). While the effects of fire can be duplicated by mechanical and other means, reproducing its influence on soil turnover, soil carbon dynamics, and nutrient cycling is more difficult (North and Keeton 2008).

Herbivory

Nationwide, grazing occurs on approximately 160 million acres of BLM land and 81 million acres of USFS land (Vincent 2012). The terms and conditions for grazing on federal lands (such as stipulations on utilization levels and season-of-use) are set forth in the permits. Grazing permits issued by the USFS and BLM last 10 years and are renewable if it is determined that the terms and conditions of the expiring permit are being met. To achieve desired conditions, these agencies use rangeland health standards and guidelines. The BLM Code of Federal Regulations establishes intervals and standards for monitoring grazing permits. The results of monitoring help managers determine whether changes are necessary for livestock grazing management. The USFS conducts both implementation monitoring annually to evaluate vegetation use and permit compliance, and effectiveness monitoring every five to six years to assess whether activities and objectives set forth in forest plans, allotment management plans, or other relevant documents are being met.

State-owned lands are typically managed in conjunction with the ownership of surrounding lands including private landowners and federal land management agencies. Every state parcel has a field sheet that describes the land's elevation, topography, annual anticipated precipitation, and soil type. The sheet also contains information about the amount and type of vegetation present which is used to calculate livestock stocking rates. An inspection of each parcel is planned once every 10 years to update the field sheet and address any concerns. Priority is given to known problem areas. The Wyoming Office of State Lands and Investments, which manages state lands, cooperates with the Natural Resources Conservation Services (NRCS) on conservation and wildlife programs as well as with the BLM on allotment plans and local RMPs.

The NRCS, conservation districts, University of Wyoming Cooperative Extension program, and local Coordinated Resource Management teams have numerous programs and initiatives to assist landowners in establishing grazing management plans. Notably, the Environmental Quality Incentives Program (EQIP), administered by the NRCS, offers financial and technical assistance to implement grazing plans and improvements. Many of these programs benefit wildlife and apply disturbance regime management principles; however, duplicating historic disturbance regimes is rarely a predominant management goal in itself.

Current Challenges for Effectively Managing for Historic Disturbance Regimes

Difficulty in quantifying historic disturbance regimes.
The integration of disturbance regimes into habitat management decisions is often difficult because of a lack of the scientific consensus about the historic frequency and extent of some disturbance regimes. This can be complicated by the large time scales that characterize various disturbance events and long-term changes in climate that can alter the type and frequency of disturbances. Additionally, there is debate as to whether historic management practices of indigenous peoples, such as fire setting, should be factored into efforts to manage for disturbance regimes. Others argue it is arbitrary to select a specific historic time period as the benchmark for modern management strategies.

Insufficient financial incentives to offset reduced economic returns and greater time requirements needed to incorporate disturbance regimes into habitat management.
Current habitat management strategies often emphasize managing for a single species or products such as livestock, game, or timber. It is often perceived that increased variability associated with disturbance regimes may reduce sustained yields. Competitive compensation in terms of direct monetary incentives or demonstrated increases in long-term production needs to be provided before historic disturbance regime strategies are widely adopted.

Human-safety and property-loss concerns often limit the degree to which natural disturbances can be allowed to proceed without intervention or can be actively prescribed in habitat management strategies.
Greater numbers of people and structures in areas where fires have historically been common have limited the ability of agencies to allow wildfires to burn or to incorporate prescribed fires into habitat management strategies. Similar concerns may apply to natural flooding events by rivers and streams. Environmental concerns, including releasing carbon into the atmosphere, may limit future fire activities.

There is often a lack of understanding about the effects of historic disturbance regimes or the landscape implications of individual management actions.
At present, there is often insufficient funding for monitoring. This can limit the ability of agencies to understand the effects of existing management actions or the long-term effects of natural disturbances when they occur. Most disturbance studies monitor the influence of a single factor for a short period of time and are not directed toward evaluating multiple changes to natural systems. There is also a need for more research on how various types of historic disturbances and management actions interact with each other. Consequently, modeling efforts regarding the effects of historic disturbance regimes and their interactions are limited.

Inadequate public and political support for implementing actions that facilitate or duplicate historic disturbance regimes.
The complexity of natural systems and the multiple effects of historic disturbances make educational efforts challenging. The benefits of historic disturbance regime management can be long term and difficult to quantify. Existing knowledge is slow to be incorporated into policy. Additionally, increasing opposition is being raised regarding diminished aesthetic qualities which may follow management treatments such as prescribed fire.

Complexity of grant administration.
WGFD employee surveys have identified grant complexity as one of the leading impediments to expanding habitat work in Wyoming (WGFD 2016). Conflicting year-end funding cycles can make reporting for cooperative projects difficult. This complexity is compounded by differences in reporting requirements. Both these factors result in multiple annual funding reports occurring for individual projects,

typically all with a slightly different formats and content.

Insufficient budgets to administer management treatments.
Administering habitat treatments such as prescribed burns is expensive. Many natural resource agencies are experiencing budget freezes or reductions and have multiple competing interests. Lack of funding limits the ability to use existing funding sources due to difficulty in meeting matching fund requirements.

Regulatory demands, including the National Environmental Protection Act (NEPA) and the Endangered Species Act, can limit the ability to apply habitat management treatments that would duplicate historic disturbance regimes.
The NEPA requirements are lengthy and complex, and federal agencies must seek public comment at many points during the process. These requirements can prevent the application of treatments to duplicate historic disturbance regimes in a timely manner or diminish the cost-effectiveness of management actions due to the time and resources needed to complete the process. Concerns regarding the incidental taking of threatened or endangered species may also limit the ability to administer habitat treatments to duplicate historic disturbance regimes.

Uncertainty surrounding future climate change will compound difficulties for incorporating historic disturbance regimes into habitat management activities.
Climate change will alter the type, frequency, and intensity of historic disturbances as well as the composition of plants and animals responding to these events. While down-scaled climate models provide more spatially precise information about future climates, the uncertainties associated with the global models that were used to generate finer-scale models may remain unresolved, unquantified, and even magnified.

Recommended Conservation Actions

General Recommendations

Incentives should be provided to offset decreased financial returns or increased input costs that may accompany management strategies focused on replicating historic disturbance regimes.
Land and water management strategies are often focused on food, fiber, and energy production. Strategies intended to replicate historic disturbance regimes can result in reductions or delays in access to these resources. Before strategies that emphasize achieving specific ecological outcomes can be widely adopted, incentives need to be developed to compensate for financial losses which do not occur with traditional approaches that are more production-oriented. This is particularly true for privately-owned wildlife habitat.

Efforts should be made to link managing for historic disturbance regimes to natural resource issues of high public importance.
Managing for historic disturbance regimes can be expensive. Budget limitations will frequently require historic disturbance regime management strategies to be linked to high profile issues or the support of existing agency priorities. Disturbance regime management activities that reduce conditions favorable for bark beetle epidemics and catastrophic fires are good examples. Educational efforts are particularly important for habitat management treatments such as fire that have safety concerns, are highly visible, and may result in diminished grazing, recreation, or other uses during recovery periods.

Greater research and professional training efforts regarding interactions between historic disturbances should be pursued.
Most educational material and training for habitat and wildlife professionals concentrates on managing for individual species or products. There is relatively little information available about managing for multiple species and

ecological outcomes, or how various natural processes and disturbances influence one other. Current research gaps need to be identified in order to create effective training programs.

The implications of climate change on historic disturbance regimes should be reviewed and incorporated into habitat management and conservation activities as scientific knowledge improves.
Possible climate warming may result in major changes in historic disturbance regimes, plant and animal dynamics, and hydrological responses, and may further result in entirely unfamiliar species communities (Botkin et al. 2007). Existing climate-modeling science needs to be improved and validated to predict alterations to historic disturbance regimes in specific habitats. Research into localized climate change and associated ecological responses should be continually reviewed and considered in habitat conservation planning and wildlife species conservation and management.

Water-flow Regime Recommendations

Maintain U.S. Geological Survey streamflow monitoring gages.
The maintenance of streamflow gages is a fundamental first step in comparing present-day patterns to historic flow regimes. The U.S. Geological Survey (USGS) maintains a network of 7,292 stream-gaging stations, comprising more than 85% of the nation's total stations[5]. The continuation of gages is always uncertain and subject to federal funding availability. Through the National Streamflow Information Program (NSIP), the USGS can match non-federal investments in the Cooperative Water Program (CWP) on a 50:50 basis. Wyoming is a cooperator in the CWP through the State Engineer's Office, the Department of Environmental Quality, Department of Agriculture, and several other entities. In addition to the economic and infrastructure concerns, streamflow and water-quality data available through these programs are critical for designing stream habitat restorations, designing fish passage approaches, administering water rights, monitoring and protecting water quality, managing wetlands, and for analyzing climate change and identifying response options. To ensure that USGS stream-gaging stations are maintained, steps or a process to provide unified state support of the NSIP and CWP programs should be identified.

Explore statutory solutions and administrative policies that allow private water-rights holders to temporarily change the use of existing water rights to in-channel flows for fish and wildlife and retain ownership of those rights without diminishing their priority or standing.
Although Wyoming law allows protection of base level streamflow, the opportunities for dedicating existing water rights to restore stream flows are limited. Slight modifications to existing temporary use legislation and instream flow law that would support temporary in channel uses would greatly improve the state's ability to address fish and wildlife improvements primarily on private land. Such added flexibility would also allow the state to participate more effectively with federal resource objectives on matters such as clean water, endangered species, and federal farm programs, but do so under a framework that allows existing private landowners and the state to retain ownership and control of water rights.

Increase beaver restoration including the creation of a stream-prioritization system for future reintroductions.
Beaver are keystone species in creating and maintaining riparian habitats through dam-building activities. In Wyoming, beaver are entirely absent or present in significantly reduced numbers from much of their historic range. A system should be established to analyze and prioritize streams for reintroductions. Prioritization should take into consideration potential conflicts through

[5] Stage and flow or discharge are the two key factors measured at most stream-gaging stations. Stage is water depth above some arbitrary datum, commonly measured in feet. Discharge is the total volume of water that flows past a point on the river for some period of time, usually measured in cubic feet per second or gallons per minute.

unwanted flooding and tree damage. On average, 10 beavers are moved annually to promote riparian benefits. In 2015, a pilot effort began to test a Beaver Restoration Assessment Tool (BRAT; Wheaton and McFarlane 2014) in the Green River Basin. The tool uses GIS data to model historic and current beaver habitat to identify best locations to move beaver. This approach has been used extensively in Utah and may be applied across Wyoming pending the outcome of the pilot work.

Enhance fish passage work by fostering coordination among various groups.
Wyoming Water Strategy (2015) identifies collaboration on fish passage as one of 10 initiatives to maintain Wyoming's water resources. A variety of organizations have an interest in the ability of fish and other aquatic organisms to freely access habitats within their range. These organizations include the WGFD, Wyoming Water Development Commission, Trout Unlimited, Conservation Districts, NRCS, U.S. Fish and Wildlife Service, BLM, U.S. Forest Service, Bureau of Reclamation, and irrigation districts.

Fire Regime Recommendations

Increase the research and application of mechanical treatments to replicate historic fire regimes.
Safety and property-loss concerns will limit the use of fire as a management tool in areas of increased human development. This trend is likely to continue as Wyoming's population continues to grow. Additionally, some climate models for Wyoming predict a rise in temperature and the frequency and severity of drought, which may lead to more fires (Christensen et al. 2007). Under these circumstances, funding directed for climate-change adaptation should be made available for research and projects to duplicate the ecological effects of fire.

Increase fire-management budgets.
Prescribed burns can be expensive in terms of planning, treatment, and post-fire monitoring and management. Long-term cost reductions through reducing future expenses in fighting catastrophic fires and associated property loss should be factored into budgeting for prescribed fires.

Herbivory Regime Recommendations

Working in cooperation with Wyoming livestock producers and federal and state agencies who issue, authorize, and manage grazing permits will be critical to implementing the following recommendations.

Management often needs to occur at a landscape level in order to replicate historic grazing regimes.
Individual pastures and grazing allotments are often not sufficiently large to replicate the historic mosaic of varying grazing intensities under which many native wildlife species evolved. Where practical, investigations should be conducted about managing multiple public grazing allotments to achieve the needed management scale. With adequate incentives, private lands could also be incorporated into these efforts. It should be noted that grazing strategies cannot be universally applied, but rather should be outcome and habitat specific. Additionally, the establishment of grazing strategies focused on duplicating past disturbance regimes may be limited in sites where there is in sufficient knowledge of historic regimes and ecological processes, and wildlife species' responses.

Use livestock grazing and associated management as a tool to improve wildlife habitat and maintain native plant communities.
Livestock grazing and livestock grazing management practices can be used as an effective tool for improving wildlife habitat. Some research suggests that livestock grazing can be managed to benefit grassland bird species (Derner et al. 2009, Toombs et al. 2010) and improve forage quality on elk winter range (Clark et al. 2000). The use of livestock grazing to meet habitat objectives should be considered. In addition, it is possible that livestock grazing

disturbances before fire may decrease cheatgrass invasions (Davies et al. 2009).

The number of grassbanks should be increased to provide flexibility in applying range management practices.
Grassbanks or forage reserves refer to scenarios where forage is reserved for use and subsequently provided in exchange for management or conservation actions on another property. Such areas can also serve as relief valves or areas for grazing when wild fires remove forage from surrounding areas. Grassbanks have been a component of habitat treatments, such as prescribed fire, where grazing must be reduced or deferred. Both public and private lands[6] have been used for grassbanks. Grassbanks can increase habitat treatment options for both land management agencies and private landowners.

Maintain hunter access to keep game herds within range capacity and evenly distribute grazing pressure.
Hunter harvest is often needed to keep big game herd populations within established herd objectives and within the carrying capacity of the land. Big game animals tend to congregate in areas where there is little hunting pressure or where hunting is prohibited, diminishing overall hunter harvest. Riparian and aspen habitats, two of Wyoming's most ecologically diverse habitats, can be locally impacted by overuse by big game animals, particularly elk. Sagebrush, mountain shrub, and some grassland communities have been degraded by overuse by big game in some areas. Efforts should continue to ensure adequate hunter access is maintained to ensure the health and productivity of these habitats.

[6] Grassbanks on private land have often been owned by conservation groups such as The Nature Conservancy.

Evaluating/monitoring Success

Benchmarks should be developed to evaluate the success of habitat treatments based on desired ecological outcomes.
Currently, the success of management actions is often quantified by the extent of treatments, such as number of acres burned. More appropriately, success should be evaluated by the ability to achieve post-treatment vegetation goals. The development of new benchmarks would require additional monitoring and research to document multiple effects of management actions. Frequently, additional resources will be needed to allow for adequate post-treatment monitoring.

Monitor the landscape changes in vegetation-distribution patterns to help guide habitat management actions to support or replicate the effects of historic disturbance regimes.
Technology, including remote sensing analysis, is useful in tracking the size and distribution of vegetation communities, which can reflect the frequency and intensity of historic disturbances such as fire and, to a lesser extent, grazing. Evaluation of vegetation patterns can assist in both determining deviations from historic disturbance regimes and directing where habitat management actions should be administered and where natural disturbance should be allowed to proceed. This technique will require the further development of monitoring protocols and the identification of sample sites. Monitoring should be conducted in relation to the possible effects of climate change.

Increase the development and accessibility of the WGFD's fish passage database.
The WGFD has established a database to track the location, type, extent, and physical characteristics of fish passage barriers on Wyoming waters. The database can be used to prioritize passage improvement efforts within and across drainages. There are 1,174 total entries in the fish passage database as of January 3, 2017. Since, 2012, there have been 342 entries into the fish passage database. These

entries have helped prioritized fish passage improvement projects, future field work, and allocating the fish passage grant money.

The potential effects of climate change should be monitored to determine alterations to historic disturbance regimes and appropriate management responses. Warmer and drier conditions, which have been predicted for Wyoming (Christensen et al. 2007), will fundamentally alter historic disturbance regimes, especially in regards to their frequency and intensity. Greater habitat diversity associated with integrating disturbance regime principles into management practices will increase ecosystem resilience to climate change (Joyce et al. 2000). Research and habitat monitoring data related to climate change should continually be reviewed and adaptive management principles applied to disturbance regime management practices.

Continue to monitor water flows through USGS streamflow monitoring stations.

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Additional Resources

USDA – Agricultural Research Service
High Plains Grasslands Research Station
8408 Hildreth Road
Cheyenne, WY 82009

Bureau of Land Management –
Wyoming State Office
5353 Yellowstone Road
Cheyenne, WY 82009
P.O. Box 1828,
Cheyenne, WY 82003-1828
Phone: (307) 775-6256
http://www.blm.gov/wy/st/en.html

Bureau of Reclamation
Wyoming Area Office
P.O. Box 1630
Casper, WY 82644
Phone: (307) 261-5671
http://www.usbr.gov/gp/wyao/

Natural Resources Conservation Services –
Wyoming State Office
100 East B Street, 3rd Floor
Casper, WY 82602-5011
P.O. Box 33124
Casper, WY 33124
Phone: (307) 233-6750
http://www.wy.nrcs.usda.gov/

The Nature Conservancy in Wyoming
258 Main Street, Suite 200
Lander, WY 82520
Phone: (307) 332-2971
http://www.nature.org/wherewework/northamerica/states/wyoming/

Trout Unlimited –Wyoming
250 North 1st Street

Lander, WY 82520
P.O. Box 64
Lander, WY 82520
Phone: (307) 332-6700
http://wyomingtu.org/

University of Wyoming Extension Cooperative Service
Dept 3354
100 East University Avenue
Laramie, WY 82071
Phone: (307) 766-5124
http://www.uwyo.edu/uwe/

U.S. Fish and Wildlife Service
Wyoming Field Office
5353 Yellowstone Road, Suite 308A
Cheyenne, WY 82009
Phone: (307) 772-2374

U.S. Forest Service R2/R4
Wyoming Capitol City Coordinator
Herschler Building 3 West, Room 3603
122 West 25th St.
Cheyenne, WY 82002-0600
Phone: (307) 777-60870

United States Geological Survey
2617 East Lincolnway, Suite B
Cheyenne, WY 82001
Phone: (307) 778-2931
http://www.usgs.gov/

Wyoming Association of Conservation Districts
517 East 19th Street
Cheyenne, WY 82001
Phone: (307) 632-5716
http://www.conservewy.com/index.htm

Wyoming Department of Agriculture
2219 Carey Ave
Cheyenne, WY 82002
Phone: (307) 777-7321
http://wyagric.state.wy.us/

Wyoming Game and Fish Department
5400 Bishop Boulevard
Cheyenne, WY 82006
http://wgfcms.wyo.gov/

Fish Division
Phone: (307) 777-4559
Terrestrial Habitat Division
Phone: (307) 777-4565

Wyoming State Engineer's Office
4th Floor East
122 West 25th Street
Cheyenne, WY 82002
Phone: (307) 777-7354
http://seo.state.wy.us/index.aspx

Office of State Lands and Investments
Herschler Building, 3rd Floor West
122 West 25th St.
Cheyenne, WY 82001
Phone: (307) 777-7331
http://lands.wyo.gov/

Wyoming State Forestry Division
1100 West 22nd Street
Cheyenne, WY 82002
Phone: 307-777-7586
http://wsfd.wyo.gov/

Wyoming Water Development Commission
6920 Yellowtail Road
Cheyenne, WY 82002
Phone: 307-777-7626
http://wwdc.state.wy.us/

Wyoming State Wildlife Action Plan
Terrestrial Habitat Types and Aquatic Basins

Introduction

Habitat is a general term which means the environment – physical and biological – that provides the necessary food, water, shelter, space, and other items in proximity to meet the seasonal and year around needs of a particular organism or group of organisms. Wyoming contains a diversity of both terrestrial and aquatic habitats. Habitats are typically classified by plant and/or animal assemblages, geographic features, ecological attributes, or a combination of these features. While the goal of classification systems is to make each unit distinct for cataloging information, addressing issues and threats, and proposing conservation strategies, there is considerable overlap between units. Some habitat groupings tend to be geographically well-defined, while others are widely distributed wherever suitable conditions exist.

Threats and potential conservation actions can vary considerably between habitat types. A habitat classification system with the following attributes was determined to best meet the purposes of Wyoming's State Wildlife Action Plan (SWAP):

1. Identifies habitats with similar flora, fauna, and conservation concerns;
2. Uses a scale consistent with those frequently used in wildlife management;
3. Describes habitats that are easily recognized by the public and policy makers; and
4. Results in a manageable number of habitats for planning purposes.

Features 2 and 3 were considered important for encouraging support for the SWAP and facilitating coordination with existing local, state, and regional wildlife conservation efforts.

Habitat Classification Systems

Terrestrial Habitat Types

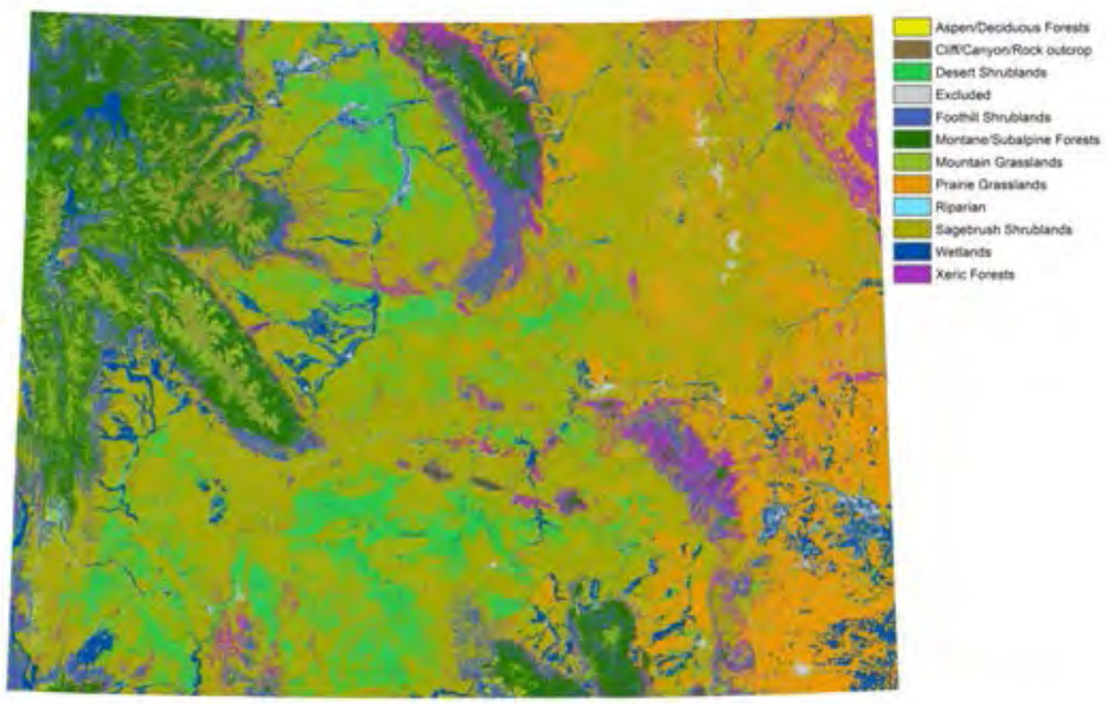
Eleven terrestrial habitat types were included in Wyoming's SWAP based on the attributes described above (Table 1). The habitat types selected closely resemble major types described by Knight (1994) and NatureServe (2010) (http://www.natureserve.org/explorer).

NatureServe Ecological Systems were then assigned to one of the 11 terrestrial habitat types based on shared characteristics by a group of habitat biologists and ecologists from the WGFD and Wyoming Natural Diversity Database (WYNDD) (Appendix A). NatureServe Ecological Systems were selected because they provide a classification unit that can be readily mapped and that can be easily identified by natural resource managers in the field (Comer et al. 2003). They are defined by biogeographic region, landscape scale, dominant land cover type, and disturbance regimes. Ecological systems are tied to, but not part of, the U.S. National Vegetation Classification (USNVC) (Federal Geographic Data Committee 2008) and can be cross-walked with other classification systems including the WGFD's Wildlife Observation System types. Ninety-six NatureServe Ecological Systems are found in Wyoming and because the systems have been identified for surrounding states, regional and national assessments and analysis can be applied to conserve wildlife. NatureServe Ecological Systems that are composed primarily of developed lands, were exceedingly small, or do not contain any Species of Greatest Conservation Need (SGCN) were excluded. Information about individual ecological systems discussed in the SWAP can be found at: http://www.natureserve.org/explorer.

TABLE 1. Wyoming SWAP Terrestrial Habitat Types

1.	Aspen/Deciduous Forests
2.	Cliff/Canyon/Cave/Rock Outcrops
3.	Desert Shrublands
4.	Foothills Shrublands
5.	Montane/Subalpine Forests
6.	Mountain Grasslands and Alpine Tundra
7.	Prairie Grasslands
8.	Riparian Areas
9.	Sagebrush Shrublands
10.	Wetlands
11.	Xeric and Lower Montane Forests

FIGURE 1. SWAP Terrestrial Habitat Types



Aquatic Basins

Three of the nation's major river systems have their headwaters in Wyoming: the Missouri, Colorado, and Columbia rivers. Additionally, the Bear River, originating in Wyoming, is major tributary to the inland Great Basin. Based on hydrographic boundaries, fish assemblages, and management considerations, these watersheds provide a natural basis for delineating the six major watersheds used for conservation planning purposes in Wyoming's SWAP (Figure 2). The areas are consistent with the aquatic ecosystems identified for freshwater biodiversity conservation worldwide by Abell et al. (2008). The watershed areas are also synonymous with "aquatic zoogeographical units" and "ecological drainage units" identified under The Nature Conservancy's (TNC) hierarchical classification framework (Higgins et al. 2005). The watersheds each include one to four "sub-regions" (4-digit hydrologic unit code [HUC] watersheds). This approach allows the nesting of multiple spatial and temporal scales for planning and prioritizing conservation actions.

TABLE 2. Wyoming SWAP Aquatic Basins

1. Bear River
2. Green River
3. Northeastern Missouri
4. Platte River
5. Snake/Salt River
6. Yellowstone River

FIGURE 2. SWAP Aquatic Basins

Information Collection

Terrestrial Habitat Types

Information on leading habitat threats, current conservation initiatives, as well as recommended conservation actions and future monitoring was sought for each terrestrial habitat type from habitat experts within the WGFD and also from experts working outside of the WGFD. Individuals were contacted in agencies and organizations that have significant jurisdictional authority, financial resources, and/or technical expertise regarding each habitat type. This approach was considered to be time-efficient for gathering information, as well as encouraging involvement of entities whose participation is important for implementing the SWAP. Collecting information in this way also fulfills Element 7 of federal SWAP guidelines, which requires "Coordination with federal, state, and local agencies and Indian tribes in developing and implementing the wildlife action plan."

The input of several habitat experts was compiled and then further supported by independent research. Existing state wildlife conservation plans used by the WGFD were consulted.[1] Drafts of each terrestrial habitat type were submitted to habitat experts for review and later to the WGFD's State Wildlife Terrestrial Habitat Manager. The reviewed habitat types were electronically posted for review by the WGFD's Nongame Section, Habitat Technical Advisory Group, State Wildlife Action Plan Interagency Advisory Team, and representatives from each agency and organization that had contributed information to at least one of the habitat sections. Near the end of each section is a list of individuals who reviewed the document and provided feedback. Before completion, additional edits were incorporated based on feedback from the WGFD's Administration, the Wyoming Game and Fish Commission, and the public.

The thoroughness of information and specificity of recommended conservation actions in the sections for each habitat type and aquatic basin vary based upon existing knowledge, the availability of information, and the input provided by section contributors. Individuals providing input were instructed to list only the threats and conservation actions that they believed would have the greatest impact on the habitat type or aquatic basin. As a result, not all issues that may apply to a particular habitat type or aquatic basin are identified, but rather each section provides an overview of the most important issues

Aquatic Basins

Information on watershed description, aquatic wildlife, identification of conservation areas, current conservation initiatives, and recommended conservation actions and future monitoring for each aquatic basin were originally developed by four WGFD biologists: the Fish Management Coordinator, Assistant Fish Management Coordinator, Aquatic Habitat Program Manager, and the Assistant Aquatic Habitat Program Manager. Information was gathered by consulting WGFD records and sources as well as other pertinent scientific and government agency sources. The WGFD Strategic Habitat Plan was consulted in some cases for development of conservation areas. Drafts of each basin were electronically posted for review by WGFD Fish Division biologists and the public.

Terrestrial Habitat Type and Aquatic Basin Format

Each SWAP habitat type and aquatic basin section is designed to function as a standalone document. This format was adopted because Wyoming's SWAP is most frequently accessed

[1] Plans included the WGFD's Strategic Habitat Plan (Wyoming Game and Fish Department 2015), Nongame Bird and Mammal Plan (Wyoming Game and Fish Department 1996), A plan for Bird and Mammal Species of Greatest Conservation Need in Eastern Wyoming Grasslands (Wyoming Game and Fish Department 2006), Wyoming Partners In Flight Wyoming Bird Conservation Plan (Nicholoff 2003), Wyoming Wetlands Conservation Strategy (Wyoming Joint Ventures Steering Committee 2010), and A Conservation Plan for Bats in Wyoming (Hester and Grenier 2005).

through the internet for information on specific subjects, as opposed to being accessed for the document in its entirety. Additionally, it is likely that individual sections of the SWAP will be duplicated and distributed. This approach resulted in some repeated information between habitat sections since many threats, conservation initiatives, conservation actions, and monitoring activities apply to more than one habitat type or aquatic basin. General descriptions of threats, conservation initiatives, and recommendations are provided along with information specific to the habitat type or aquatic basin. Various sections are frequently cross-referenced throughout the SWAP to provide the reader with additional information on a given topic.

The following subject headings are addressed within each terrestrial habitat type and aquatic basin:

Background
This topic heading provides a brief description of the geology, precipitation, vegetation, disturbances, and land uses of each habitat type and aquatic basin.

Maps depicting location
Terrestrial maps for the 11 habitat sections were created by displaying the locations of all NatureServe Ecological Systems that comprised a particular habitat type. Maps depicting the aquatic basins were developed in GIS following Habitat Unit Code boundaries. Separate maps were developed to portray conservation priority areas.

Associated SGCN
This topic heading lists Wyoming SGCN dependent upon the habitat type or aquatic basin. SGCN may be listed under more than one terrestrial habitat type or aquatic basin. Within the aquatic basin sections, introduced aquatic species, extirpated species, and examples of non-SGCN native species are provided. The lists and discussion include fish, aquatic reptiles, mollusks, clams, and gastropods.

Wildlife
This topic heading includes information on: wildlife numbers and species diversity within the habitat or aquatic basin; how the habitat's structure, function, and ecological processes relate to the wildlife it supports; habitat attributes that are critical to supporting associated SGCN; and non-SGCN wildlife species of high social, ecological, or economic value, including keystone species and game species that are associated with the habitat or aquatic basin.

Threats
This topic heading contains primary threats to habitat types or aquatic basins. The threats listed are not intended to be exhaustive, but represent the most significant threats in Wyoming. A description of the general impacts of the threats is provided. Threats were ranked as high, medium, or low in severity based on the input provided by habitat and wildlife experts.

Current conservation initiatives
This topic heading lists local, regional, or national efforts to conserve, manage and/or enhance the habitat type or aquatic basin relevant to Wyoming. Efforts that are listed include those that are particularly large in size and scope, address conservation goals, or threats identified within the particular habitat type or aquatic basin.

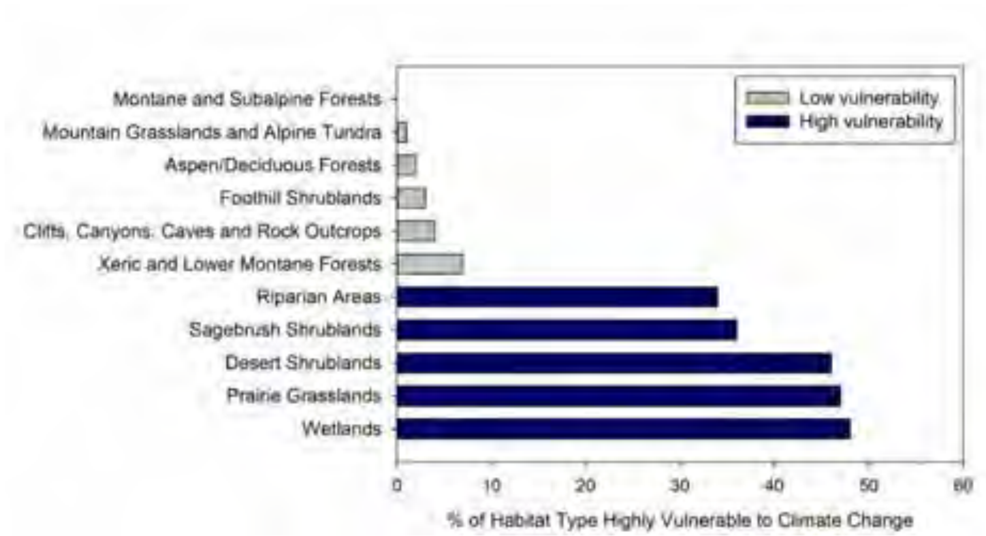
Recommended conservation actions
This topic heading identifies conservation actions that may have the most significant impact for the long-term conservation of each specific habitat type or aquatic basin. Conservation actions are listed in general order of priority.

Monitoring activities
This topic heading lists activities that are most achievable and effective in determining the quantity and condition of the habitat type or aquatic basin, status of associated SGCN, or the success of the recommended conservation actions.

2014 Habitat Vulnerability Assessment

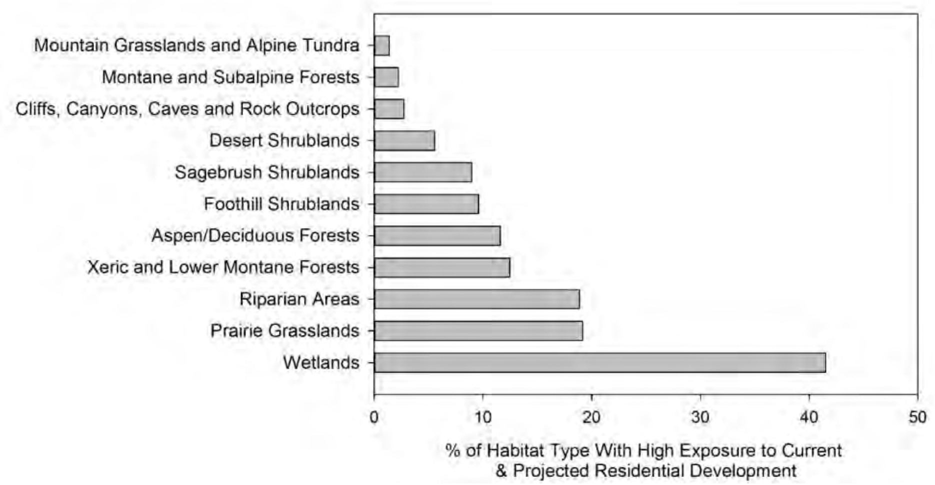
Wyoming's 2010 State Wildlife Action Plan (SWAP) identified residential development, energy development, climate change, invasive species, and disruption of historic disturbance regimes as the five leading challenges facing Wyoming Wildlife. TNC, WGFD, and WYNDD cooperatively completed a vulnerability assessment to analyze wildlife vulnerability to three of these challenges: residential development, energy development, and climate change. Vulnerability to wildlife disease was also studied but is not reported here. The entire report, including study design can be view at: Wyoming - Wildlife Vulnerability Assessment. A synthesis of study results are found below.

FIGURE 3. Climate Change Habitat Vulnerability



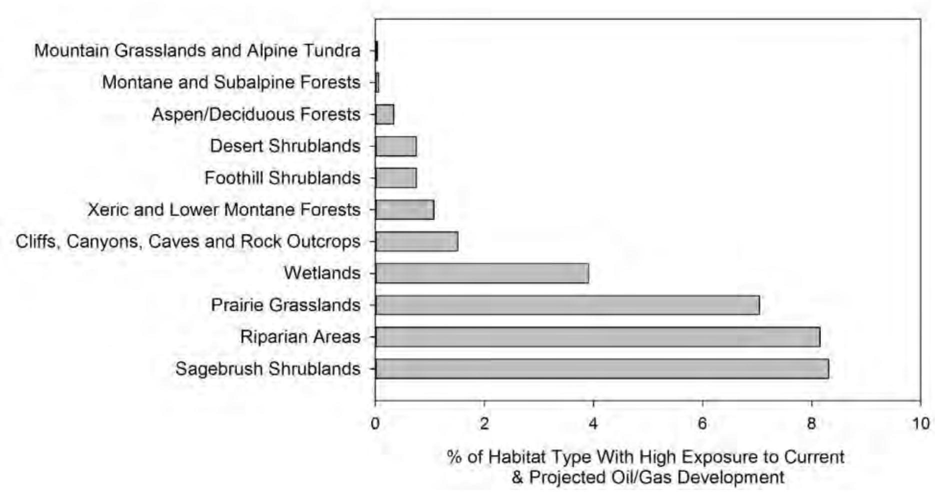
The 11 habitat types are ranked in order of increasing vulnerability to climate change. Those habitats ranked as having low vulnerability had less than 10% of their land area classified as highly vulnerable to climate change, while those ranked as highly vulnerable had more than 33% of their land area classified as highly vulnerable to climate change. Climate change vulnerability was calculated as exposure to climate change minus resilience to climate change, as described in the Climate Change section of this report.

FIGURE 4. Residential Development Habitat Vulnerability



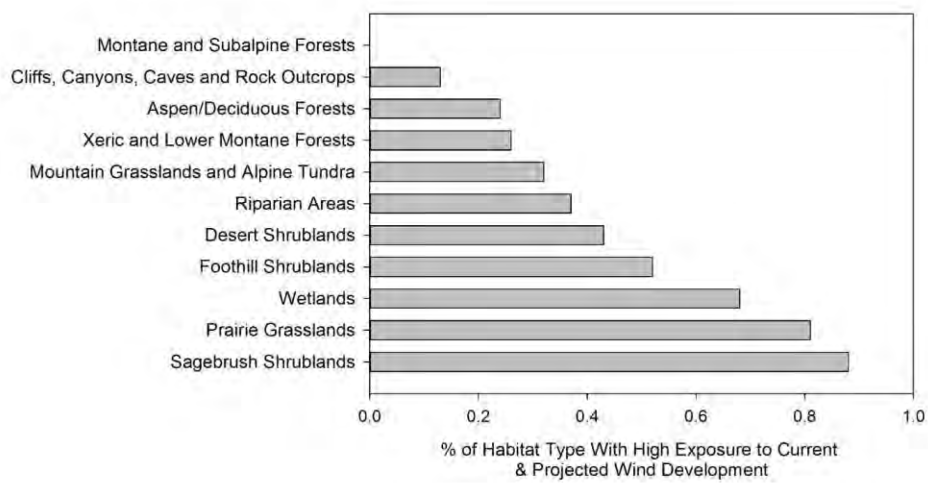
The 11 habitat types are displayed in order of increasing exposure to current and projected residential development. Exposure to residential development was calculated from 2010 and projected 2030 housing points, as described in the Residential Development section of this report.

FIGURE 5. Oil and Gas Development Habitat Vulnerability



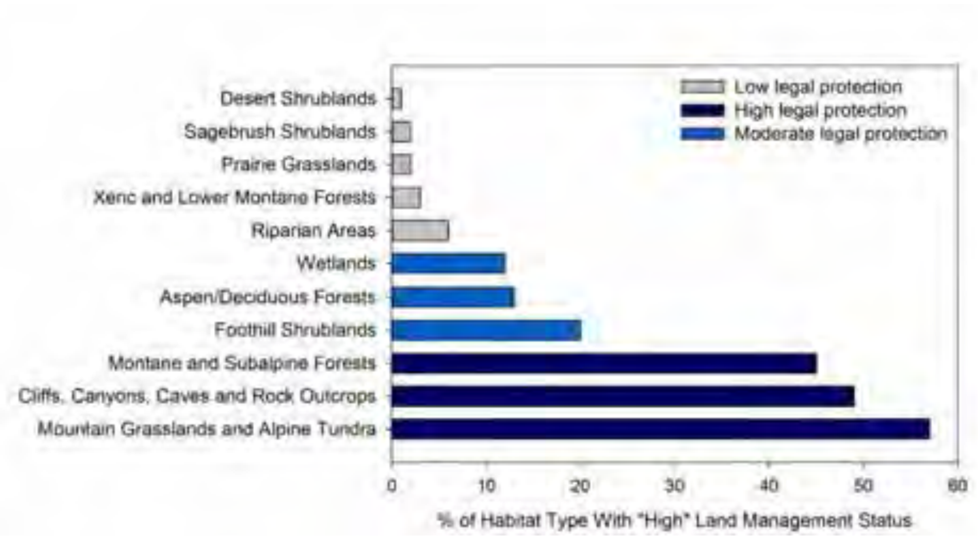
The 11 habitat types are displayed in order of increasing exposure to current and projected oil and gas development. Exposure to oil and gas development was calculated from 2010 and projected 2030 well locations, as described in the Energy Development section of this report.

FIGURE 6. Wind Development Habitat Vulnerability



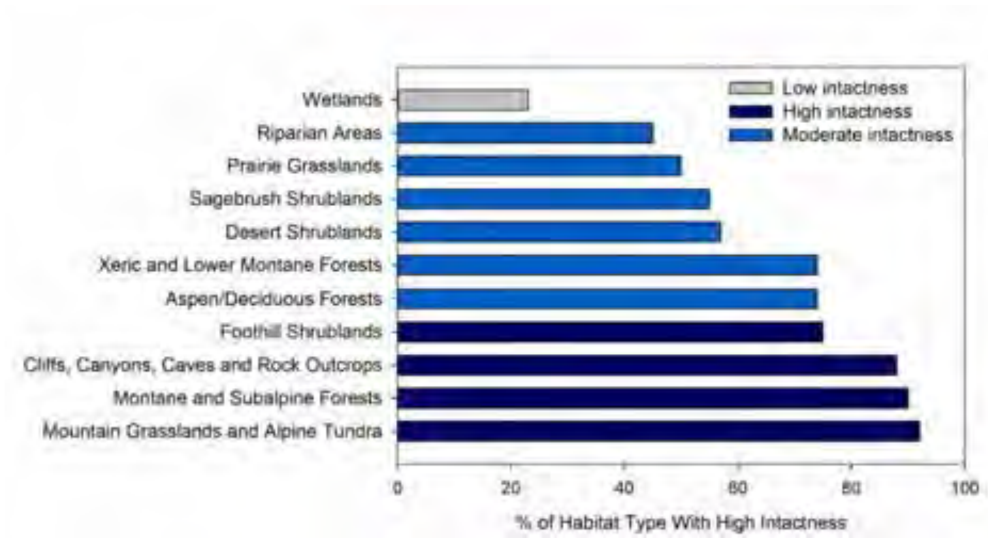
The 11 habitat types are displayed in order of increasing exposure to current and wind energy development. Exposure to wind development was calculated from 2010 and projected 2030 turbine locations, as described in the Energy Development section of this report.

FIGURE 7. Terrestrial Habitat Landownership



For land management status, high corresponds to the percent of the habitat occurring in GAP status 1 or 2, moderate to the percent occurring in GAP status 2b or 3, and low to the percent occurring in GAP status 4. Those habitats ranked as having low legal protection had less than 10% of their land area classified as high land management status. A ranking of moderate legal protection corresponded with 10-33% of the habitat type's land area in high land management status, and a ranking of high legal protection corresponded with 33% or more of the habitat type's land area in high land management status. More information about land management status calculations can be found in Appendix B.

FIGURE 8. Current Terrestrial Habitat Integrity



The habitat intactness scores ranging from 0 to 1 were assigned to categories as follows: low (<0.34), moderate (0.34-0.67), and high (>0.67). Those habitats ranked as having low intactness had less than 25% of their land area classified as highly intact. A ranking of moderate intactness corresponded with 25-75% of the habitat type's land area classified as highly intact, and a ranking of high intactness corresponded with 75% or more of the habitat type's land area classified as highly intact.

Priority Area Identification

Terrestrial Habitat Types
Providing improved maps for conservation planning was a priority for the 2017 SWAP revision. A working group composed of representatives from the WGFD's Nongame, GIS, and Property Rights Administration sections; TNC; and WYNDD was established to make recommendations for achieving this goal.

In the 2010 SWAP, areas of the state important for terrestrial SGCN were identified using Marxan, a software tool for systematic conservation planning and reserve selection (Ball et al. 2009, Game and Grantham 2008). Based on the results of Marxan, 44 priority areas were identified. Individual priority areas ranged in size from 7 to approximately 4,550 square miles with a mean size of 665 square miles, and in total covered slightly less than 30% of the state (29,225 square miles).

Working group discussions revealed that Marxan generated priority areas were not being regularly consulted for conservation planning by WGFD employees and other stakeholders. Instead, other priority areas including the WGFD's SHP Crucial and Enhancement Priority Areas, Big Game Crucial Habitats, and Sage-grouse Core Areas were used most frequently for this purpose.

It was decided that to best integrate terrestrial SGCN considerations into conservation planning, an improved mapping system should be developed with two primary goals:

1) Enhancing the targeting of SGCN habitat conservation efforts (conservation easements, land acquisitions, habitat improvement etc.) to the areas providing the greatest return on investment.
2) Guiding development and other types of habitat alterations away from important SGCN habitat as well as providing a relative baseline for future habitat mitigation.

A revised terrestrial SGCN habitat priority identification process was established to meet these goals based on four electronic map layers:

1) A layer that displays SGCN richness (number of SGCN species per one-mile statewide hexagon layer). Figure 7.
2) Habitat intactness layer (Current anthropogenic surface disturbances based on eight criteria: cultivated and hay lands, oil and gas pipelines, oil and gas wells, powerlines, residential development, roads, surface mines, and wind turbines). Figure 8. Appendix B.
3) A layer displaying the protected status of land from highly protected areas (federal parks or wilderness areas) to lowest protected areas (private land). Figure 9, Appendix C.
4) SWAP terrestrial habitat types. Figure 1.

Providing these layers electronically, individually and in combination, would enable users to receive SGCN geographic data in relation to their project needs.

All maps would be made publically available. The Wyoming Geographic Information Science Center was contracted to establish mapping layers through the Natural Resource and Energy Explorer (NREX) application. The NREX application allows maps to be accessed by users without GIS software. Additionally, NREX has a number of other benefits including a user friendly format, reporting functions that can be based on delineated project boundaries, and the ability to integrate SWAP data with other WGFD and external GIS mapping layers. Furthermore, all maps would be interactive and searchable.

A summary reporting function is also being created for all GIS mapping hexagons and associated delineated project boundaries that will display:

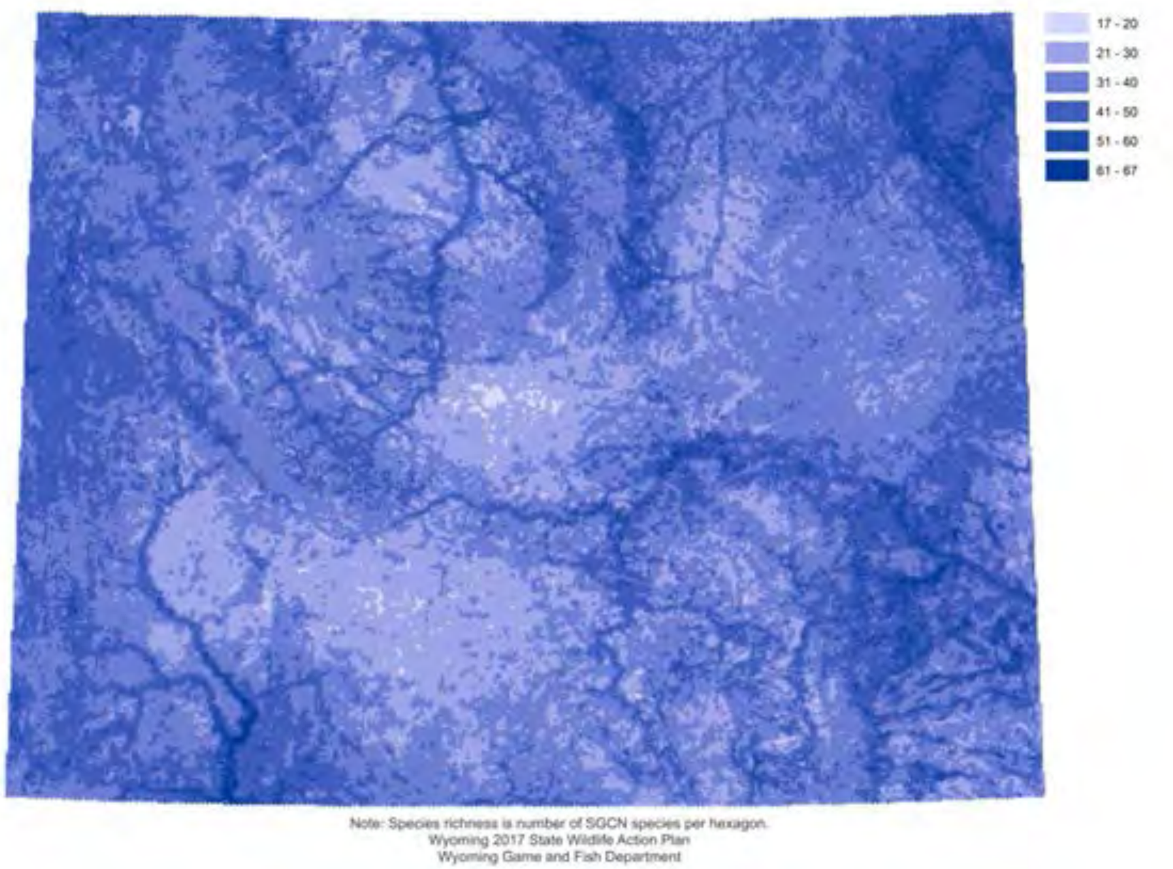
1. Total number of SGCN species,
2. Species by sorted by Conservation Tier and Wyoming Native Species Status rank,
3. Links to SWAP terrestrial SGCN species accounts,
4. Endangered Species Act listed species,

5. Percent SWAP terrestrial habitat type,
6. Land management status, and
7. Habitat intactness.

Map layers are also being integrated into the WGFD's internal WISDOM (Wyoming Interagency and Spatial Database Management System). All map layers are planned to be publically available on NREX by the second quarter of 2017.

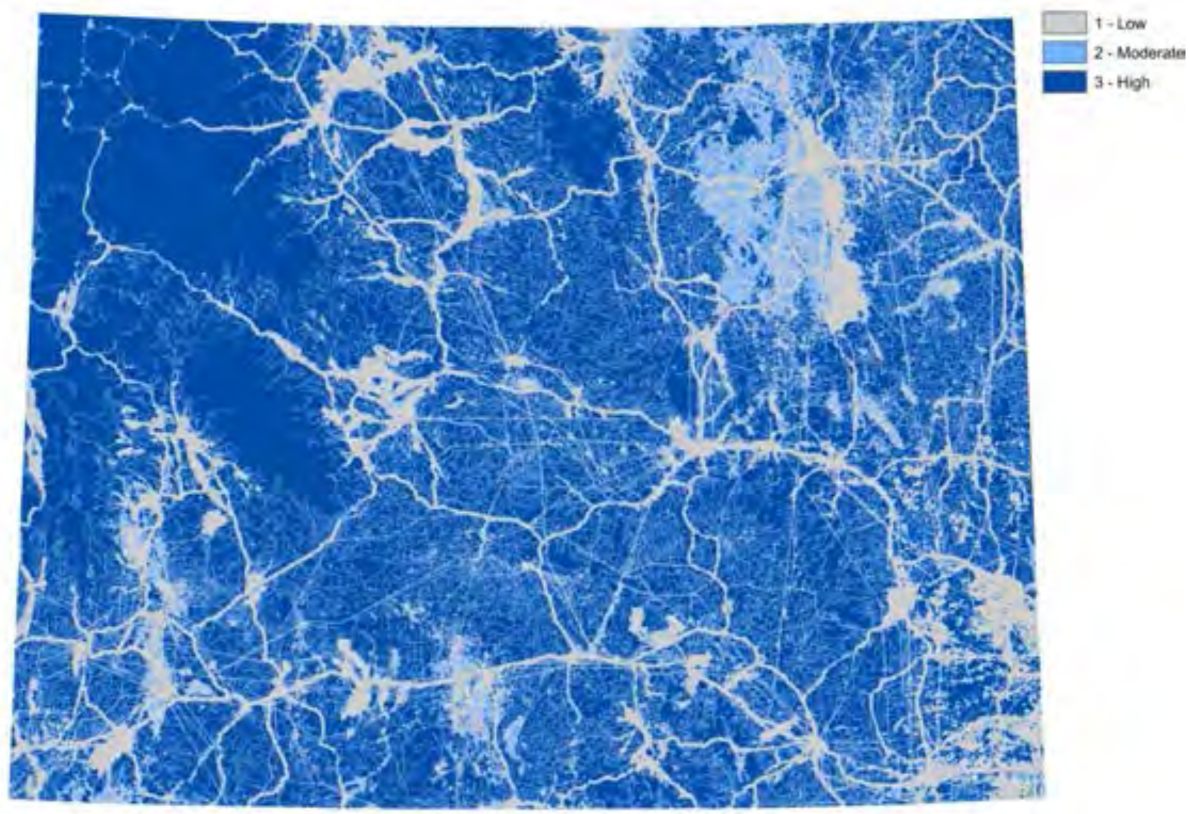
Illustrations of these maps layers are found below.

FIGURE 9. Species Richness SGCN Map Layer



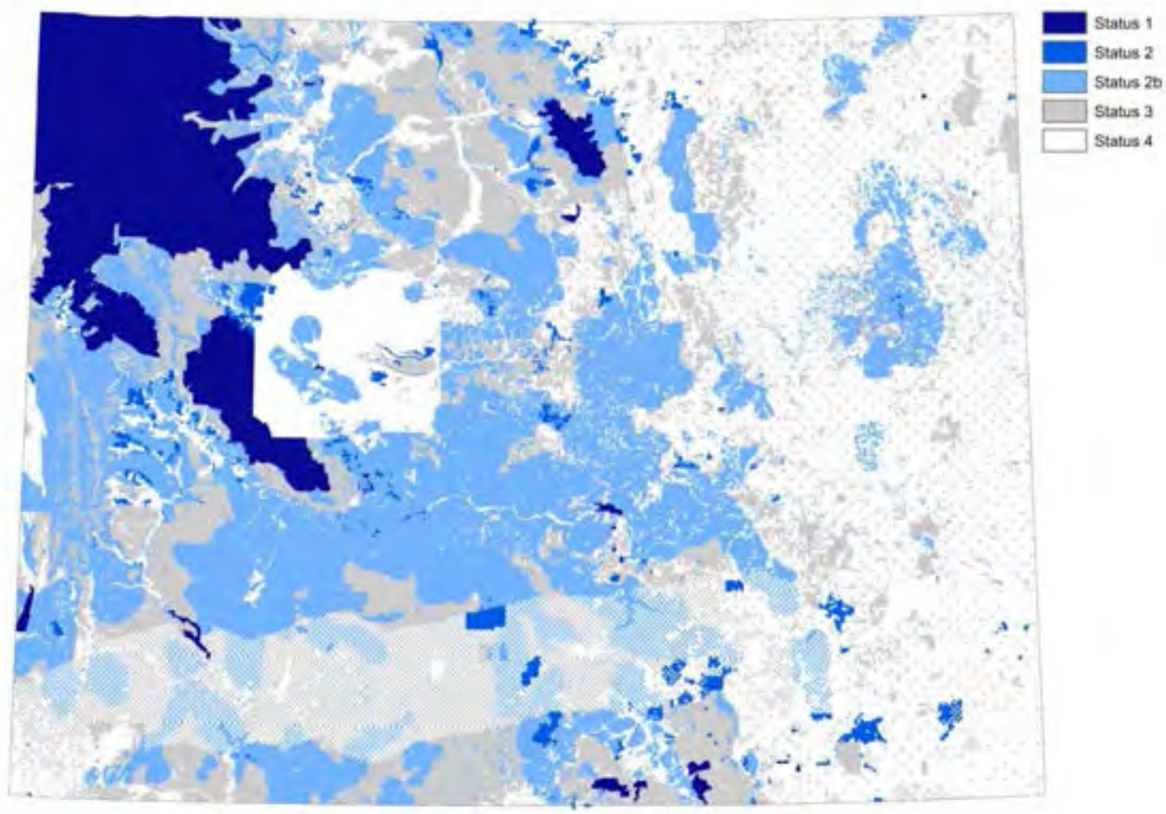
Species Richness – The distribution of each SGCN bird, mammal, amphibian, and reptile species excluding the northern long-eared myotis, eastern spotted skunk, western spotted skunk, Preble's meadow jumping mouse, and the northern leopard frog was intersected with a 1 mile statewide hexagon layer. The hexagons were then merged together and the number of species in each hexagon was calculated.

FIGURE 10. Habitat Intactness Map Layer



The habitat intactness layer was created to reflect current anthropogenic surface disturbance based on eight criteria: cultivated and hay lands, oil and gas pipelines, oil and gas wells, powerlines, residential development, roads, surface mines, and wind turbines. Disturbance was calculated for each dataset at a 30-meter resolution and then combined to give a score from zero to one and assigned the following categories: low (<0.34), moderate (0.34-0.67), and high (>0.67).

FIGURE 11. Land Management Status Map Layer



Lands fall into five categories, ranging from strictly protected areas such as Wilderness Areas to private lands having no legally recognized restrictions. See Appendix C for additional information.

Aquatic Priority Conservation Areas

Some native fish species have been lost from the major river basins in Wyoming. For example, shovelnose sturgeon, sauger, goldeye, sturgeon chub, and plains minnow are no longer found in the North Platte River basin due primarily to the construction of large reservoirs and habitat alteration. However, these and the majority of other Wyoming fishes can still be found in some waters in the state. Biologists recognize that they cannot conserve these species in every location where they are currently identified, so they strive to identify the best places throughout the state so that they can actively work to conserve native fish, amphibians, turtles, and mollusks. These areas are referred to as priority conservation areas. The most valuable areas that remain for Wyoming's warmwater species are generally found on private ranch lands and lands owned and managed by the Bureau of Land Management. Priority coldwater habitats are generally found on lands owned and managed by the U.S. Forest Service or National Park Service.

Over the last decade the addition of new funding sources has allowed the WGFD to conduct extensive inventories of aquatic wildlife in the state. These new data have provided a wealth of information in some basins, which has greatly aided in the identification of places for the conservation of Wyoming's native aquatic wildlife. With this data, biologists are now moving towards management actions to conserve and enhance species within areas identified as priority basins. Additionally biologists are working towards development and refinement of monitoring plans to ensure that WGFD is aware of changes in species abundance that necessitate management intervention.

The priority conservation areas in the SWAP were identified using the best available fish and habitat survey information. These areas generally represent only a fraction of the streams in each basin, but the management of fishes and habitats in these streams is critical to WGFD efforts to conserve Wyoming's rarest native fishes. Unfortunately, detailed survey information is still lacking for mollusks, and crustaceans. The list of priority conservation areas will likely evolve as the WGFD gains more information about where these species are found and what habitats they require.

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Appendix A

Wyoming State Wildlife Action Plan Terrestrial Habitat Type	NatureServe Ecological System
Mountain Grassland	1. Northern Rocky Mountain Subalpine-Upper Montane Grassland 1. Northern Rocky Mountain Subalpine Deciduous Shrubland 2. Rocky Mountain Alpine Turf 3. Rocky Mountain Alpine Dwarf-Shrubland 4. Rocky Mountain Subalpine-Montane Mesic Meadow 5. Southern Rocky Mountain Montane-Subalpine Grassland
Prairie Grasslands	1. Inter-Mountain Basins Semi-Desert Grassland 2. Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland 3. Northwestern Great Plains Mixedgrass Prairie 4. Western Great Plains Foothill and Piedmont Grassland 5. Western Great Plains Sand Prairie 6. Western Great Plains Shortgrass Prairie 7. Introduced Upland Vegetation – Forbland 8. Introduced Upland Vegetation - Annual Grassland 9. Introduced Upland Vegetation - Perennial Grassland 10. Recently burned grassland
Sagebrush Shrublands	1. Great Basin Xeric Mixed Sagebrush Shrubland 2. Inter-Mountain Basins Big Sagebrush Shrubland 3. Columbia Plateau Low Sagebrush Steppe 4. Inter-Mountain Basins Big Sagebrush Steppe 5. Inter-Mountain Basins Active and Stabilized Dune 6. Wyoming Basins Dwarf Sagebrush Shrubland and Steppe

Desert Shrublands	1. Western Great Plains Badland 2. Inter-Mountain Basins Shale Badland 3. Northwestern Great Plains Shrubland 4. Inter-Mountain Basins Semi-Desert Shrub-Steppe 5. Introduced Upland Vegetation - Shrub 6. Inter-Mountain Basins Mat Saltbush Shrubland 7. Inter-Mountain Basins Mixed Salt Desert Scrub 8. Inter-Mountain Basins Greasewood Flat
Foothills Shrublands	1. Harvested forest-shrub regeneration 2. Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland 3. Northern Rocky Mountain Montane-Foothill Deciduous Shrubland 4. Rocky Mountain Lower Montane-Foothill Shrubland 5. Western Great Plains Wooded Draw and Ravine 6. Inter-Mountain Basins Montane Sagebrush Steppe
Montane/Subalpine Forests	1. Northern Rocky Mountain Subalpine Woodland and Parkland 2. Northern Rocky Mountain Mesic Montane Mixed Conifer Forest 3. Rocky Mountain Lodgepole Pine Forest 4. Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland 5. Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland 6. Middle Rocky Mountain Montane Douglas-fir Forest and Woodland 7. Rocky Mountain Poor-Site Lodgepole Pine Forest 8. Recently burned forest 9. Harvested forest-tree regeneration 10. Harvested forest-grass regeneration 11. Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland 12. Harvested forest-grass regeneration
Aspen/Deciduous Forests	1. Rocky Mountain Aspen Forest and Woodland 2. Western Great Plains Dry Bur Oak Forest and Woodland 3. Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland 4. Rocky Mountain Bigtooth Maple Ravine Woodland

Xeric Forests	1. Rocky Mountain Foothill Limber Pine-Juniper Woodland 2. Northern Rocky Mountain Ponderosa Pine Woodland and Savanna 3. Southern Rocky Mountain Ponderosa Pine Woodland 4. Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland 5. Inter-Mountain Basins Juniper Savanna 6. Northern Rocky Mountain Foothill Conifer Wooded Steppe 7. Northwestern Great Plains - Black Hills Ponderosa Pine Woodland and Savanna 8. Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland
Riparian Areas	1. Western Great Plains Floodplain 2. Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland 3. Rocky Mountain Lower Montane Riparian Woodland and Shrubland 4. Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland 5. Rocky Mountain Subalpine-Montane Riparian Woodland 6. Rocky Mountain Subalpine-Montane Riparian Shrubland 7. Northwestern Great Plains Riparian 8. Western Great Plains Riparian Woodland and Shrubland
Wetlands	1. Open Water 2. Pasture/Hay 3. Inter-Mountain Basins Playa 4. Introduced Riparian and Wetland Vegetation 5. Great Plains Prairie Pothole 6. Rocky Mountain Alpine-Montane Wet Meadow 7. Western Great Plains Open Freshwater Depression Wetland 8. North American Arid West Emergent Marsh 9. Columbia Plateau Vernal Pool 10. Rocky Mountain Subalpine-Montane Fen 11. Western Great Plains Closed Depression Wetland 12. Western Great Plains Saline Depression Wetland 13. Inter-Mountain Basins Alkaline Closed Depression 14. Inter-Mountain Basins Interdunal Swale Wetland

Cliff/Canyon/Rock Outcrop	1. Rocky Mountain Cliff, Canyon and Massive Bedrock 2. North American Alpine Ice Field 3. Rocky Mountain Alpine Bedrock and Scree 4. Western Great Plains Cliff and Outcrop 5. Inter-Mountain Basins Cliff and Canyon 6. Rocky Mountain Alpine Fell-Field
Excluded	1. Developed, Open Space 2. Developed, Low Intensity 3. Developed, Medium Intensity 4. Developed, High Intensity 5. Quarries, Mines and Gravel Pits 6. Cultivated Cropland 7. Introduced Upland Vegetation - Treed 8. Geysers and Hot Springs

Appendix B
Habitat Intactness Methodology

Intactness – Following methodology outlined in Assessing Tradeoffs in Biodiversity, Vulnerability and Cost when Prioritizing Conservation Sites (Copeland et al. 2007), a cost layer was created to reflect current anthropogenic surface intactness based on eight criteria: cultivated and hay lands, oil and gas pipelines, oil and gas wells, power lines, residential development, roads, surface mines, and wind turbines. Subsections were created that included high/medium urban development, low urban development, tilled agriculture, untilled agriculture, primary/secondary roads, local/primitive roads, active oil and gas wells, inactive oil and gas wells, pipelines, power lines, wind turbines, active mines, inactive mines, and meteorological and cell towers. Each was given a disturbance weight, cutoff distance of impact, and distance decay function based on euclidean distance at a 30-meter resolution. They were then combined to give a score from zero to one and assigned the following categories: 1 or low intactness/high human disturbance (<0.34), 2 or moderate intactness/high human disturbance (0.34-0.67), and 3 or high intactness/high human disturbance (>0.67).

Table 3

Impacts	Weight	Distance Decay Function	Distance Cutoff
Urban Development - High/Medium	500	gradual	2000 m
Urban Development - Low	300	gradual	2000 m
Agriculture - Tilled	300	moderate-abrupt	600 m
Agriculture - Untilled	200	moderate-abrupt	250 m
Roads - Primary/Secondary	500	moderate	1250 m
Roads - Local/Primitive	300	abrupt	250 m
Oil and Gas Wells - active	400	moderate	1250 m
Oil and Gas Wells - inactive	200	moderate-abrupt	600 m
Pipelines	100	abrupt	250 m
Powerlines	200	moderate-abrupt	600 m

Wind Turbines	400	moderate	1250 m
Surface Mines - active	500	moderate	1250 m
Surface Mines - inactive	300	moderate	600 m
Meteorological Towers and Cell Towers	200	moderate	600 m

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Appendix C
Land Management Status methodology

Amy Pocewicz, The Nature Conservancy
October 19, 2015

Land management status was described across Wyoming using GAP land management status codes (Table 4), which are a measure of intent to manage for and conserve biodiversity (Scott et al. 1993, US Geological Survey Gap Analysis Program 2010). Lands fall into five categories, ranging from strictly protected areas such as Wilderness Areas to private lands having no legally recognized restrictions.

GAP analysis methods (US Geological Survey Gap Analysis Program 2010) were applied, with the following modifications. The land status definitions used in the 2010 GAP analysis did not include lands that have temporary legal protections or designations that afford limited legal protections. Therefore, a new category – status 2b – was added which was defined as areas having temporary protection from conversion of natural land cover or legally-mandated restrictions that limit extractive uses. The 2010 GAP analysis categorized BLM Areas of Critical Environmental Concern (ACEC) and Wilderness Study Areas (WSA) as either status 2 or 3, but all of these were categorized in the new status 2b. Status 2b also included Sage-grouse Core Areas, version 4 (State of Wyoming Executive Department 2015) and sage-grouse related restrictions on federal lands according to 2015 RMP revisions. Within the state-designated Sage-grouse core Areas, only public lands or private lands with federal minerals under status 2b were included, because the core area policy does not have jurisdiction over oil and gas development on private lands having private minerals. Other modifications included the categorization of all wilderness areas and national wildlife refuges as status 1 and the categorization of all conservation easements and wildlife habitat management areas as status 2.

For a 2014 vulnerability assessment (Pocewicz et al. 2014), in order to assign land management status scores to focal landscapes, a relative "resilience support" score was assigned to each land management status category that reflected the estimate of that status' ability to support resilient wildlife habitats (Table 4). It was assumed that the high level of protections afforded by GAP status 1 would maintain high resilience, with a resilience support score equal to 1. For status 4 lands, there is high uncertainty whether these lands might facilitate resilience, so these lands were assigned a score of 0. For the remaining three categories, scores consistent with land use practices typical of that status were assigned (Table 4).

Table 4. GAP land management status categories assigned to Wyoming lands and estimates of the probability that each status will support the resilience of wildlife habitats.

GAP status	GAP status definition[1]	Management designations included	Resilience support score
1	An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency, intensity, and legacy) are allowed to proceed without interference or are mimicked through management.	Wilderness Areas, Nature Conservancy Preserves, National Wildlife Refuges, National Parks	1
2	An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive uses or management practices that degrade the quality of existing natural communities, including suppression of natural disturbance.[1]	State Wildlife Habitat Management Areas, State Parks, Conservation Easements, TNC fee lands, federal special designations (e.g., research natural area, scenic river)	0.75
2b	An area having temporary protection from conversion of natural land cover or legally-mandated restrictions that limit extractive uses (i.e., oil and gas development, wind development, mining).	BLM Areas of Critical Environmental Concern and Wilderness Study Areas, No Surface Occupancy designations, Development stipulations for sage-grouse, including core areas	0.5
3	An area having permanent protection from conversion of natural land cover for the majority of the area, but subject to extractive uses of either a broad, low-intensity type (e.g., logging, OHV recreation) or localized intense type (e.g., mining). It also confers protection to federally listed endangered and threatened species throughout the area.	Publicly-managed lands with management plans in place, including Forest Service, Bureau of Land Management, Bureau of Reclamation, State Trust Lands	0.25
4	There are no known institutional mandates or legally recognized easements or deed restrictions held by the managing entity to prevent conversion of natural habitat types to anthropogenic habitat types. The area generally allows conversion to unnatural land cover throughout or management intent is unknown.	All other lands not assigned a different land management status.	0

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Aspen/Deciduous Forest

Photos courtesy of WGFD

Table of Contents

Habitat Description

Deciduous trees and shrubs occur in a number of Wyoming's State Wildlife Action Plan (SWAP) habitat types in varying proportions. For the purposes of this plan, the Aspen/ Deciduous habitat type is defined as the four NatureServe Ecological Systems where aspen, bur oak, Gambel oak, or bigtooth maple are dominant (Table 1). It spans a range of sites from pure upland to almost completely riparian in nature. A review of the NatureServe land cover classification (NatureServe 2010) reveals several other ecological systems that support deciduous vegetation in Wyoming. Common dominant species in these systems include narrowleaf and plains cottonwood, green ash, box elder, elm, choke cherry, Rocky Mountain maple, alder, and peachleaf willow. Importantly, these cover types are almost exclusively riparian in nature and are thus covered in the SWAP's Riparian Area habitat type description (page III-8-1).

Quaking aspen provides important wildlife habitat in Wyoming. It is the most widely distributed deciduous tree in North America (Little 1971), and about 467,000 acres (190,000 ha) of it occur throughout Wyoming (Nicholoff 2003). The largest concentrations are found on the Sierra Madre, Wyoming, Wind River, and Gros Ventre ranges with sizable stands also occurring in the Medicine Bow and Laramie Mountains of southeastern Wyoming. Relatively little contiguous aspen occurs in the Black Hills and Bear Lodge Mountains, Bighorn Mountains, Absaroka Range, Teton Range, or the Yellowstone Plateau (Nicholoff 2003). Aspen tends to be found in smaller and more isolated stands in Wyoming than elsewhere in the West. An exception would be the west slope of the Sierra Madre Mountains.

Very small and isolated aspen stands occur in Wyoming's intermountain basins as well, typically where large and persistent snowdrifts collect through the winter and provide abundant moisture into the growing season. These small stands often support unique forest wildlife species that otherwise would not occur in these dry, sagebrush-dominated landscapes (Jones 2009).

Aspen occurs where annual precipitation exceeds evapotranspiration. Typically, these sites have at least 15 inches of annual precipitation, but more than 20 inches is common (Jones and DeByle 1985). At these sites winters, are often cold with deep snowpack, but the growing season is reasonably long (Jones and DeByle 1985). Aspen communities commonly occur in riparian or spring/seep situations where there is permanent or semi-permanent surface water. The restriction of aspen to moist areas is probably more related to the intolerance of aspen seedlings to drought, as opposed to conditions needed by mature trees (Knight 1994).

Aspen is one of the few plants that can be found in all mountain vegetation zones from alpine tundra to the basal plains (Daubenmire 1943). Elevation limits of aspen in the western United States range from 5,200 to 10,500 ft (Mueggler 1988). At low elevations, aspen growth is often restricted by the availability of moisture, while at higher elevations the length of the growing season is the limiting factor. As a result, at lower elevations, aspen frequently occurs as stringers or small islands on the fringe of the semi-arid sagebrush-grass steppes (Jones 2009). At intermediate elevations, aspen commonly occur on northerly and easterly exposures or in swales or draws which collect moisture (Mueggler 1988). At the higher elevations, persistent stands of aspen are frequently restricted to southern exposures.

Successful regeneration of aspen is associated with natural and human-caused disturbances and gaps in the vegetation canopy. This is due to the inability of aspen to compete in low light environments (Manier and Laven 2001). Natural disturbances include blowdowns, landslides, flooding, and disease, but fire is probably the most important (Nicholoff 2003). Over time, aspens are often replaced by Engelmann spruce, subalpine fir, Douglas fir, blue spruce, lodgepole pine, and ponderosa pine. The conversion back to conifer-dominated species can occur in less than 100 years or take as long as 400 years depending upon disturbance factors, proximity to conifer seed sources, site conditions, and rate of conifer seedling growth (Nicholoff 2003). At higher elevations, aspens can persist as a subdominant species within lodgepole pine and spruce-fir communities. At intermediate elevations and on deep soils, aspen can occur as scattered stands of successionally-stable, climax woodlands within coniferous forests (Nicholoff 2003).

The location of aspen groves is highly related to microsites that provide favorable moisture and soil site conditions. The tendency of aspen to grow in stands is also influenced by the ability of new trees to be formed by genetically identical sprouts or suckers (Knight 1994). Although individual trees or shoots die after about a hundred years, the clonal root system can survive for thousands of years (Barnes 1975). Single clones can be as large as 200 acres (Kemperman and Barnes 1976). The fact that aspen stands are typically composed of genetically identical trees explains why nearby stands of aspen often turn color at different times in the fall.

Aspen suckers sprout most vigorously following disturbance, with more than thirty thousand sprouts per hectare especially following hot fires; however, many do not survive (Brown and DeByle 1989, Bartos and Mueggler 1991). Aspen sprouts have access to relatively large amounts of stored carbohydrates, allowing them to grow quickly and providing them with a competitive advantage over trees that reproduce by seeds (Knight 1994). The majority of aspen sprouting occurs during the first three to six years after a disturbance which contributes to the formation of even-aged stands. Multiple age classes can occur when older stands begin to die and the canopy opens, stimulating the production of new suckers (Nicholoff 2003). The sexual reproduction of aspen in the Rocky Mountain West is extremely rare. Some speculate that proper conditions for seedling establishment may exist at intervals of 200–400 years (Jelinski and Cheliak 1992). Therefore, when aspen is lost from the landscape it may not re-establish from seed over a management-relevant time scale (Dale 2001).

A broad range of plant species can be found in association with aspen because of the diverse elevation and topography at which it occurs. A characteristic element among nearly all aspen communities is the lush understory of plants when compared to nearby coniferous forests. The abundance and diversity of plants found in the aspen understory results in very high forage availability for both wildlife and livestock. This understory produces insect biomass as well.

Aspen can be considered a keystone species because of the relatively high diversity of plant and animals that depend on them (Dale 2001). Aspen have declined from 50–96% throughout the West (Bartos and Mitchell 2000). It has been estimated that aspen loss in Wyoming since European settlement is as high as 53% (Stam et al. 2008), but there is some debate by researchers over such high estimates. A recent study estimated an average of only 10% loss in the Greater Yellowstone Ecosystem (Brown et al. 2006). Current extensive mortality of conifers from bark beetle infestations may benefit aspen regeneration and expansion in much of Wyoming.

Due to their productivity and species diversity, aspen communities are one of the most valued western habitat types. Besides wildlife habitat and livestock forage production, aspen contribute to maintaining water quality and quantity, provide valued recreational sites, and are appreciated for their aesthetic beauty.

Other deciduous woody species commonly found in association with aspen in Wyoming foothills escarpments are bur oak (in northeastern Wyoming only), Gambel oak (in south central Wyoming only), choke cherry, box elder, and wild plum. Paper birch co-occurs with aspen in the upper elevations of the Wyoming Black Hills. Like aspen, these species occur on wetter sites with deeper soils. The wetter nature of these sites is most commonly due to greater snow accumulation, more summer precipitation, or runoff from adjacent slopes.

Oak-dominated woodlands are found only in small areas of the northern and eastern slopes of the Black Hills (bur oak) and on the east side of the Sierra Madre (Gambel oak) (Knight 1994). Spring frost and summer drought have limited the spread of Gambel oak northward (Neilson and Wullstein 1983). Both bur oak and Gambel oak woodlands are fire prone, but the species re-sprout vigorously and may increase in density after fire (Harper et al. 1985). Fire suppression has enabled these species to locally expand into less fire-adapted communities, including Rocky Mountain juniper and ponderosa pine. Such mixed communities often present a multi-tiered canopy, with oak species forming a prominent deciduous mid-layer between the understory and conifer canopy. This physical habitat arrangement is rather rare in Wyoming and is perhaps more reminiscent of eastern North American woodlands. Its value to wildlife communities in the West is not well understood and may be a valuable topic for future research.

Portions of northeastern Wyoming support moist ravines and draws dominated by bigtooth maple and a suite of associated deciduous shrubs. These rather productive communities are most common in the foothill zones of the eastern Bighorn Mountains and Black Hills, and are more typical in the northern Great Plains to the north and east of Wyoming.

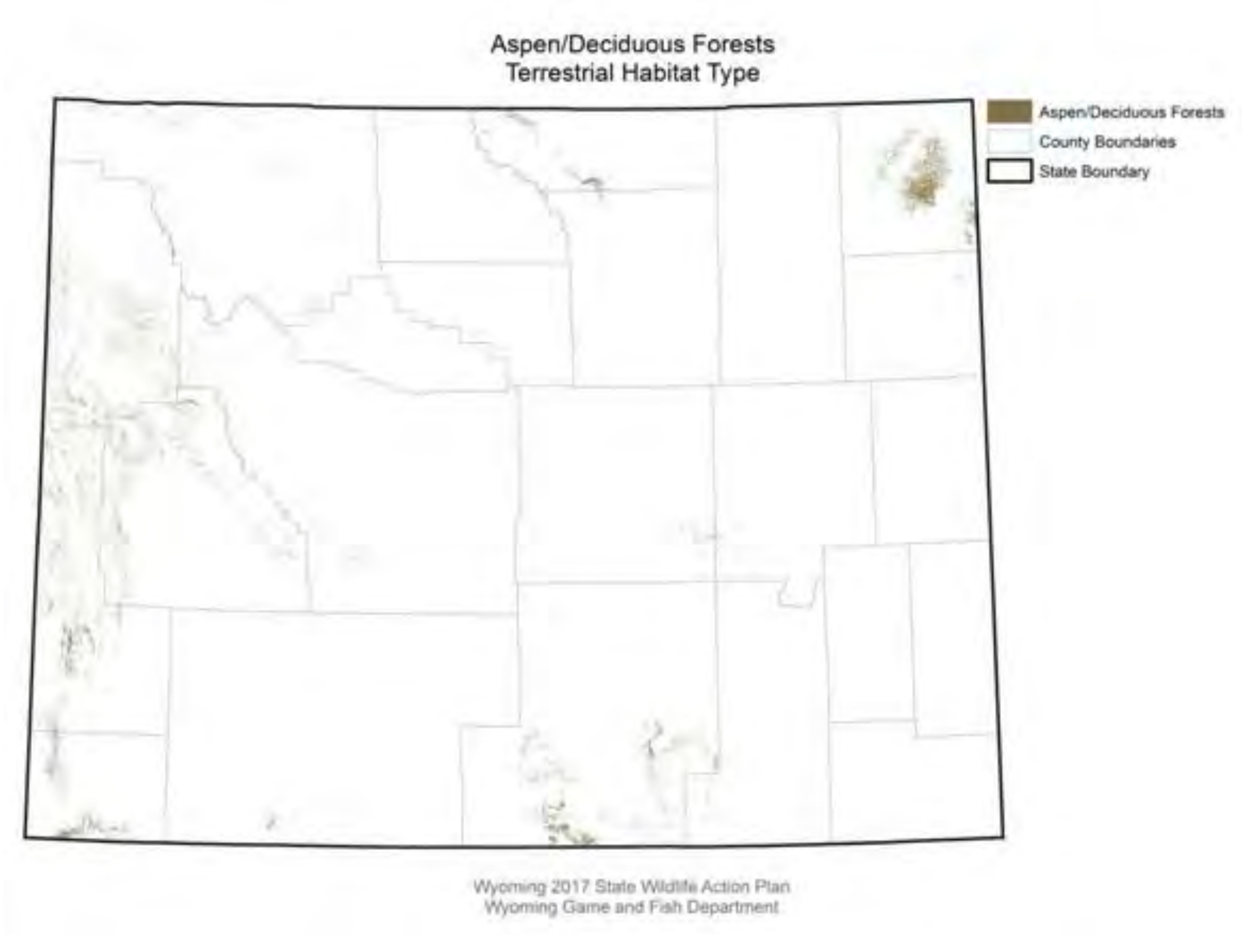


FIGURE 1. Wyoming Aspen/Deciduous

TABLE 1. Wyoming Aspen/Deciduous Forest NatureServe Ecological Systems[1]

1. Rocky Mountain Aspen Forest and Woodland
2. Western Great Plains Dry Bur Oak Forest and Woodland
3. Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland
4. Rocky Mountain Bigtooth Maple Ravine Woodland

[1] Descriptions of NatureServe Ecological Systems which make up this habitat type can be found at: NatureServe Explorer: an online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, VA. http://www.natureserve.org/explorer.

TABLE 2. Wyoming Aspen/Deciduous Forest Species of Greatest Conservation Need

Mammals
Dwarf Shrew
Eastern Red Bat
Fringed Myotis
Little Brown Myotis
Long-eared Myotis
Long-legged Myotis
Moose
Northern Long-eared Myotis
Pallid Bat
Pygmy Shrew
Spotted BatTownsend's Big-eared Bat
Western Small-footed Myotis

Birds
American Kestrel
Boreal Owl
Calliope Hummingbird
Clark's Nutcracker
Columbian Sharp-tailed Grouse
Flammulated Owl
Great Gray Owl
Lewis's Woodpecker
MacGillivray's Warbler
Northern Goshawk
Purple Martin
Pygmy Nuthatch
Red-headed Woodpecker
Rufous Hummingbird
Williamson's Sapsucker

Reptiles
Black Hills Red-bellied Snake
Plains Gartersnake
Red-sided Gartersnake
Smooth Greensnake
Valley Gartersnake

Amphibians
Columbian Spotted Frog
Wood Frog
Western Toad

Aspen/Deciduous Forest Wildlife

Aspen communities are valued for high water yield and high biomass productivity, and are ranked second only to riparian areas in wildlife diversity (Kay 1997). These attributes result in aspen having the second highest priority for habitat improvement projects in the Wyoming Game and Fish Department (WGFD) Strategic Habitat Plan (SHP).

Aspen stands typically support high grass and forb production in their understories, providing important foraging sites for large and small herbivores such as mule deer, elk, moose, black bear, blue grouse, chipmunks, and snowshoe hares. High productivity conditions usually also produce large numbers of invertebrates, which make aspen forests important foraging sites for insectivores such as shrews, bats, and many bird species.

About 88 species of birds potentially use aspen habitats in Wyoming (Nicholoff 2003). Bird communities within aspen stands include species which spend the majority of their time within the aspen community itself, as well as species that visit aspen stands periodically for foraging or other specific purposes while also using surrounding habitats. Breeding bird density in aspen stands is related to surface water and ground moisture levels, the number and size of insects in the aspen understory, and the structure and species diversity of plants found on the border of adjoining habitat types (Nicholoff 2003). Bird diversity has been positively correlated to the size (Johns 1993) and maturity of aspen stands (McGraw-Bergstrom 1986), and mature stands of aspen have greater bird diversity than younger stands and those being invaded by conifers. Mature aspen stands are particularly important to cavity nesting birds, as the trees have soft wood and are prone to infection and decay. The trunks of deciduous trees are often excavated by primary cavity excavators, such as woodpeckers, which are then followed by secondary cavity nesters including bluebirds, swallows, and wrens.

Deciduous and aspen forests are especially important to bats. Generally, activity increases as the proportion of deciduous vegetation bordering streams and moth abundance increase. Bat diversity is greater in deciduous habitats than in coniferous habitats. Proximity to open water may provide a critical element for many bats that use deciduous forests. The greatest resources that aspen woodlands provide for bats are cavities for roosting. Aspen trees greater than 40 years of age almost always harbor heart rot while they are alive and provide excellent conditions for primary cavity excavators (such as woodpeckers) and natural-cavity formation. These live trees are potentially more important to bats in this habitat type than snags (Hester and Grenier 2005).

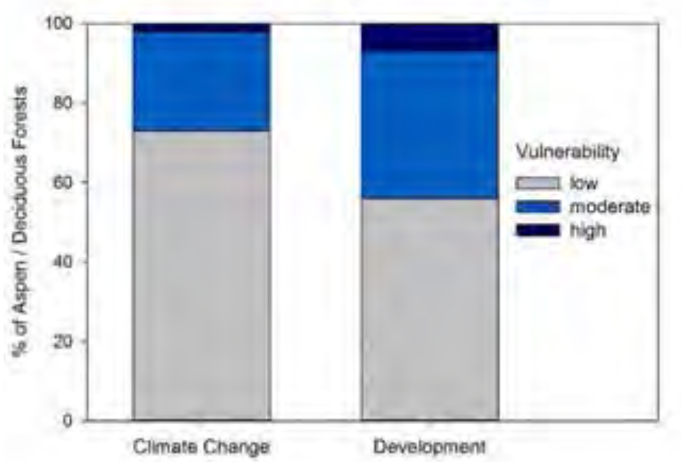
The northern pocket gopher and beaver serve as keystone species in aspen communities by increasing local productivity and site diversity. Northern pocket gophers accomplish this through constant soil disturbance and root herbivory, which facilitates nutrient cycling, air and water penetration into the soil, and creates a fine-grained patchwork of understory plant communities in various stages of vegetational succession. In riparian and spring/seep situations, beavers create wetlands through damming, which can drown some aspen stems but can also increase adjacent soil moisture, which favors aspen growth. Beavers also affect aspen successional dynamics by browsing aspen heavily. Over time, older beaver ponds fail and drain, leaving moist soils and meadows that can be reclaimed by aspen.

In addition to cover, the acorns of bur oak and Gambel oak provide energy-rich food for wildlife including deer, elk, turkey, bear, and squirrels. Old stands of Gambel oak contain large amounts of dead crown wood and hollow boles and limbs that provide nesting sites for small mammals and birds (Nicholoff 2003). Co-occurring plant species such as choke cherry, box elder, black hawthorn, and wild plum are also important food and cover sources for wildlife. These same species commonly co-occur in bigtooth maple ravines as well. As previously discussed, mixed communities in which oak forms a prominent mid-story between a herbaceous layer and conifer canopy are rather rare in Wyoming and may play an important role in providing a unique habitat for some wildlife.

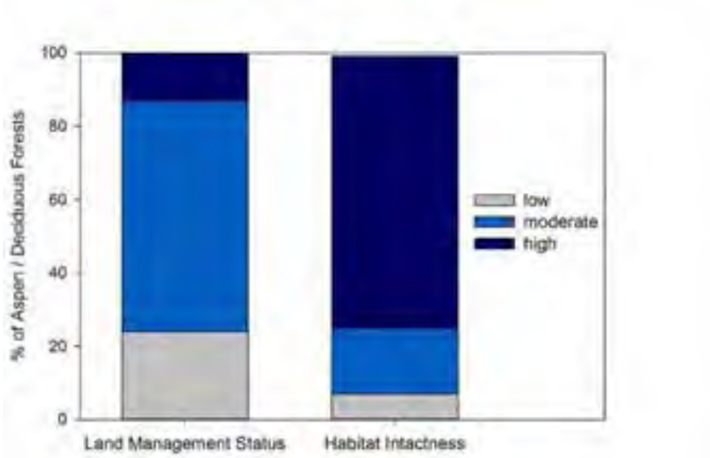
One of the largest remaining populations of Columbian sharp-tailed grouse in western North America spans the Colorado-Wyoming border in the vicinity of Baggs, Wyoming, and extends as far north as I-80. These birds depend heavily on aspen/deciduous forest habitat in this area, including sites dominated by Gambel oak and other associated species like choke cherry and serviceberry. The habitat in this area also supports smooth green snakes and, occasionally, band-tailed pigeons—both species are rather rare in Wyoming. White-tailed deer throughout Wyoming are often found in, or in close proximity to, aspen/deciduous forest habitat.

Aspen/Deciduous Forest Habitat Threats

Figure 2. Aspen/Deciduous Forest Vulnerability Analysis



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high vulnerability to climate change or development, based on classification of scores ranging from 0 to 1 into the following categories: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for climate change or development vulnerability were based on the land area of the habitat type classified as having high vulnerability: low (<10%), moderate (10-33%), or high (>33%). Vulnerability was calculated as exposure minus resilience. Development vulnerability includes existing and projected residential, oil and gas, and wind energy development. Further details are provided in the Leading Challenges section of this report and in Pocewicz et al. (2014).



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high land management status or habitat intactness. For land management status, high corresponds to the percent of the habitat occurring in GAP status 1 or 2, moderate to the percent occurring in GAP status 2b or 3, and low to the percent occurring in GAP status 4. Rankings for land management status were based on the land area of the habitat type classified as having high status or legal protection: low (<10%), moderate (10-33%), or high (>33%). For habitat intactness, scores ranging from 0 to 1 were assigned to categories as follows: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for intactness were based on the land area of the habitat type classified as having high intactness: low (<25%), moderate (25-75%), or high (>75%).

Lack of aspen stand regeneration due to disruption of historic disturbance regimes – High
Aspen stands require periodic disturbance to become established and regenerate. Extensive fire episodes during the late 1800s and early 1900s resulted in many aspen stands being from 80 to +130 years old (Gruell 1980). Since this time, fire suppression and reduction of intentionally set human fires has reduced fire frequency in aspen communities. Many aspen stands are now reaching maturity and are increasingly vulnerable to disease or senescence. Colorado, Utah, and Wyoming have recently experienced major episodes of aspen death suspected to be related to both age and climate stress (U.S. Forest Service 2008). Recent increases in conifer mortality in Wyoming may create more opportunities for aspen regeneration.

Overbrowsing and trampling by wild and domestic ungulates can also have a negative impact on aspen regeneration, particularly in riparian areas and in areas with limited aspen groves. Both cattle and sheep browse on aspen leaves and twigs, but sheep typically eat four times as many aspen sprouts as cattle (Stubbendieck et al. 1986, U.S. Department of Agriculture, Forest Service 1937). Deer and moose can impact aspen regeneration, but elk are usually the most damaging because elk typically winter in or near mid-elevation zones where aspen forests are most common. Additionally, elk populations in Wyoming have increased dramatically over the last century. Moose, which can spend the entire winter within a single aspen patch, can also cause significant, localized damage.

Fire suppression works in concert with overbrowsing to reduce aspen regeneration. As aspen stands mature and sprouts become less common, browsing pressure intensifies on sprouts that remain. Furthermore, the removal of fine fuels by browsing and grazing can reduce fire frequency.
Fire suppression and overbrowsing, along with other factors such as disease, drought, and natural succession, often lead to the replacement of aspen by conifers. A decrease in plant diversity and water yield is common as conifers begin to dominate aspen stands (Dale 2001). Water loss can be as much as 5% (Harper et al 1981; Gifford et al. 1984). This results in less water being available for undergrowth and groundwater recharge. Over time this water loss reduces overall site productivity. Although conifer mortality from the current bark beetle epidemic may encourage aspen growth at some sites, the heavy fuel loads created by beetle kill may increase wildfire risk and intensity. Intense fires may overcome the natural fire resilience of aspen stands, resulting in significant above-ground stand mortality and possible below-ground mortality of parent rootstock, although aspen regeneration is often closely linked to the level of ungulate herbivory in the area (Bartos and Mueggler 1981).

Although browsing may not be of such concern in oak and bigtooth maple communities, successional dynamics related to fire are just as critical. Oak, in particular, regenerates vigorously after fire. Depending on site conditions, conifers and other vegetation can replace oak under scenarios of fire suppression; in other situations, fire may be used to reduce oak invasion of other vegetation types.

Drought and climate change – High
Drought has been known to cause the loss of seral aspen stands and contribute to a decline in aspen regeneration. In recent years, there have been dramatic die-offs of aspen in a number of locations in the West including Wyoming, Colorado, and Utah. The phenomenon has been termed Sudden Aspen Decline (SAD). SAD has been differentiated from known past aspen die-offs as it occurs on a landscape scale as opposed to within individual stands, displaying rapid mortality, and involving pathogens and insects which previously have not been a significant threat to aspen.

The onset of SAD has been linked to drought. Aspen stands located at low elevation, on south to west aspects, or with open canopies, are the most vulnerable to SAD, possibly due to higher localized temperatures (U.S. Forest Service

2009). During drought, aspen close off openings in their leaves as a survival measure to reduce water loss. This closure also slows the uptake of carbon dioxide which reduces the rate of photosynthesis. It is speculated that this may cause trees to absorb stored energy from their roots, eventually killing the roots and preventing the growth of new aspen sprouts (Worrall et al. 2008). Simultaneously, drought-weakened trees are more susceptible to attack from disease and insects, which would not be fatal for healthy trees.

In 2008 and 2009, U.S. Forest Service Aerial Detection Survey concluded that approximately 48,300 acres were affected by SAD in Wyoming within USDA Forest Service Region 2. Of this, 63% was in Carbon County, 12% in Converse County, and 9% in Albany County. SAD is a relatively new phenomenon and its causes are not fully understood. The phenomenon is particularly unusual because it appears to weaken even moderately vigorous root systems. A drier, warmer climate, which some climate models project for Wyoming (Christensen et al. 2007), may further impact the health of aspen communities in the state.

Aspen woodlands in riparian situations may be suffering drought-like effects from the historic reductions in beaver numbers and distribution. Fur trapping in the 19th century greatly reduced beaver numbers, extirpating them from many areas in Wyoming. By the late 20th century beavers re-occupied most of their historic range, but only at roughly 10% of pre-European-contact densities (Naiman et al. 1988). Among other important effects, beaver ponds raise water tables and increase the size of the riparian zones near surface water, which increases habitat quality for aspen. Ponds and adjacent banks also store snowmelt for release later in the year, increasing flows, riparian quality, and aspen habitat quality downstream. Although beaver browsing and ponding can reduce aspen numbers at times, over the long term a healthy beaver population forms a dynamic mosaic of patches of varying aspen seral stages along a stream network.

Small and isolated stands of aspen in Wyoming's intermountain basins are likely completely dependent on soil moisture from locally-formed snowdrifts, and thus are predictably threatened by drought (Jones 2009). Other deciduous tree communities in the West that rely on soil moisture may also be threatened by changing climate conditions, including warming temperatures and extended drought.

Lack of industry infrastructure – Moderate

The wood products industry has been a valuable contributor to aspen habitat improvement projects through removing encroaching conifers as part of aspen regeneration projects, lopping and scattering slash to augment fuel in aspen stands for broadcast burning, and using equipment to create control breaks for broadcast burning. Proceeds from timber sales on both U.S. Forest Service and Bureau of Land Management (BLM) lands have also been used to fund aspen habitat treatments.

Poor market conditions due to a depressed economy has resulted in the closure of timber mills and delayed harvest of timber sales under contract. Travel distances for sawmills that remain open can make timber harvest uneconomical. In many areas of Wyoming there is currently a lack of access to biomass, wood pellet, engineered wood products, or pulp industries to offset the loss of timber saw mills. The influence of beetle kill on the quality and amount of pine sawtimber will further alter the future of the wood products industry in Wyoming by having less usable sawtimber, but large amounts of dead biomass available.

Rural subdivision and development – Moderate

Rural subdivision and development can reduce, degrade, and fragment aspen and deciduous forest habitats (see Wyoming Leading Wildlife Conservation Challenges – Rural Subdivision and Development). Houses, outbuildings, and lawns directly replace native wildlife habitat. Soil disturbance from construction, year-round grazing of horses and other hobby livestock, and the use of non-native plants as ornamentals can facilitate the establishment of invasive species that compete with native vegetation on site and, eventually, throughout a given region (Maestas et al. 2002).

Wildlife commonly abandons or alters use of habitats with greater human, vehicle, and pet activity. Increased energy expenditures in avoiding people or greater use of lower quality habitats can decrease animal health and reproductive capacity. Greater road densities and traffic volume can increase wildlife–vehicle collisions. Predation on wildlife can intensify with greater numbers of domestic dogs and cats, as well as increases in generalist predatory species such as ravens and human-commensal species like raccoons (U.S. Department of Agriculture 2007).

Rural subdivisions make accessing deciduous habitats for habitat treatments difficult. The number of private landowners from whom permission must be obtained to gain access to some public lands increases. Some new landowners are absentee landowners who reside in other states or countries, are often unaware of the need for habitat treatment, and tend to be initially opposed to cutting conifers.

Additionally, gaining the involvement of a sufficient number of private landowners to make the size of treatments ecologically and economically feasible can be difficult. This is often true of projects that involve portions of both public and private lands. This problem is particularly relevant for the BLM, which manages hundreds of isolated parcels that are landlocked by private properties and which have no legal access easements. The number, size, and condition of many deciduous stands in these areas are unknown.

Clearly, fire management options are greatly restricted in the vicinity of rural subdivisions, and, as previously discussed, fire is a large factor in determining the presence and persistence of aspen, oak, and other deciduous types. Fire managers have little choice but to suppress wildfires and avoid prescribed fires near subdivisions.

Current Aspen/Deciduous Forest Conservation Initiatives

A number of both public and private organizations have worked independently and cooperatively on aspen regeneration and habitat improvement projects. They include the Wyoming Game and Fish Department (WGFD), U.S. Forest Service, BLM, Wyoming State Forestry Division, Native American Tribes, the wood products industries, local conservation districts, and nonprofit wildlife conservation organizations such as the Rocky Mountain Elk Foundation. Coordination among these organizations is increasing as habitat improvement projects are more often implemented across administrative boundaries including public and private lands.

Considerable research has been conducted on aspen regeneration treatments over the last 30 years. The most common methods include prescribed fire, wildfire management, and mechanical techniques.

Fire can be more cost-effective for larger projects than mechanical treatments. An exception is when the conifer removal portion of some aspen regeneration projects generates commercially valuable timber, which can offset the cost of mechanical treatment.

Mechanical treatments through conifer removal are often coordinated with activities of the wood products industries. The BLM has been able to establish such projects with the cooperation of multiple private landowners in order to increase timber volumes to levels that are economically feasible. The establishment of the wood products biomass energy industry may provide new opportunities for aspen regeneration projects, both as a mechanism to administer treatments and as a funding source. To support the development of the biomass industry in Wyoming, several studies have researched forest products transportation costs, generating woody biomass energy at facilities associated with local sawmills, and building wood pellet manufacturing plants in the Bighorn Basin.

Funding and technical assistance for aspen regeneration projects in areas that are not commercially viable has come from timber sale proceeds, hazardous fuels reduction programs, the Wyoming Wildlife and Natural Resource Trust, Wyoming Game and Fish Trust Fund, Rocky Mountain Elk Foundation, and the Wyoming Conservation Corps. These treatments are often conducted using service contracts or seasonal BLM and U.S. Forest Service labor.

The U.S. Forest Service has been re-evaluating all grazing allotments for the last 10 years and is close to completing this effort. Where degraded habitat conditions have been caused by livestock overgrazing, grazing management strategies have been enacted. Local conservation districts and the Natural Resources Conservation Service (NRCS) have provided technical and financial support for activities such as water development or fence construction to support the implementation of grazing plans. Inventory and monitoring of the condition of allotment, including aspen, is conducted by U.S. Forest Service range staff during annual inspections and during the 10-year allotment reviews. Many aspen stands proposed for regeneration are identified by these inspections.

The WGFD Mule Deer Working Group (MDWG) was established in 1998 to explore solutions to the many challenges confronting mule deer conservation and management. Crucial areas for mule deer often encompass sagebrush habitat, particularly on mule deer winter range. In 2007, the MDWG drafted the *Wyoming Mule Deer Initiative* which was adopted by the Wyoming Game and Fish Commission. Among other topics, the initiative addresses habitat issues pertaining to crucial mule deer habitat improvement, the implementation of strategies to minimize negative impacts of energy development, and habitat monitoring to ensure that deer populations do not negatively impact plant species on which they browse. Beginning in 2016 the Wyoming Game and Fish Commission began allocating $500,000 per year through the Mule Deer Initiative with the intent of working collaboratively with partners to improve habitat conditions for mule deer as well as furthering knowledge on migration routes, corridors and stopover sites.

The WGFD has instituted liberal elk hunting seasons for the last decade in some hunt areas, in part, to reduce the impact of overbrowsing by elk on aspen communities. Additionally, aspen/deciduous forest habitat has been identified in the WGFD Strategic Habitat Plan (SHP) as one of eight priority habitats to enhance or maintain. The WGFD began the North Laramie Habitat Restoration Project in the Deer Creek watershed in 2007 to create aspen stands with more age-class diversity using mechanical techniques and prescribed burns. Relatively few conservation initiatives have been aimed directly at oak and bigtooth maple communities, likely because these communities cover significantly less area and show fewer signs of decline than do aspen communities.

Recommended Aspen/Deciduous Forest Conservation Actions

Conduct a statewide inventory of aspen stands to identify priority sites for aspen regeneration projects.
Stand-specific information is essential in identifying and prioritizing aspen stands for regeneration treatments. Flights or aerial photos during the fall, when the colorful leaves of aspen causes them to stand out, can be a cost-effective way to conduct initial surveys to determine status of overstory trees (mortality, defoliation, etc.). On-the-ground stand assessments are necessary to determine a community's seral stage, evaluate the extent of conifer encroachment, and assess the amount and species composition of the understory.

The presence of SAD and levels of regeneration and conifer encroachment should be used to prioritize aspen habitat treatments. Highest priority should go to stands where conditions will allow for successful establishment of mature aspen stands based on topographic and environmental conditions in order to prevent rapid conifer succession from overwhelming regenerating aspen shoots. The chance of success at regenerating stands with high levels of mortality can be low, but the possibility of limited success must be balanced against the possibility of permanent loss of aspen regeneration once an aspen clone dies.

Increase the number of treatments to regenerate aspen stands and create a mosaic of tree age classes.
Prescribed fire can be applied to closely resemble historic disturbance patterns and is often the most biologically and economically effective method to treat large aspen stands. It is important that fire not only occurs within the stands, but also around the stands to reduce seed cast from adjacent conifer. Conifer-encroached stands, with commercial-size conifers, can be effectively treated in a two-stage process in which a mechanical treatment or commercial harvest is used to put slash on the ground, which is then followed by broadcast burning. Slash can facilitate the spread of fire through more open aspen stands. Mechanical treatment may be the only option in stands where fire is not feasible due to safety, invasive species, or other concerns.

Whenever possible, treatments should be conducted after landscape level assessments have been completed. To reduce impacts on wildlife species dependent upon large contiguous forests, adequate planning is needed to determine spacing and timing of aspen treatments . This will often involve cooperation among multiple landowners and agencies. The Wyden Amendment can be used to support these efforts. This law allows U.S. Forest Service and BLM money to be spent on non-federal lands as long as the project benefits fish, wildlife, and other resources on National Forest or BLM lands within an affected watershed (Public Law 105-277, Section 323 Public Law 104-208, Section 124, and Public Law 105-277, Section 136). Additional funding can be obtained through partnering with non-profit conservation organizations such as the Rocky Mountain Elk Foundation. Public education about the value and purpose of aspen regeneration treatments should occur to ensure ongoing support for aspen habitat improvement projects. Fire treatment can be used as a management tool for oak stands as well, with many of the above concerns applicable.

Encourage careful management of ungulates grazing in aspen habitats to facilitate regeneration.
Successful aspen recruitment in the presence of high ungulate use has been documented, but aspen sprouts can be destroyed by three successive years of browsing (Kilpatrick and Abendroth 2001, Keigley et al. 2002, Tew 1981). Several techniques are effective at managing ungulate browsing levels. Regenerating large amounts of aspen simultaneously and in close proximity to each other can disperse browsing pressure. Temporary solar-powered electric fences can be erected for several years after habitat treatments if browsing exceeds sucker growth. Timber slash placement can often mimic natural disturbances such as snags falling down following fire or bark beetle infestation and can be used as a fencing tool to inhibit ungulate access to the aspen regeneration sites. Within this context, resource managers should carefully consider stocking rates and other allotment specifications regarding livestock use of aspen-occupied areas, especially if such areas are undergoing or scheduled to undergo aspen treatments.

In cooperation with land management agencies and private landowners, reintroduce beavers into stream systems where they have been extirpated or occur at low densities and where appropriate food, security, and dam-building vegetation exists.

- Reintroduce beaver. Beaver dam-building activities can increase the size and quality of riparian habitats for a range of terrestrial and aquatic species (see Wyoming Leading Wildlife Conservation Challenges – Disruption of

Natural Disturbance Regimes), and create a shifting mosaic ofriparian aspen stands in different seral stages.

- Use enhanced GIS mapping of riparian areas or other means to identify suitable reintroduction locations. Careful consultation should occur with landowners on or adjacent to reintroduction sites prior to reintroductions to minimize unintended economic losses.
- Restore watersheds and develop aspen and willow vegetation (another preferred beaver forage) to levels that will support beaver in targeted areas.

Land management agencies should require reciprocal access easements for the purpose of habitat treatments where access to new subdivisions crosses agency lands.

To reduce habitat loss and fragmentation, land trusts should be encouraged to negotiate conservation easements or other land agreements on private lands within and adjacent to U.S. Forest Service, BLM, and state trust lands.

Efforts should be made to support the continued role of the wood products industry in aspen regeneration projects by providing grants, such as those that were available through the U.S. Forest Service Economic Action Program, for market feasibility studies and new business ventures.

Additional research should be conducted to gain a better understanding of the causes of SAD and the potential impacts of climate change on aspen communities.

Aspen/Deciduous Forest Monitoring Activities

Continue existing SGCN monitoring in aspen/deciduous forests and develop new protocols for species not being adequately surveyed.

Monitor the landscape distribution and habitat intactness of aspen/deciduous forests through remote sensing and work to improve accuracy of these methods.
Remote sensing is useful in tracking the size and distribution of this habitat type in Wyoming.
Information gathered would be helpful in determining the regeneration rate of aspen stands and the impact of SAD. Special attention should be given to monitoring the level and location of aspen death and regeneration in relation to the SWAP. This technique will require the further development of monitoring protocols and the identification of sample sites.
Monitoring should be conducted in relation to the possible effects of climate change.

Inventory and monitor aspen stands in federal grazing allotments as part of annual inspections and during the 10-year allotment reviews.
Monitoring should include evaluation of aspen regeneration, community age and structure, conifer encroachment, plant understory composition, and whether or not SAD is present. Completed aspen treatments should be monitored to determine effectiveness of treatments, or whether the regeneration needs additional protection from excessive browsing for it to become established.

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Cliffs, Canyons, Caves, and Rock Outcrops

Photo courtesy of WGFD

Table of Contents

Much of the information for this section pertaining to caves and bats was derived from A Conservation Plan for Bats in Wyoming *(Hester and Grenier 2005). Those desiring additional information on bat conservation not covered in this section should consult this document.*

Habitat Description

Cliffs, canyons, and rock outcrops are common features of the mountainous West. Formation of the Rocky Mountains by uplift and volcanism, followed by erosion by glacial and other forces, led to the development of a landscape with high topographic relief (Hester and Grenier 2005). This habitat type is found across a wide elevational range—from high, wet, cold alpine landscapes all the way down to dry desert and warm plains environments. Cliffs, canyons, caves, and rock outcrops are unique habitats that can provide topographic diversity in otherwise homogeneous landscapes.

Cliffs are steep rocky outcrops with greater than 65° in slope and 4 ft in height (New Hampshire Fish and Game Department 2005). Cliffs are exposed to the elements, do not accumulate significant amounts of snow pack, and may be protected from runoff by overhangs. Vegetation of cliffs and outcrops is typically sparse, and often restricted to shelves, cracks, and crevices in the rock, or other areas where soil accumulation allows growth (Colorado Natural Heritage Programs 2010). Larson et al. (2000) describe three basic parts of a cliff habitat: 1) the relatively level plateau at the top, 2) the vertical or near-vertical cliff face, and 3) the pediment or talus at the bottom of the face. These three elements share some physical characteristics, are linked by similar ecological processes, and often support similar plants and animals (Larson et al. 2000). Within larger cliffs, a mosaic of microhabitats can occur including steep slopes, small terraced ledges, overhangs, and cracks and crevices, which contribute to the biodiversity that cliffs can support (Graham and Knight 2004). On the faces of cliffs, there is less hydraulic pressure retaining water than within the rock, so liquid water is more consistently found here than in surrounding habitats (Larson et al. 2000). Erosion by wind, water, and the force of gravity are the primary natural disturbances in cliff habitats. The lack of vegetation on many sites protects them from fire.

Caves and/or rock shelters are associated with cliffs, canyons, and rock outcrops. A cave is any naturally-occurring cavity, recess, or system of interconnected passageways beneath the surface of the earth or within a cliff or ledge that is large enough to be traversed by humans (Kerbo 2002). In Wyoming, caves are found in widely scattered locations, from 4,000 to 11,000 ft. in elevation. Although at least 23 different types of caves exist, including lava tubes, tectonic fractures, sea caves, and ice caves (Kerbo 2002), caves in Wyoming have primarily karst and pseudokarst features. Karst caves are formed by dissolution of rock rather than mechanical erosion, and they occur most frequently in limestone and dolomite. Caves similar to karst, but occurring in nonsoluble rocks are classified as pseudokarst caves which are formed by the process of piping. Cavities form by the action of certain clays that swell and contract with the presence or absence of water (Hester and Grenier 2005). Although most caves in Wyoming have karst features, pseudokarst features are common in Wyoming's basins (Hill et al. 1976).

Caves generally provide an overall climate that is less variable than at the surface, with stable temperatures, high humidity levels, low evaporation rates, and an absence of light (Washington Department of Wildlife 1994). Most have temperatures between 30–50 °F (Hill et al. 1976). Although relatively constant, not all cave temperatures are similar, and may be influenced by a number of factors, including the number, size, and position of portals; the size, slope, and contour of passages; the cave's overall volume; the seasonality and dynamics of airflow; and water intrusion (Washington Department of Wildlife 1994). Cave habitats may be simple or complex, and often include many smaller tubes, cracks, and fissures

(Washington Department of Wildlife 1994; Altenbach et al. 2002).

Caves are irreplaceable natural resources, taking centuries to form, having limited distributions, and containing unique biological communities. Additionally, about 25% of the groundwater in the U.S. is located in cave and karst regions, further increasing their value for society (Kerbo 2002).

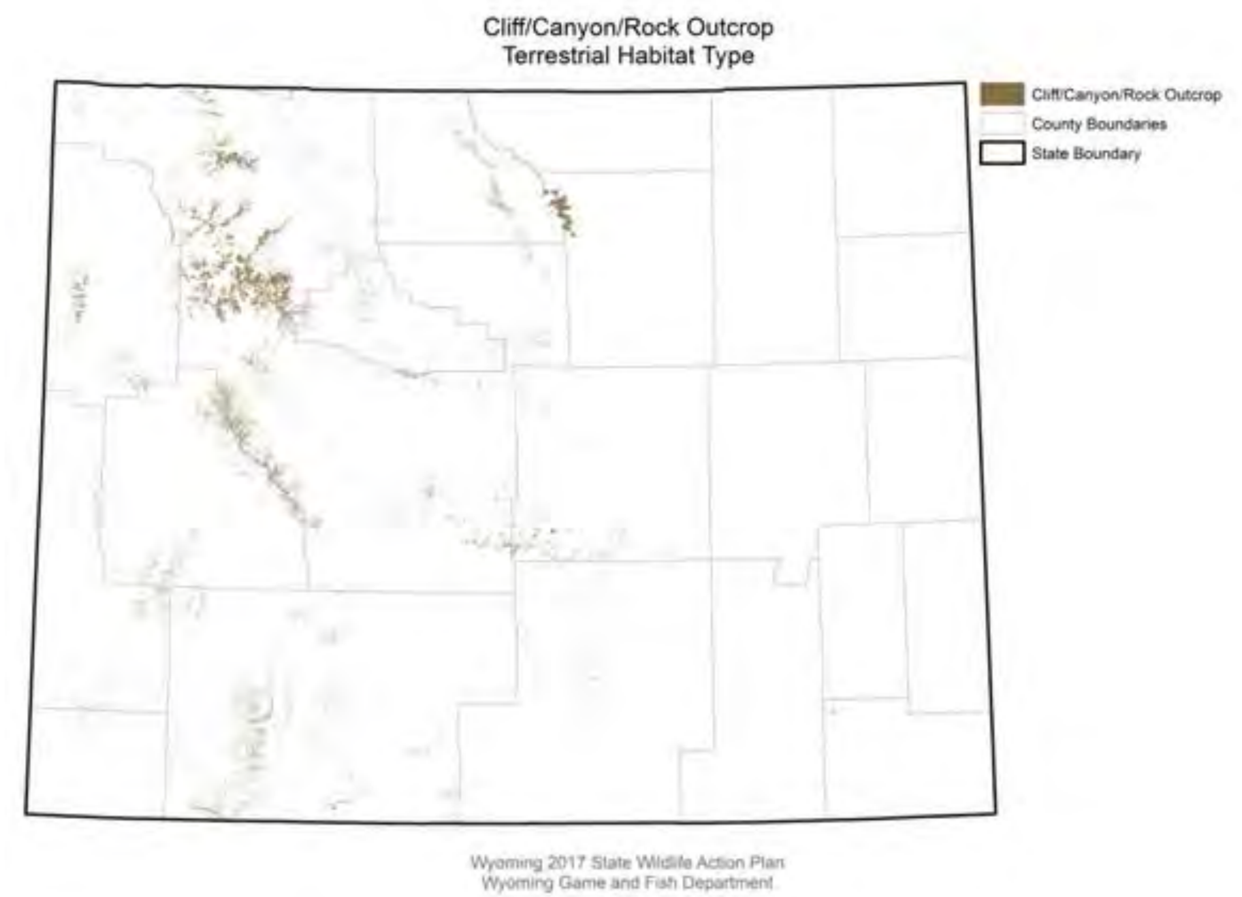


FIGURE 3. **Wyoming Cliffs, Canyons, and Rock Outcrops** (*Note: This map does not depict the location of any caves which were not represented as a NatureServe Ecological System*)

TABLE 3. Wyoming Cliffs, Canyons, and Rock Outcrops NatureServe Ecological Systems[1]

1. Rocky Mountain Cliff, Canyon, and Massive Bedrock
2. North American Alpine Ice Field
3. Rocky Mountain Alpine Bedrock and Scree
4. Western Great Plains Cliff and Outcrop
5. Inter-Mountain Basins Cliff and Canyon
6. Rocky Mountain Alpine Fell-Field

[1] Descriptions of NatureServe Ecological Systems which make up this habitat type can be found at: NatureServe Explorer: an online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, VA. http://www.natureserve.org/explorer.

TABLE 4. Wyoming Cliffs, Canyons, Caves, and Rock Outcrops Species of Greatest Conservation Need

Mammals
American Pika
Bighorn Sheep
Canyon Mouse
Cliff Chipmunk
Dwarf Shrew
Eastern Spotted Skunk
Fringed Myotis
Little Brown Myotis
Long-eared Myotis
Long-legged Myotis
Northern Long-eared Myotis
Pallid Bat
Piñon Mouse
Plains Harvest Mouse
Ringtail
Spotted Bat
Townsend's Big-eared Bat
Uinta Chipmunk
Western Small-footed Myotis
Western Spotted Skunk
Wolverine
Yuma Myotis

Birds
Black Rosy-finch
Brown-capped Rosy-finch
Canyon Wren
Clark's Nutcracker
Golden Eagle
Peregrine Falcon

Reptiles
Great Basin Gophersnake
Great Basin Skink
Midget Faded Rattlesnake
Northern Tree Lizard
Plains Black-headed Snake
Plateau Fence Lizard
Prairie Lizard
Prairie Rattlesnake

Cliffs, Canyons, Caves, and Rock Outcrops Wildlife

Cliffs, canyons, caves, and rock outcrops occupy a small percentage of the land base, but they are disproportionately important as wildlife habitat. The uniqueness of this habitat often results in entirely different communities during the breeding season compared with adjacent habitats, increasing overall species richness and diversity (Hester and Grenier 2005). Cliffs, canyons, caves, and rock outcrops benefit birds and mammals directly by providing shelter and breeding sites, and indirectly by providing diverse vegetation structure. For example, some shrub species, such as skunkbush sumac, chokecherry, currant, and juniper, are primarily associated with rock outcrops.

The wildlife that use these habitats are highly specialized and are often dependent upon cliffs, rock outcrops, or canyons for reproduction, foraging, or predator avoidance. The stability and persistence of cliff, rock, and canyon formations encourage the repeated use of specific areas as breeding habitat. Well-known cliff-nesting raptors include the peregrine falcon, prairie falcon, golden eagle, and turkey vulture. Big game species such as bighorn sheep and mountain goat feed on the vegetation found on cliffs, canyons, and rock outcrops and also use these habitats to escape predators such as mountain lions. Pika, dwarf shrew, canyon mouse, cliff chipmunk, bushy-tailed woodrat, and spotted skunks are examples of smaller mammals found in this habitat type. Permanent snow and ice in proximity to exposed rock are important features of breeding habitat for black rosy finches and brown-capped rosy finches, as well as wolverine, the latter using snow drifts to cache food. Rock shelters also provide very important roosts for several species of bats (Hester and Grenier 2005). In southern Sweetwater County in proximity to juniper habitats, rock outcrops are particularly valuable to several SGCN mammals. The distribution of the cliff chipmunk, canyon mouse, and piñon mouse is restricted to this portion of the state. Important habitat components include high diversity of invertebrates, as well as vegetative seeds and berries.

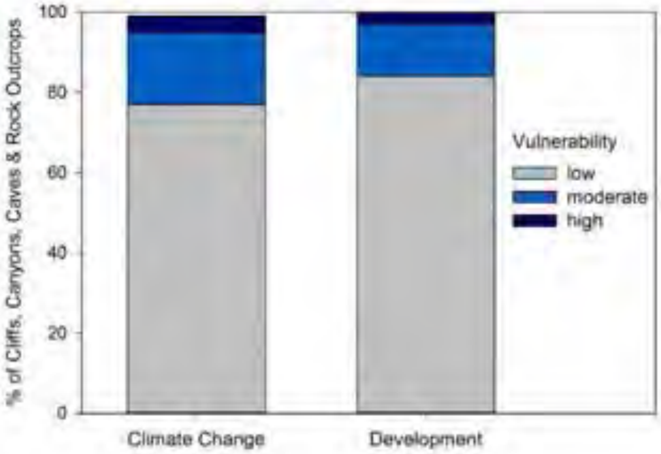
The preservation of bat roosts in caves is one of the most important issues in bat conservation (Sheffield et al. 1992). At least 21 of the 45 bat species in North America use caves regularly, and many of the remaining species use them at least occasionally (Racey and Entwhistle 2003. Eighteen species of bats are found in Wyoming and occupy all areas of the state, constituting 15% of all Wyoming's mammal species (Hester and Grenier 2005). Bats use caves as winter hibernacula, summer maternity roosts, day roosts, and even night roosts (Sheffield et al. 1992, Hinman and Snow 2003). Caves may serve as refugia for bats in the event of loss or degradation of other roosts in the surrounding landscape, and in some areas, the availability of suitable caves plays a major role in determining the size and distribution of bat populations (Christy and West 1993). Important roosts are often traditional and are used by successive generations of bats over many years (Hester and Grenier 2005). There have been 161 caves documented in Wyoming that could provide bat habitat (Luce 1998).

Even though they are manmade features, many abandoned mines share characteristics with caves that make them some of the most important roosting sites for bats (Hinman and Snow 2003). At this time, approximately 1,000 abandoned mines that have not undergone reclamation are known to exist across Wyoming. The Wyoming Game and Fish Department (WGFD) has located and surveyed only about 300 of these mines. Nearly 100 have been confirmed to be occupied by bats, although WGFD personnel have identified numerous others as having significant habitat potential for bats (Hester and Grenier 2005).

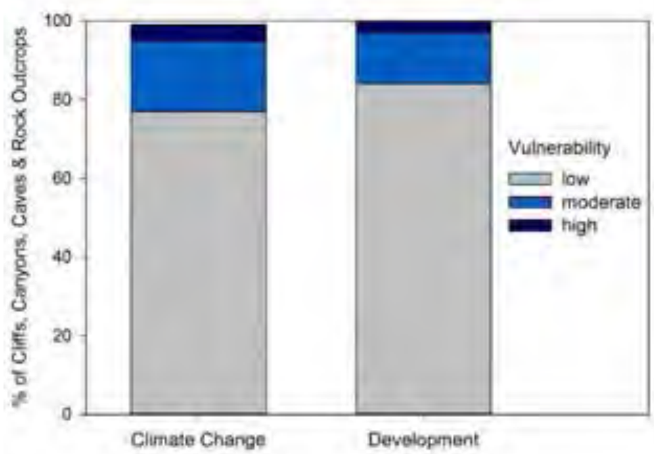
Cliffs, canyons, caves, and rock outcrops are also immensely important to a variety of reptile species. These habitats provide thermally favorable refuges, cover, and hibernacula. These habitats do not need to be expansive to harbor reptile populations, and the presence of only a few exposed rocks could attract snakes and lizards. Snakes are particularly dependent on rock outcroppings for winter dens. Rocky outcrops often provide crevices or other geologic features that allow snakes to travel below the frost line to escape freezing temperatures during winter. Often snakes are intimately tied to their hibernacula, returning to the same den their whole lives. The destruction of a den site often results in the reduction or elimination of local snake populations.

Cliffs, Canyons, Caves, and Rock Outcrops Habitat Threats

Figure 4. Cliffs, Canyons, Caves, and Rock Outcrops Vulnerability Analysis



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high vulnerability to climate change or development, based on classification of scores ranging from 0 to 1 into the following categories: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for climate change or development vulnerability were based on the land area of the habitat type classified as having high vulnerability: low (<10%), moderate (10-33%), or high (>33%). Vulnerability was calculated as exposure minus resilience. Development vulnerability includes existing and projected residential, oil and gas, and wind energy development. Further details are provided in the Leading Challenges section of this report and in Pocewicz et al. (2014).



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high land management status or habitat intactness. For land management status, high corresponds to the percent of the habitat occurring in GAP status 1 or 2, moderate to the percent occurring in GAP status 2b or 3, and low to the percent occurring in GAP status 4. Rankings for land management status were based on the land area of the habitat type classified as having high status or legal protection: low (<10%), moderate (10-33%), or high (>33%). For habitat intactness, scores ranging from 0 to 1 were assigned to categories as follows: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for intactness were based on the land area of the habitat type classified as having high intactness: low (<25%), moderate (25-75%), or high (>75%).

Recreation and human disturbance – Locally High
Recreational activities such as rock climbing, hiking, camping, bouldering, bicycling, horseback riding, and spelunking are common in cliffs, canyons, caves, and rock outcrop habitats. Disturbance to birds can be caused by the presence of humans and associated noise or erosion. Rock climbing, in particular, has become more popular during the last few decades and may have reduced the nesting success of some cliff and rock outcrop nesting birds (Nicholoff 2003). Such disturbance may gradually reduce the total number of suitable nesting sites available for birds dependent upon this habitat.

Recreation in caves and abandoned mines impacts roosting bats by the disruption of hibernacula and maternity colonies. Even when bats are not currently present, recreation can diminish the quality of caves and abandoned mines through accumulation of garbage or damage to cave walls from graffiti and smoke from fires. Excessive disturbance may result in the loss of subpopulations and can present a significant threat to bats and bat habitat (Hester and Grenier 2005). Interest in recreational caving is increasing in the U.S. The National Speleological Society currently has more than 12,000 members (National Speleological Society 2010). Disturbance during hibernation may cause bats to arouse prematurely and burn stored energy reserves that usually cannot be spared (Sheffield et al. 1992). Even disturbances that may seem trivial, such as light or body heat emitted from humans, as well as noises from movements or whispering that produce high-frequency sounds, can disturb bats (Hester and Grenier 2005). Because bats can require up to an hour or more to arouse from hibernation, they may appear to be undisturbed, but become fully awakened only after humans have left the cave. Furthermore, repeated disturbances may force bats to abandon optimal hibernacula and move to alternative, less-suitable locations where survival rates are lower (Hester and Grenier 2005).

Recreational searching for reptiles may also affect this habitat type. Rock flipping is a common method to search for snakes and lizards, and numerous rocks can be moved during the course of one afternoon. If disturbed rocks are not placed back into their original positions, microclimates necessary to reptiles can be destroyed. If enthusiasts disturb a large area of rocky habitat, reptile populations could be directly impacted.

Mining – Moderate
Mine reclamation projects have provided habitat for a diversity of wildlife species including cliff-nesting birds, bighorn sheep, mule deer, and others. Where ledges and crevices occur in open-pit mine walls, bats and some species of cliff-nesting birds utilize these sites for nesting or roosting.

However, mining and construction can have negative impacts when they occur at the base or the top of cliffs, rock outcrops, or canyons. Gravel quarries may actually remove buttes and cliffs and disturb or destroy the cracks and crevices where bats roost (Hester and Grenier 2005). The potential for oil shale development in southwestern Wyoming threatens rock outcrop habitats occupied by SGCN including the midget faded rattlesnake, cliff tree lizard, cliff chipmunk, canyon mouse, pallid bat, spotted bat, and Townsend's big-eared bat.

Bat roosting habitat has been lost in Wyoming and continues to be threatened by abandoned mine reclamation or the resumption of mining operations. New mining techniques usually produce open pits, which are unsuitable as bat habitat, and often destroy existing mine entrances and shafts (Brown 1995, Pierson 1998). Some gates or other closures on caves and abandoned mines do not allow access for bats (Oakleaf et al. 1996).

Inappropriate wind-energy development siting and design – Moderate
Wind has become the world's fastest growing power source, increasing about 30% annually since 1996 (Kunz 2004) (see Wyoming Leading Conservation Challenges – Energy

Development). Suitable sites for wind development are often found on or near cliff, canyon, and rock outcrops.

Raptor collisions with wind turbines are more common when wind turbines are sited on steep slopes and hillsides, in canyons and draws, on ridge crests and peaks within canyons, and when rock piles that attract prey species are located near turbines (Hoover and Morrison 2005, Kingsley and Whittam 2003, Smallwood and Thelander 2004). Excessive or continuous noise from wind turbines can interfere with the vocal communication of birds, particularly during the breeding season (March through July for most raptors and April through July for most passerines) (Wyoming Game and Fish Department 2010).

Of the 18 bat species found in Wyoming, almost half have been identified in turbine-related mortality assessments conducted throughout the U.S. (Johnson 2005, Arnett et al. 2008). The average bat fatality rate for U.S. wind projects is 3.4 fatalities per turbine per year (Johnson 2004). Nearly 90% of bat fatalities occur in late summer and early fall, during the peak of fall migration (Keeley et al. 2001, Erickson et al. 2002, Johnson 2004). Migrating and commuting bats often follow linear landscape features, and may be drawn to ridges where wind energy facilities are located (Erickson et al. 2002, Kunz 2004). The physical characteristics of wind turbines might also attract bats. It has been hypothesized that light, heat, or high-pitched sounds emitted by wind turbines, or their tall, vertical structures, may attract bats or the insects upon which they feed (Hester and Grenier 2005). Wind turbines may also attract bats as potential roost sites.

Housing development and construction – Low

Development or construction activity that significantly increases human activity levels may decrease habitat use by wildlife. Additionally, development that removes vegetation above caves can alter internal cave climate and light levels, reducing insect populations, and eliminating visual barriers to the entrance of caves, which may increase human visitation (Washington Department of Wildlife 1994). As housing development and construction occur in an area, humans may be motivated to destroy snake hibernacula. This is often a common practice in regards to venomous species. Rattlesnake dens are located and destroyed to ensure the safety of others. The destruction of these dens often results in the modification of rocky habitats.

Current Cliffs, Canyons, Caves, and Rock Outcrops Conservation Initiatives

Caves on federal lands are protected through the Federal Cave Resources Protection Act of 1988, which requires federal agencies to inventory and list significant caves on federal lands and to protect such caves from harm, either to the cave or its biota (Hester and Grenier 2005).

Before 1994, bats were not legally protected in Wyoming. In 1994, the Wyoming Game and Fish Commission approved nongame wildlife regulations protecting several wildlife species, including bats. In 1998, the Western Bat Working Group was formed as an outgrowth of a range-wide effort to protect the Townsend's big-eared bat. Subsequently, each participating state, including Wyoming, has established its own working group. The Wyoming Bat Working Group (WYBWG), comprised of multiple agencies, meets annually to prioritize and discuss bat conservation efforts in Wyoming.

In 2003, the WGFD and the WYBWG initiated the development of *A Conservation Plan for Bats in Wyoming* which was completed in 2005 (Hester and Grenier 2005). The overall goal of the plan was to consolidate current knowledge about bats in Wyoming and to provide a cooperative framework to identify and coordinate actions to facilitate bat conservation in Wyoming. The plan includes management recommendations for cliff, rock outcrop, and cave habitats. Since the 1990s, the WGFD Nongame Program, U.S.

Fish and Wildlife Service, Bureau of Land Management (BLM), U.S. Forest Service, Wyoming Department of Environmental Quality (DEQ), and private landowners have actively taken steps to conserve caves and abandoned mines in Wyoming that are important to bats. Identifying caves and mines that provide important hibernacula and maternity roosts remains a priority for bat conservation in Wyoming. Where these areas have been or have the potential to be negatively impacted by human disturbance, the Department, in collaboration with other state and federal agencies and private landowners, installs bat-friendly closures that exclude humans during important life-history stages. Currently, 72 caves and mines have closures that exclude humans for at least part of the year, and additional closure projects are planned.

Recommended Cliffs, Canyons, Caves, and Rock Outcrops Conservation Actions

Inform land managers about potential negative effects and mitigation measures for recreational activities on or near cliff, canyon, cave, and rock outcrop habitats.

- Outlets such as the WYBWG, Wyoming Wildlife magazine, recreational clubs, schools, and public education programs can be used to inform the public and agency personnel about potential negative impacts on wildlife caused by recreation and discuss associated mitigation techniques. In addition to distributing educational materials, recreational clubs, such as climbing and spelunking organizations, can be useful sources for collecting information on wildlife observations.
- In cooperation with land management agencies, wildlife agencies, recreational clubs, and private landowners, review current human use levels for cliffs, canyons, caves, and rock outcrops that serve as crucial wildlife habitat. Potential impacts should be evaluated and management scenarios developed where necessary. Where recreational cavers may come into conflict with key maternity or hibernation sites, close hibernation sites to visitation from November 1 to April 1 and maternity sites from April 1 to October 1 (Hester and Grenier 2005). The critical time periods of hibernation and maternity activity may vary regionally and may allow some site-specific flexibility in seasonal closures. At some caves where human disturbance is affecting bat populations, it may be necessary to install bat-friendly closures to allow passage by bats while restricting human access.
- Keep the locations of caves, bat roosts, and cliff-dwelling bird nests confidential. Avoid including them on maps, road or trail signs, brochures, or press releases.
- Use signs and other interpretive media to help people appreciate bats and understand the fragility of roosting bats, and enlist professional outfitter/guides and climbing organizations as allies.

Work with the appropriate federal and state agencies to protect and maintain cliffs, caves, and abandoned mines that provide valuable habitat for bats and other wildlife.

- Where possible, avoid renewed mining activities above, inside, or near abandoned mines inhabited by bats.
- Maintain the microclimate of cliffs and rock outcrops used by bats as roosts by protecting and managing the vegetation up to 790 feet from the roost area (Ormsbee 1996).
- After construction or mining has been completed, reclaim lands with consideration for the unique foraging and roosting needs of bats. All components of bat habitat must be in close proximity (within several miles) for bats to use them efficiently (Keinath 2004). Maintain all vegetation above caves inhabited by bats and near cave portals to avoid altering the internal cave climate and light levels and reducing insect populations, and to avoid removing visual screening barriers that may discourage human use (Hester and Grenier 2005). Avoid timber harvest activities and prescribed burning within

a quarter-mile radius of caves inhabited by bats (Stringer et al 1991; Keinath 2004). Time construction and mining activities to avoid disturbing known maternity colonies between April 1 and October 1 (Hester and Grenier 2005).

- Avoid building roads within 300 feet of caves inhabited by bats. Where caves will be visible from roads, or where roads will cause erosion into caves or alter the climate or flow of water in or around caves, institute a quarter-mile buffer (Washington Department of Wildlife 1994). Close roads or apply seasonal restrictions on roads that increase public access to vulnerable bat cave habitat (Oakleaf et al. 1996).
- Where human recreation is or has the potential to negatively impact roosting or hibernating bats, install bat-friendly closures that exclude humans while allowing access for bats and other cave-dwelling wildlife species. Where bat use is season-specific and recreational use is high, investigate the potential for bat-friendly gates that can be locked during hibernation or pup-rearing but opened to recreational caving when not in use by bats.

Work with state and federal agencies, as well as private landowners, to reduce potential negative impacts to wildlife from mining and abandoned mine reclamation projects.

- Enhance habitat for birds and other wildlife by placing suitable rocks on reclaimed mined land. Rock should be placed in piles of varying sizes up to 6 feet in height. Rocks and rock piles should be grouped—as opposed to evenly scattered—over large areas with approximately four rock piles taller than 3 feet per acre. The minimum area to include in outcrop habitats should be about 2.5 acres (1 ha), and shrub species should be planted in and around piles to encourage establishment of unique plant communities (Nicholoff 2003).
- Utilize the WYBWG to enhance current cooperative efforts and communication between land management agencies, the Abandoned Mine Lands Division (AML) of the DEQ, WGFD, and private landowners to reduce impacts from the reclamation of abandoned mines that provide bat habitat. Integrate ongoing Office of Surface Mining and AML abandoned-mine safety campaigns with bat habitat education programs and actively discourage recreation in abandoned mines. Identify abandoned mines that have gates or other closures that exclude bats and appear to have significant bat habitat potential.
- Prior to mine closure or renewed mining, evaluate all abandoned mines as bat habitat. Multiple surveys within and across seasons are essential to determine the significance of mine structures to bats for hibernation and maternity, as well as day, night, and lek roost activities (Hester and Grenier 2005).
- Where possible, avoid hard closure of mines that include activities such as bulldozing, backfilling, blasting, sealing with concrete, and foaming that make mines inaccessible to bats and other wildlife. If the destruction of bat-occupied abandoned mines or caves is unavoidable, safely exclude or remove bats during a non-critical season to avoid mortality (Altenbach et al. 2002). Identify and protect replacement roosts or consider reopening already closed mines in nearby habitat within five miles (Hester and Grenier 2005).

Consult the WGFD *Wildlife Protection Recommendations for Wind Energy Development in Wyoming* (2010) when planning and constructing wind energy development projects.

Recommendations most relevant to the cliff, canyon, cave, rock and outcrop habitats include:

- In coordination with WGFD and U.S. Fish and Wildlife Service, determine appropriate set-backs from ridges, bluffs, or other features to avoid or minimize impacts to bats, neotropical birds, migratory birds, raptors, and reptile hibernacula. Determinations should be made on a project-specific basis based upon site-specific data and information.

- Construction around raptor nests on cliffs, canyons, and rock outcrops should be suspended within specified buffers and seasonal dates to be found in Appendix B of *Wildlife Protection Recommendations for Wind Energy Development in Wyoming* (Wyoming Game and Fish Department 2010).
- Adopt appropriate turbine design and siting standards to minimize bird and bat collisions (see U.S. Fish and Wildlife Service 2003 and Department of the Interior Wind Turbine Guideline Advisory Committee Recommendations 2010).

Cliffs, Canyons, Caves, and Rock Outcrops Monitoring Activities

Continue monitoring SGCN in cliff, canyon, cave, and rock outcrop habitats in order to detect population trends or changes in distribution that may reflect habitat problems.
Implement cliff, canyon, cave, and rock outcrop monitoring programs to establish baseline data and identify changes in habitat quality, both positive and negative, over time. This information should be used to guide future monitoring and research, as well as habitat conservation needs. Monitoring should include documentations of caves and abandoned mines that receive significant bat use.

Monitor recreational use in cliff, canyon, cave, and rock outcrop habitats.
Increase educational efforts and develop management plans for sites where the level, timing, or type of recreational activity may negatively impact wildlife.

Continue to monitor the distribution and condition of cliff, canyon, cave, and rock outcrop habitats through remote sensing and ground surveys.
Remote sensing is useful in tracking the size and distribution of this habitat in Wyoming. Information gathered would be helpful in determining the cumulative impacts of activities such as mining.

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Desert Shrublands

Photo courtesy of WGFD

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Habitat Description

Desert shrublands typically occur in basins at elevations between 4,980 and 7,220 feet (Colorado Natural Heritage Programs website) where less than 10 inches of precipitation falls annually (Knight 1994). Soils are often poorly developed and are characterized by being fine-textured, moderately deep, with lower infiltration rates, and a tendency to alkalinity or salinity. With the exception of soil salinity, desert shrublands share many features with sagebrush habitats including a predominance of shrubs, moisture and nutrient limitations to plant growth, and sensitivity to various forms of herbivory (Knight 1994).

Desert shrub communities vary from almost pure stands of single species to fairly complex mixtures. Common Wyoming desert shrubs include greasewood, shadscale, fourwing saltbush, Gardner's saltbush, winter-fat, spiny hop-sage, and kochia which are all characteristic of the Great Basin Deserts to the west (Knight 1994). Cushion-plant vegetation is a community of forbs that commonly provide ground cover under similar location and climate conditions as desert shrubs, but are a distinct form of habitat on windblown rims and rock outcrops in south-central Wyoming (Jones 2005). The composition and distribution of plant species is most heavily influenced by complex relations among physical, chemical, moisture, and topographic gradients (Blaisdell and Holmgren 1984). Greasewood desert shrubland and saltgrass meadows are characteristic of playas (small basins that periodically fill with water) and other comparatively wet depressions (Knight 1994). Bud sagebrush, early sagebrush, and bird's-foot sagebrush are also common short-statured shrubs found in these habitats (Winward 2004). Basin big sagebrush is often found along intermittent drainages (NatureServe 2010). Uplands are composed of mixed desert shrublands, salt desert shrublands, and desert grasslands. Wyoming big sagebrush-dominated shrublands are often found intermingled with desert shrublands, where soils are less saline and better drained, and on the lee side of slopes where snowdrifts form. Expanses of sagebrush steppe often border desert shrublands at slightly higher elevations or where annual precipitation is greater (Knight 1994). Cool-season grasses associated with desert shrublands include Indian ricegrass, squirrel-tail, wild ryes, western wheatgrass and Sandberg bluegrass. Important warm-season grasses are galleta, alkali sacaton, sand dropseed, and blue grama (Blaisdell and Holmgren 1984). A number of annual species may also grow in association with this habitat type, although they are usually rare and confined to areas of recent disturbances (Blaisdell and Holmgren 1984). Perennial forb cover is generally sparse, although in some areas woody aster, Hooker's sandwort, Hood's phlox, and globemallow are common (NatureServe 2010).

Desert shrublands have low primary productivity due to dry conditions, cold temperatures, high soil salinity, and a short growing season. Bare ground is common. Sparse plant cover, along with fine-grained saline soils, makes this habitat type vulnerable to water and wind erosion. Many areas within this habitat resemble badlands. Desert pavement and coppice dunes often form in mixed-desert shrublands. Wind can erode silt and sand, leaving a surface of pebbles adjacent to small dunes, where finer particles accumulate around shrubs (Knight 1994). Some desert shrubland soils and plants have high levels of selenium, a naturally occurring chemical element that can be toxic at high levels. High erosion rates in desert shrublands raise concern about both salt and selenium water contamination.

The space between plants is frequently covered by a biotic soil crust (West 1982). This crust is important to long-term soil formation and stability, and its blue-green algal component is a major fixer of nitrogen.

Drought and herbivory are the most common disturbances in desert shrubland communities (Knight 1994). Fires occur infrequently, but can occur in stands of greasewood or mixed-desert shrublands where adequate fuel levels accumulate as a result of light grazing or the invasion of cheatgrass (Knight 1994). Unlike most species of sagebrush, many desert shrubs have the ability to sprout following disturbance.

Land uses that occur in desert shrublands habitats include livestock production, energy production and mining, wildlife habitat, and a variety of outdoor recreational activities.

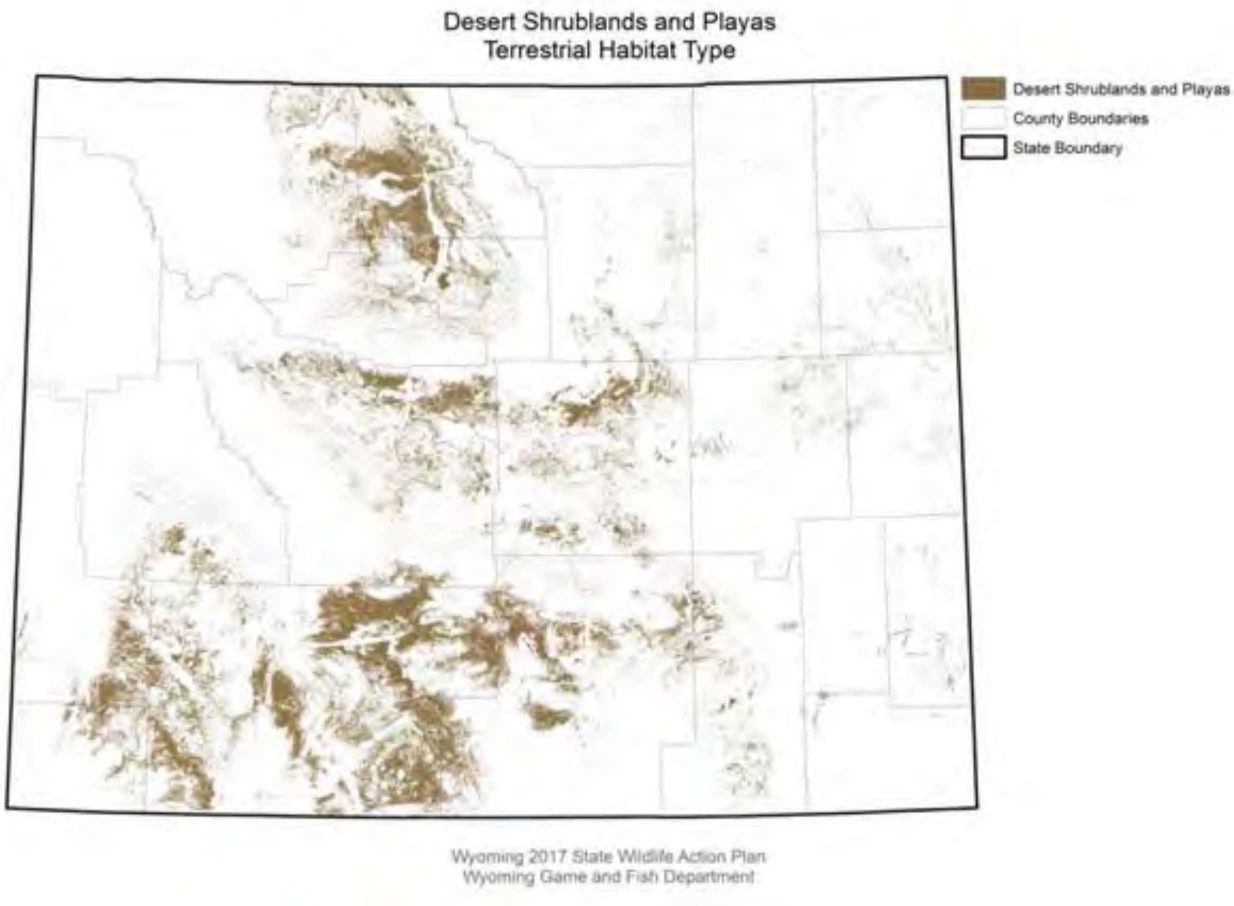


FIGURE 5. Wyoming Desert Shrublands

TABLE 5. Wyoming Desert Shrublands NatureServe Ecological Systems[1]

1. Western Great Plains Badland
2. Inter-Mountain Basins Shale Badland
3. Northwestern Great Plains Shrubland
4. Inter-Mountain Basins Semi-Desert Shrub-Steppe
5. Introduced Upland Vegetation – Shrub
6. Inter-Mountain Basins Mat Saltbush Shrubland
7. Inter-Mountain Basins Mixed Salt Desert Scrub
8. Inter-Mountain Basins Greasewood Flat

[1] Descriptions of NatureServe Ecological Systems which make up this habitat type can be found at: NatureServe Explorer: an online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, VA. http://www.natureserve.org/explorer.

TABLE 6. Wyoming Desert Shrublands Species of Greatest Conservation Need

Mammals
Great Basin Pocket Mouse
Olive-backed Pocket Mouse
Pygmy Rabbit
Wyoming Pocket Gopher
Yuma Myotis
White-tailed Prairie Dog

Birds
Burrowing Owl
Brewer's Sparrow
Ferruginous Hawk
Greater Sage-Grouse
Loggerhead Shrike
Mountain Plover
Sagebrush Sparrow
Sage Thrasher
Short-eared Owl

Reptiles
Great Basin Gophersnake
Greater Short-horned Lizard
Midget Faded Rattlesnake
Northern Tree Lizard
Plains Hog-nosed Snake
Plateau Fence Lizard
Prairie Rattlesnake

Amphibians
Great Basin Spadefoot
Great Plains Spadefoot
Western Tiger Salamander

Desert Shrublands Wildlife

Desert shrub communities serve as habitat for wildlife that range in size from insects and small mammals to birds and large herbivores. Animals, as well as plants, exhibit wide fluctuations in productivity from year to year, largely as a result of varying weather conditions.

The Wyoming pocket gopher, Wyoming's only endemic mammal, is associated with dry, salty, low-productivity sites. Although there is some overlap, Wyoming pocket gopher habitat is distinct from northern pocket gopher habitat in terms of soils and vegetation. Specifically, Wyoming pocket gophers tend to occur on flatter slopes with ample bare ground where Gardner's saltbush and winter-fat are present and Wyoming big sagebrush is subdominant. Wyoming pocket gopher soils have higher clay content and fewer coarse fragments when compared to northern pocket gopher soils (Keinath et al. 2014).

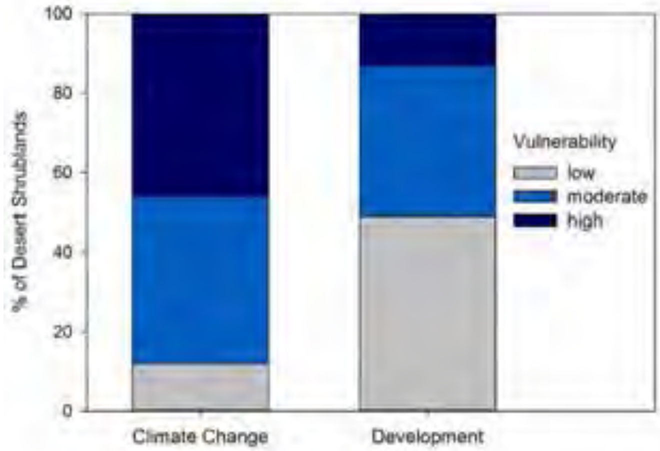
Game species found in desert shrublands habitat include mourning dove, sage-grouse, desert and mountain cottontails, pronghorn, and mule deer. Crucial winter range for pronghorn and mule deer has been designated in some desert shrublands areas. Pronghorn are more common than deer in salt-desert shrub vegetation; however, both are highly mobile and make much use of associated habitats, especially sagebrush and grasslands (Blaisdell and Holmgren 1984). Well known desert shrubland small mammals include the white-tailed jackrabbit and bushy-tailed woodrat. Common predators include coyote, bobcat, badger, great horned owl, golden eagle, Swainson's hawk, red-tailed hawks, and prairie falcon.

Mountain plover are one species of special concern due to their specific habitat needs in desert shrublands, particularly where they nest. On May 12, 2011, the U.S Fish and Wildlife Service announced the decision to withdraw the proposed listing of the mountain plover as a threatened species under the Endangered Species Act. Mountain plovers prefer flat terrain (less than 5% slope), with low-growing vegetation, and a minimum of 30% bare ground. Pesticide use to control grasshoppers and Mormon crickets can reduce prey availability for grassland birds, especially the mountain plover.

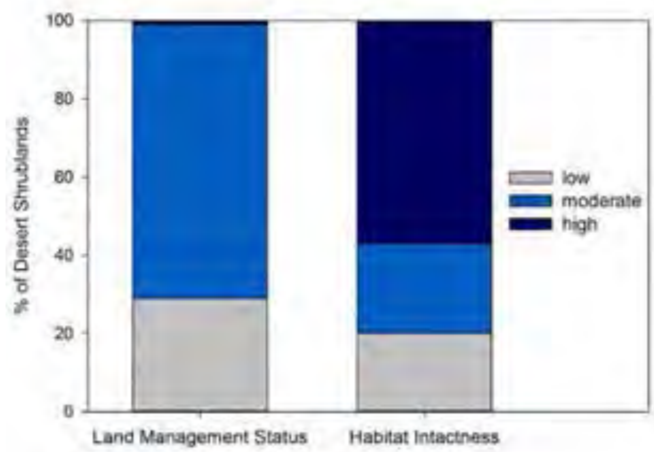
Invertebrates may be important to the overall wildlife value of desert shrub systems, similar to the way invertebrates operate in sagebrush systems where they may provide a crucial forage base, helping bridge seasonal shortages of protein (spring) and water (late summer, fall) for vertebrate wildlife.

Desert Shrublands Habitat Threats

Figure 6. Desert Shrublands Vulnerability Analysis



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high vulnerability to climate change or development, based on classification of scores ranging from 0 to 1 into the following categories: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for climate change or development vulnerability were based on the land area of the habitat type classified as having high vulnerability: low (<10%), moderate (10-33%), or high (>33%). Vulnerability was calculated as exposure minus resilience. Development vulnerability includes existing and projected residential, oil and gas, and wind energy development. Further details are provided in the Leading Challenges section of this report and in Pocewicz et al. (2014).



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high land management status or habitat intactness. For land management status, high corresponds to the percent of the habitat occurring in GAP status 1 or 2, moderate to the percent occurring in GAP status 2b or 3, and low to the percent occurring in GAP status 4. Rankings for land management status were based on the land area of the habitat type classified as having high status or legal protection: low (<10%), moderate (10-33%), or high (>33%). For habitat intactness, scores ranging from 0 to 1 were assigned to categories as follows: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for intactness were based on the land area of the habitat type classified as having high intactness: low (<25%), moderate (25-75%), or high (>75%).

Invasive plant species – High
Halogeton, Russian thistle, and cheatgrass are the three most significant invasive annual species in Wyoming desert shrublands. Alyssum, pepperweed, hound's-tongue, Russian knapweed, and whitetop are also common on bare ground.

Invasive species frequently become established in desert shrubland habitats adjacent to or within ephemeral drainages, near reservoirs, in areas of livestock overuse, or locations of high human traffic, such as roadways for recreation, energy development, or bentonite mining.

Halogeton and Russian thistle are primary invaders on clay soils in saline shrub plant communities where there is soil disturbance. Halogeton is extremely poisonous to sheep and is restricting winter grazing in some areas. The spread of halogeton could alter livestock distribution and encourage the conversion of sheep allotments to cattle allotments. These changes could further modify grazing dynamics and in turn influence plant diversity and seasonal use patterns by wildlife (A. Warren, personal communication, April 2010).

Increases in cheatgrass are considered to contribute to a shift from sagebrush dominance to greasewood dominance in some locations in Washington shrublands (Rickard 1964). Similar shifts could occur in Wyoming if cheatgrass becomes more abundant (Knight 1994). Increases in fire frequency in communities where cheatgrass is prevalent can decrease spring insect availability for birds and contribute to the spread of other invasive species.

Many invasive plant species decrease native plant diversity and reduce forage quality for wildlife and livestock that use these habitats (see Wyoming Wildlife Leading Conservation Challenges – Invasive Species). Additionally, the establishment of invasive species is correlated with increasing soil erosion and reductions in site productivity. Invasive plant species that become established in desert shrublands can serve as a seed source, facilitating their spread to nearby riparian and sagebrush habitats.

Incompatible energy development and mining practices – Moderate
Natural gas development is common in desert shrubland habitats and wind-power development is expanding. Energy development can result in direct and indirect impacts to wildlife species and their habitat (see Wyoming Wildlife Leading Wildlife Conservation Challenges – Energy Development). Direct impacts include the removal and fragmentation of desert shrubland habitats by activities such as mine excavation and the building of roads, drill pads, fences, power lines, and pipelines. Indirect impacts include increased human activity and noise. These impacts can displace animals and decrease reproductive success if animals are forced to use less productive habitats or expend more energy to avoid people. Soil disturbance from roads and other types of construction and increased vehicle traffic are significant contributors to the establishment and spread of invasive plant species.

Even more so than actual construction of energy production facilities, the establishment of roads can be problematic in desert shrubland habitats due to their length, drainage crossings, and overall change in hydrologic processes. Soil compaction due to road construction may be particularly important for burrowing mammals, including the Wyoming pocket gopher (Cudworth and Grenier 2015). Much of this habitat type is transected by roads and pipelines from past oil and gas explorations. Some older wells are being reworked, resulting in damage to previous reclamation efforts, which are slowly returning to pre-disturbance conditions. (E. Warren, personal communication, 12 November 2009). Reclamation can be difficult in desert shrubland habitats due to saline, fine-textured and unproductive soils, and low precipitation levels.

Off-road vehicle use – Moderate/Locally High
Off-road vehicle use, primarily by all-terrain vehicles (ATVs), is increasing in desert shrublands. Vehicle use off established roads

can enhance the spread of invasive species including halogeton, alyssum, pepperweed, and cheatgrass. Tires can damage biological soil crusts leading to decreased organism diversity, soil nutrients, stability, and organic matter. This can result in greater erosion and reduced water quality. Wildlife often avoid areas of increased noise and disturbance from outdoor recreational vehicles, and riding off-road can destroy the nests, eggs, and young of ground-nesting birds. These impacts can also lead to conflicts with hunting, wildlife viewing, and other forms of nature-based recreation. Managing off-road vehicle use can be difficult and controversial in desert shrubland habitats where new trails are relatively easy to create and where some off-road vehicle users have little value for what appears to be an unproductive and barren landscape.

Inappropriate grazing practices – Moderate
Desert shrublands are more sensitive to livestock grazing than the grasslands of the Great Plains, in part because their evolutionary history did not include large numbers of bison (Knight 1994). Cattle grazing can have profound effects on the composition of desert plant communities. Intensive, long-term grazing has been shown to decrease the abundance of perennial grasses and forbs and increase the amount of annual grasses and weeds in these areas (Rice and Westoby 1978, Brotherson and Brotherson 1981, Hanley and Page 1981, Medin and Clary 1990). Cattle grazing can also decrease the amount of litter (Milchunas et al. 1992), and moderate to intense grazing increases soil bulk density (Van Harren 1983) and decreases soil aggregate stability (Warren et al. 1986). Palatable species are most commonly damaged by growing season grazing, heavy use, or a combination of the two (Blaisdell and Holmgren 1984). Even under moderate stocking rates, the use of palatable species by livestock may be high, even if the plant is in low abundance. As a result, in overgrazed areas where a palatable species is poorly represented, its recovery can be especially difficult. When livestock graze in ephemeral riparian areas populated with rabbitbrush or greasewood, the biotic soil crusts can be damaged from trampling during wet periods, and soil compaction is common during dry periods.

Both stocking rates (Holechek 1988) and grazing season (Whisenant and Wagstaff 1991) have an influence on determining vegetation compositions and trends. In particular, these studies suggest that annual March-April grazing is an important cause of the deterioration of range conditions in some salt desert shrub ecosystem.

Wild horse numbers in the Adobe Town & Salt Wells herd management areas have been known to exceed the appropriate management level by two to three times (Bureau of Land Management 2010). Although wild horse diets typically are dominated by grasses, at high population levels and during drought, their diets shift more to shrubs, particularly winter-fat, saltbush, and sagebrush. During these periods, horse grazing may be particularly detrimental to the cover and vigor of these species.

Practices such as periodic rest, rotation of use, or adjustments in stocking rates have been demonstrated to improve range conditions in desert shrubland habitats (Blaisdell and Holmgren 1984). Desert shrubs such as shadscale and winter-fat have been known to decline following cessation of grazing, whereas perennial grasses and a few other species increase (Harper et al. 1990).

Rural subdivisions – Low
Rural subdivision and development can reduce, degrade, and fragment desert shrubland habitats (see Wyoming Leading Wildlife Conservation Challenges – Rural Subdivision and Development). Houses, outbuildings, and lawns directly replace native wildlife habitat. Soil disturbance from construction, year-round grazing of horses and other hobby livestock, and the use of nonnative plants as ornamentals can facilitate the establishment of invasive species (Maestas et al. 2002).

Wildlife commonly abandons or alters use of habitats with greater human and pet activity. Increased energy expenditures in avoiding people or greater use of lower quality habitats can decrease animal health and reproductive capacity. Greater road densities and traffic volume can increase wildlife–vehicle collisions. Predation on wildlife can intensify with greater numbers of domestic dogs and cats, as well as increases in generalist predatory species such as ravens and human-commensal species such as raccoons (U.S. Department of Agriculture 2007).

Current Desert Shrublands Conservation Initiatives

Controlling invasive species has received less attention in desert shrublands, compared to other habitats, because of low productivity and poor vegetative states that can require additional forms of treatment to restore sites to their natural conditions. Also, in desert shrubland habitats herbicide use can be restricted due to extended soil residence times as a result of low organic soil content. Most of the herbicides available for use by the Bureau of Land Management (BLM) have restrictions on spraying less than 200 feet from water sources. Weed Management Areas, organized by the County Weed and Pest Districts, and Coordinated Resource Management teams (CRM), which are generally landowner-driven and facilitated by the Wyoming Department of Agriculture, have been established in various locations to control invasive species in desert shrublands.

Several efforts focused on enhancing the wildlife compatibility of energy development in Wyoming encompass desert shrub habitats. The Wyoming Landscape Conservation Initiative (WLCI) is a multi-agency and stakeholder initiative focused on data collection, monitoring, research, and facilitating land management actions in southwest Wyoming. Its purpose is to protect or enhance wildlife habitat and other resource values in the face of intensive energy development. The Jonah Interagency Office (JIO) is an example of a mitigation fund that has been established to support projects to maintain important biological areas in the vicinity of the natural gas field near Pinedale, Wyoming. Similar mitigation activities are underway for other oil and gas fields, including the Continental Divide-Creston, Hiawatha, and Pinedale Anticline.

The BLM and other partners, including the Wyoming Game and Fish Department (WGFD), are developing transportation plans, many of which were established primarily for wildlife habitat. Enforcement of new state laws limiting the time when shed antlers can be collected west of the Continental Divide should help reduce disturbance to desert shrubland habitats in late winter and early spring when they are prone to erosion.

In general, adverse grazing impacts have been reduced in desert shrubland habitats with the adoption of grazing management practices that control grazing intensity, opportunity for recovery, and season of use. There are continuing efforts by the livestock industry, BLM, Natural Resources Conservation Service (NRCS), conservation districts, county extension, and sage-grouse working groups to promote best management practices to improve rangeland health. Some BLM grazing permittees are incorporating private monitoring efforts into their grazing operations in addition to the monitoring conducted by agencies.

Land use plans, such as the one developed by Carbon County promoting development close to existing infrastructure, help to maintain open space and wildlife habitats, as well as to provide more cost-efficient community services. Conservation easements have been acquired on desert shrubland habitats in a number of locations by land trusts operating in Wyoming.

Recommended Desert Shrublands Conservation Actions

Increase awareness about grazing best management practices in desert shrubland habitats.
Desert shrubland habitats are often used for wintering livestock. Early winter grazing has

less impact on desert shrubland habitats than grazing in late winter or early spring. Sheepherders should also be encouraged to not keep their camps or flocks on areas known to support sage-grouse leks and nesting habitat.

Wild horse populations should be kept at herd objectives to avoid negatively affecting plant vigor and cover. Uses by wild horses, livestock, and wildlife should be evaluated simultaneously to address the needs of all large ungulates making use of this habitat type. Activities like grazing and events such as energy and water development, which may alter animal distribution patterns, and drought, should be taken into consideration when establishing herd objectives and grazing strategies

Increase invasive species mapping and treatment efforts in desert shrubland habitats.
Greater mapping of the locations of invasive species is needed, and new types of control technologies and treatments should be developed to advance reclamation efforts associated with energy and other forms of development. This would require additional soil testing and project trials. Greater attention should be placed on ensuring energy industry compliance with invasive species control permitting stipulations.

Enhance planning and mitigation efforts to minimize the negative impacts of energy development on desert shrubland habitats.
The development and implementation of energy development plans for oil, gas, and wind, is crucial to the success of accommodating growth in these industries while minimizing negative impacts to natural habitats and wildlife species. Bentonite mining should also be considered in these plans. Mitigation plans should stress avoiding biologically sensitive areas within project sites and directing off-site mitigation funds to nearby high-value wildlife locations. Energy-development planning and mitigation efforts could be specifically benefited by:

- Developing new mitigation and reclamation techniques and technologies for the harsh, unproductive environment found in desert shrubland habitats. Due to their low productivity, desert shrubland habitats can be slow to recover from disturbance. Even with good management or complete protection, direct revegetation is often necessary. However, the harsh environment usually makes the successful establishment of vegetation difficult (Bleak et al. 1965, Van Epps and McKell 1980). Special practices such as transplanting, watering, shading, soil additives, or extremely careful selection of plant materials may be necessary.
- Continuing research on the effects of energy development on desert shrubland wildlife species and ecosystems the Wyoming Chapter of the Nature Conservancy, Wyoming Natural Diversity Database, and Wyoming Game and Fish Department completed research evaluating the vulnerability of Wyoming terrestrial SGCN to oil, gas, and wind development. Vulnerability was investigated by evaluating each species' potential exposure and sensitivity to energy development. Exposure was evaluated through a GIS analysis that overlays distribution maps of SGCN with areas of known and projected energy development. Sensitivity was determined by examining habitat and behavioral attributes of SGCN as well as reviewing existing impact studies. Research results give an indication of which species and taxonomic groups are potentially vulnerable to development, as well as help direct future research to address information gaps. The project was jointly funded jointly by the U. S. Geological Survey, Wyoming Landscape Conservation Initiative (WLCI), and WGFD and can be found at:: http://www.nature.org/media/wyoming/wyoming-wildlife-vulnerability-assessment-June-2014.pdf.
- Encouraging, where appropriate, the implementation of mitigation measures and/or best management practices detailed within the Wyoming Game and Fish

Commission documents *Recommendations for Development of Oil and Gas Resources within Crucial and Important Wildlife Habitats* (Wyoming Game and Fish Department 2010a) and *Recommendations for Wind Energy Development in Crucial and Important Wildlife Habitat* (Wyoming Game and Fish Department 2010b). Sage-grouse habitat protection recommendations for uranium and bentonite mining as well as other significant surface disturbing activities are addressed in the Sage-grouse Core Population Area implementation recommendations available on the WGFD website.

- Reviewing management actions proposed by state and federal agencies involving desert shrubland ecosystems and associated wildlife habitats, and working closely with the Wyoming Governor's office, industry, private land owners, and agency staff during early stages of energy development project planning. The SWAP, SHP, and Sage-grouse Core Population Areas should be consulted during development and mitigation planning. Maintaining connectivity between core areas will be important for the long-term conservation of sage-grouse and other desert shrubland associated species.

The enforcement of reclamation and weed treatments in BLM Resource Management Plans conditions of approval (COAs) will help ensure the maintenance or restoration of the health of desert shrubland communities.

Manage off-road vehicle use in environmentally sensitive areas or during seasons where wildlife is particularly sensitive to disturbance.
More efforts should be made on public lands to identify areas that are appropriate and inappropriate for off-road vehicle use including using carsonite markers. Locations may vary seasonally to minimize disturbance to wildlife during critical periods such as when animals are on winter range or during nesting or fawning seasons. Public education should include increasing awareness of the ecological role of maintaining unbroken biological soil crust and the value of all types of vegetation.

Increase public awareness of wildlife values of desert shrublands.
Desert shrublands are often underappreciated and overlooked for wildlife conservation efforts due to their barren appearance and low productivity. Species such as Wyoming pocket gophers are desert shrub obligates while others species such as sage-grouse, loggerhead shrikes, pronghorn, and mule deer are seasonally dependent upon this habitat. Educational efforts should include increasing awareness about the importance of biotic soil crust to desert shrubland plants and ecology.

Desert Shrublands Monitoring Activities

Continue monitoring population trends or changes in distribution of desert shrubland SGCN and other obligates in order to infer changes in habitat quality or other threats.

More inventory and monitoring data for specific sites within Wyoming are needed to fully understand current plant communities, their health, and the effects of management practices upon desert shrubland habitats.
Basic long-term monitoring of desert shrublands condition can be accomplished by a combination of photo points (a series of photographs taken at specific points to identify vegetative changes) and monitoring residual plant cover. More long-term monitoring of the biotic integrity and the hydrologic function of desert shrubland sites can be determined through a combination of data collected by the belt transect method and either line-point intercept or gap intercept methods (Herrick et al. 2005). Long- and short-term monitoring efforts should occur at the same locations.

Monitor the size and landscape distribution of desert shrubland habitats through remote sensing.

Remote sensing is useful in tracking the size and distribution of desert shrublands in Wyoming. Information gathered would contribute to determining the cumulative impacts of activities and events such as energy development, rural subdivision, road construction, and the spread of invasive species. Monitoring should be conducted in relation to the possible effects of climate change.

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Foothill Shrublands

Photo courtesy of Jerry Altermatt, WGFD

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Habitat Description

The foothill shrublands habitat type, commonly known as mixed mountain shrubs, comprises diverse plant communities dominated by an equally diverse list of shrub species. NatureServe (2010) estimates over 4.1 million acres of foothills shrublands systems in Wyoming when the Inter-Mountain Basins Montane Sagebrush Steppe system is included. Typically found in patches of pure or mixed stands, predominant shrub species include true mountain-mahogany, curl-leaf mountain-mahogany, serviceberry, antelope bitterbrush, skunkbush sumac, currant, gooseberry, and snowberry. Mountain big sagebrush and silver sagebrush are also common. Choke cherry may also be present, sometimes in abundance in moist sites. Associated grasses and forbs include arrow-leaf balsam-root, bluebunch wheatgrass, hairy golden-aster, Junegrass, and lupine (Knight 1994).

Two types of mountain-mahogany commonly occur in Wyoming. True mountain-mahogany, a deciduous species, is found in the Black Hills and across the southern half of the state, while curl-leaf mountain-mahogany, an evergreen species, is in the foothills of the Bighorn Mountains and to the west and south (Knight 1994). These shrubs form dense thickets on rocky or shallow soils from the western Great Plains up to an elevation of 7,800 feet. Both species have the ability to fix nitrogen, which improves soil fertility over time (Hoeppel and Wollum 1971, Lepper and Fleschner 1977). Mountain-mahogany also plays an important role in erosion control because the shrubs are long-lived, produce extensive root systems, and survive well on dry steep slopes. Additional information on these two species has been compiled by Blauer et al. (1975); some is available on the Nature Serve (2010) web site, within the summary for the Inter-Mountain Basin Curl-leaf Woodland and Shrubland ecological system.

Saskatoon serviceberry is a common foothills shrub, but is scattered throughout the state. Utah serviceberry is found in drier foothill habitats in southern and western Wyoming at elevations from 5,000 to 9,000 feet (Harrington 1954). It is primarily found on dry ridges and slopes in association with big sagebrush, piñon pine, juniper, and aspen. Antelope bitterbrush is found in many of the same locations as serviceberry, including central Wyoming, but is often more confined to areas where snow accumulates, such as ravines, or in areas with higher precipitation. Snowberry is found along stream banks in Wyoming, in swampy thickets, moist clearings, and open forests at elevations from about 4,600 to 9,200 feet.

The quality and composition, including dominant species, of foothill shrublands have varied since European settlement (Nicholoff 2003). Many stands have declined through a combination of fire suppression and overbrowsing. Fire is a naturally occurring process in lower montane and foothill shrublands. Native fire regimes in these communities probably vary widely with local site factors. Severe, high-intensity fires are probably rare under natural conditions due to low and patchy fuel loads and relatively high site moisture (Decker 2007). Historically, foothill shrublands likely burned every 50 to >100 years (J. Derner personal communication 2010). In the absence of fire, foothill shrublands are often invaded by juniper and pine, and also increase in shrub density. Both changes can increase fire intensity and hinder post-fire recovery time.

The ability of true mountain-mahogany to resprout from the crown allows it to recover relatively quickly from fires. Alternatively, curl-leaf mountain-mahogany only regenerates from seed, which can result in extremely long fire recovery times (Kitchen 2008). Fire suppression is believed to be contributing to curl-leaf mountain-mahogany encroachment into adjacent communities (Arno and Wilson 1986); however, over time, some stands become decadent and are unable to compete with conifers (Nicholoff 2003). A similar trend of expansion has occurred within antelope bitterbrush in ponderosa pine communities. Likewise, serviceberry and skunkbush sumac have declined with increasing shade from higher densities of mature trees (Nicholoff 2003).

Foothills receive considerable recreational activity, especially in the warmer seasons, including hiking, camping, hunting, and motorized vehicle use. Some locations are also popular for housing. Livestock grazing is common. Limited oil and gas development occurs in foothill shrublands, but wind energy development is increasing.

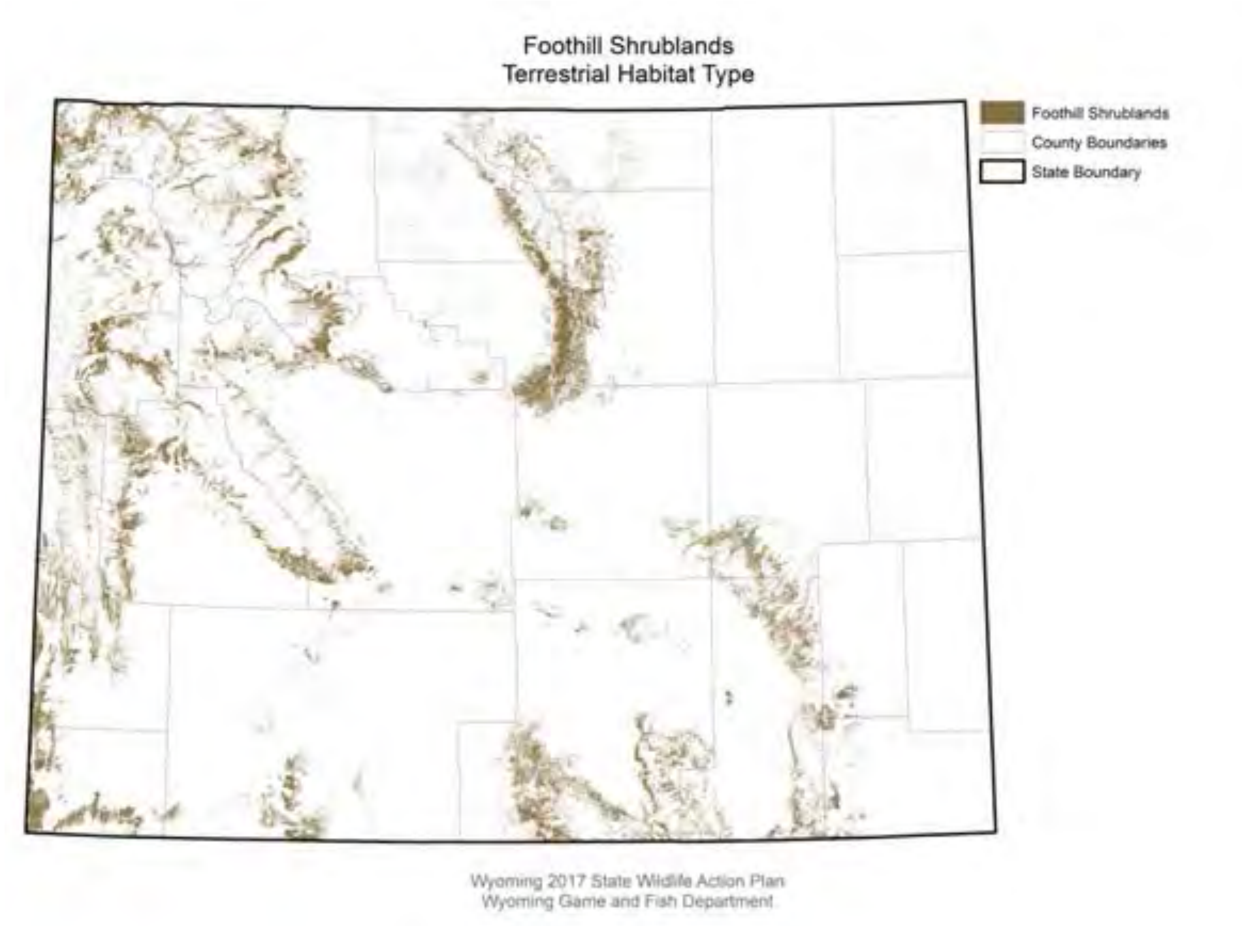


FIGURE 7. Wyoming Foothill Shrublands

TABLE 7. Wyoming Foothill Shrublands NatureServe Ecological Systems[1]

1. Harvested forest-shrub regeneration
2. Inter-Mountain Basins Mountain-Mahogany Woodland and Shrubland
3. Northern Rocky Mountain Montane-Foothill Deciduous Shrubland
4. Rocky Mountain Lower Montane-Foothill Shrubland
5. Western Great Plains Wooded Draw and Ravine
6. Inter-Mountain Basins Montane Sagebrush Steppe

[1] Descriptions of NatureServe Ecological Systems which make up this habitat type can be found at: NatureServe Explorer: an online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. http://www.natureserve.org/explorer.

TABLE 8. Wyoming Foothill Shrublands Species of Greatest Conservation Need

Mammals
Bighorn Sheep
Dwarf Shrew
Eastern Spotted Skunk
Hispid Pocket Mouse
Idaho Pocket Gopher
Olive-backed Pocket Mouse
Pygmy Rabbit
Silky Pocket Mouse
Yuma Myotis

Birds
Bewick's Wren
Black-throated Gray Warbler
Ble-gray Gnatcatcher
Brewer's Sparrow
Calliope Hummingbird
Canyon Wren
Columbian Sharp-tailed Grouse
Greater Sage-Grouse
Loggerhead Shrike
Sagebrush Sparrow
Sage Thrasher

Reptiles
Smooth Greensnake
Pale Milksnake
Rubber Boa
Valley Gartersnake

Amphibians
Northern Leopard Frog
Columbia Spotted Frog

Foothill Shrublands Wildlife

The mid-elevation position of foothill shrublands denotes a rather mesic environment which is not as cold and snowy as mountains, but not as dry and hot as basins. Thus, this habitat type is often more productive than the forests above it and the shrublands below it. It supports many berry-producing shrubs such as snowberry, currant, serviceberry, choke cherry, and Oregon-grape, which are important forage for many mammals, such as black bears and grizzly bears, and birds, such as dusky (blue) grouse and waxwings. Foothill shrublands also often encompass patches and stringers of trees, including aspen and conifers, that further increase cover and forage for wildlife. Frequent rock outcrops can serve as important substrates for bats, bighorn sheep, bushy-tailed woodrats, and other species. Foothill shrublands often occupy rough topography which provides cover for various wildlife, and also a high diversity of micro-climates, which in turn increases plant diversity. Many of these communities have been designated as crucial winter ranges for mule deer, elk, moose, and bighorn sheep.

Foothill shrublands provide habitats for bird species including Columbian sharp-tailed grouse, dusky (blue) grouse, Brewer's sparrow, gray flycatcher, dusky flycatcher, green-tailed towhee, common poorwill, Virginia's warbler, black-throated gray warbler, and Lazuli bunting (Nicholoff 2003). Presence of substantial amounts of sagebrush, typically mountain big sagebrush, promotes occupation by several sagebrush obligate wildlife species including sage-grouse, sage sparrow, and sage thrasher. In fact, in some seasons and conditions, like late summer and during droughts, the wetter foothill shrub communities may provide better habitat for sage-grouse than lower and drier communities of pure big sagebrush.

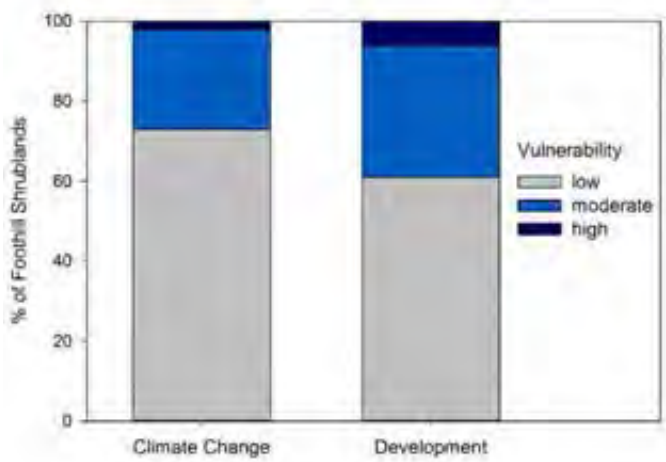
Foothill shrublands provide particularly important habitat for big game in winter and during seasonal migrations. Both species of mahogany are particularly favored by mule deer for browsing. Curl-leaf mountain-mahogany communities provide important wintering habitat for mule deer, elk, and bighorn sheep in Wyoming (Despain 1973, Olson 1992, Kauffman et al. 2009). It tends to grow on dry, steep slopes that are typically more accessible to big game and other wildlife during deep snow conditions. Curl-leaf mountain-mahogany maintains high levels of crude protein (Welch 1981) and is one of the few shrubs that meet big game protein requirements throughout winter.

Antelope bitterbrush is another high-quality preferred forage for both big game and livestock, especially in fall and early winter (Austin and Urness 1983, Clements and Young 1997). It also provides cover for small animals and birds, including sage-grouse and Columbian sharp-tailed grouse. Antelope bitterbrush seeds are important food for rodents, including kangaroo rats and deer mice (Evans et al. 1983). These rodents play an important ecological role in the natural regeneration of bitterbrush by planting seeds in caches.

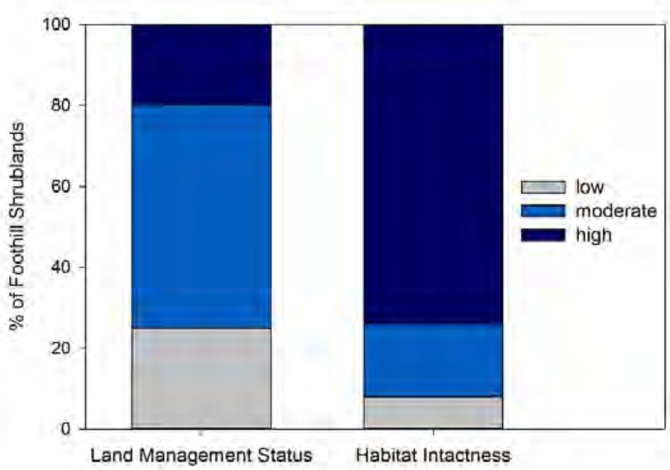
Snowberry is browsed by most wild ungulates, and its fruits are consumed by both black bears and grizzly bears, as well as many birds and small mammals (McWilliams 2000). It is particularly sought after by mule deer in spring. Skunkbush fruits, which persist through fall and winter, provide a food source when other fruits are scarce or unavailable. Serviceberry and currant are browsed by big game, and their berries are consumed by a variety of birds and small animals.

Foothill Shrublands Habitat Threats

Figure 8. Foothill Shrublands Vulnerability Analysis



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high vulnerability to climate change or development, based on classification of scores ranging from 0 to 1 into the following categories: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for climate change or development vulnerability were based on the land area of the habitat type classified as having high vulnerability: low (<10%), moderate (10-33%), or high (>33%). Vulnerability was calculated as exposure minus resilience. Development vulnerability includes existing and projected residential, oil and gas, and wind energy development. Further details are provided in the Leading Challenges section of this report and in Pocewicz et al. (2014).



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high land management status or habitat intactness. For land management status, high corresponds to the percent of the habitat occurring in GAP status 1 or 2, moderate to the percent occurring in GAP status 2b or 3, and low to the percent occurring in GAP status 4. Rankings for land management status were based on the land area of the habitat type classified as having high status or legal protection: low (<10%), moderate (10-33%), or high (>33%). For habitat intactness, scores ranging from 0 to 1 were assigned to categories as follows: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for intactness were based on the land area of the habitat type classified as having high intactness: low (<25%), moderate (25-75%), or high (>75%).

Drought and potential climate change - High

Periods of prolonged and extreme drought can have severe effects on foothill shrub species. These species tend to be deep rooted and can normally withstand short-term drought conditions; however, prolonged drought, especially a lack of winter or early spring precipitation that depletes deep soil moisture, can cause high plant mortality. Drought conditions that persisted throughout Wyoming from 2000 through 2006 caused heavy plant mortality in many shrub stands (A. Winward, personal communication, 2008), particularly where shrubs were growing in the more xeric portions of their range.

Many shrub species may have established their current range in Wyoming under a historic period of unusually wet climatic conditions. If the climate becomes warmer and drier in Wyoming, as some climate modeling predicts (Christensen et al. 2007), the distribution of some shrub species may recede from areas where growing conditions are currently marginal (see Wyoming Leading Wildlife Conservation Challenges – Climate Change).

Conifer encroachment - High

Juniper and limber pine have been actively expanding into true mountain-mahogany and bitterbrush shrub communities in a number of locations in the state, including the Little Snake River and North Platte River Valleys and in the Ferris and Shirley Mountains (see Terrestrial Habitat Types – Xeric and Lower Montane Forests – Juniper). Ponderosa pine has also been encroaching in foothill shrubland communities, including stands of curl-leaf mountain-mahogany, in a number of areas around the state, particularly in the Bighorn Mountains. Shrub and overall plant diversity decreases as juniper begins to dominate. Under these conditions, suitable habitat for species that depend upon true mountain-mahogany and bitterbrush, including mule deer, may decline. If juniper densities reach a point where crown fires can be sustained, the post-burn plant community can become dominated by cheatgrass. On the west slope of the Bighorn Mountains, juniper and Douglas fir have encroached into curl-leaf mountain-mahogany communities. Curl-leaf mountain-mahogany, especially where it grows in more mesic environments, may be seral to these conifer species and thus require periodic burns or other tree removal for persistence. In many areas, limber pine encroachment is receding due to infestations of white pine blister rust and mountain pine beetles (see Terrestrial Habitat Types – Montane and Subalpine Forests, Threats – Disease and insects).

Wildlife browsing pressure - High

While most shrubs are stimulated by light to moderate browsing, high browsing pressure can negatively impact some shrub species. Many of these shrub species are highly palatable and are preferred by most big game species (Blauer et al. 1975). Excessive browsing is most common during late summer and fall and into the winter months. This is particularly true with curl-leaf and true mountain-mahogany, and also bitterbrush. These species are highly desired by mule deer and used in a much greater proportion than they are found on winter range. This makes eliminating the effects of overbrowsing difficult, since deer will continue to use such preferred shrubs even at low deer densities. High browsing pressure over time reduces the recruitment of young plants, and is often accompanied by juniper encroachment, which further reduces plant diversity and habitat quality (see Terrestrial Habitat Types – Xeric and Lower Montane Forests – Juniper). As plant understory decreases, there is an increase in bare ground, cheatgrass, and other annual weeds, as well as greater soil erosion and reduced site productivity.

Fire suppression - High

Fire has historically been a natural disturbance in foothill shrublands, but fire intensity and frequency has been altered due to many decades of fire suppression (Gruell et al. 1985). Although the impact to shrub communities is variable by shrub species, in general, fire promotes regeneration resulting in higher palatability and nutrition. With lack of naturally occurring fire, these communities often become dominated by dense shrubs with a high level of decadence. Therefore, when fire does occur, it is often intense, resulting in slow recovery. Fire intensity in this community can also be exacerbated by annual invasives such as cheatgrass. And due to the presence of such invasives, prescribed fire as a management tool in this community is used with great caution (see below Threats - Invasive .plants species).

Rural subdivision and development – Moderate
Rural subdivision and development can reduce, degrade, and fragment foothill shrublands habitats (see Wyoming Leading Wildlife Conservation Challenges – Rural Subdivision and Development). Houses, outbuildings, and lawns directly replace native wildlife habitat. Soil disturbance from construction, year-round grazing of horses and other hobby livestock, and the use of non-native plants as ornamentals can facilitate the establishment of invasive species (Maestas et al. 2002).

Wildlife commonly abandons or alters their use of habitats with greater human, vehicle, and pet activity. Increased energy expenditures in avoiding people or greater use of lower quality habitats can decrease animal health and reproductive capacity. Greater road densities and traffic volume can increase wildlife–vehicle collisions. Predation on wildlife can intensify with greater numbers of domestic dogs and cats, as well as increases in generalist predatory species such as ravens, and human-commensal species such as raccoons (U.S. Department of Agriculture 2007). The frequent location of foothill shrublands within big game winter range and migration corridors intensifies concern about the impact of subdivisions where increases in human activity levels can significantly impact wildlife use (Feeney et al. 2004).

Invasive plant species - Moderate
Nonnative invasive plants can reduce shrub vigor and recruitment, and in some circumstances eliminate foothill shrublands communities (see Wyoming Leading Wildlife Conservation Challenges – Invasive Species). Cheatgrass is the most problematic invasive species in lower elevation bitterbrush habitats on sandy soils, as well as in true mountain-mahogany, curl-leaf mountain-mahogany, mountain big sagebrush, and antelope bitterbrush habitats.

Cheatgrass can form a dense understory that inhibits germination and survival of shrub seedlings. Additionally, cheatgrass can significantly increase fire frequency, which can result in the elimination of shrub species, especially those that respond poorly to fire such as curl-leaf mountain-mahogany and big sagebrush.

The threat of cheatgrass is reduced in some true and curl-leaf mountain-mahogany habitats with rocky substrate because bare rock limits cheatgrass establishment and the potential for fire. Serviceberry, snowberry, and mixed sagebrush/foothill shrub communities at higher elevations or on north- and east-facing slopes generally have high enough native plant cover to preclude invasion by cheatgrass.

Alyssum is an invasive plant species that has been invading lower elevation bitterbrush and true mountain-mahogany communities, particularly after prescribed burns intended to reduce mountain big sagebrush. Spotted knapweed, musk thistle, and leafy spurge are also important invasive plants in foothill shrublands communities.

Foothill shrublands are sometimes subject to prescribed burns, with the intent of increasing the cover and quality of forage species. It is critical that such treatments are conducted with an understanding of the likely responses of important invasive weeds, especially cheatgrass.

Incompatible energy development practices - Moderate
Energy development can result in the direct removal of native vegetation and habitat fragmentation through road building, well pad drilling, power line construction, buried pipelines, booster stations, and facility buildings (see Wyoming Leading Wildlife Conservation

Challenges – Energy Development). Wind energy development is increasing in Wyoming and will likely have an impact on foothill habitats located on ridge tops. Habitat loss and fragmentation also occurs indirectly through increased traffic and noise. Greater amounts of broken or bare ground, as well as greater vehicle traffic associated with the construction and production phases of energy development, can contribute to the spread of invasive plant species.

Incompatible livestock grazing practices - Moderate

Inappropriate livestock grazing can negatively impact shrub communities, particularly where livestock are grazed in areas with highly palatable shrubs. If livestock are allowed to graze for too long, especially during the hot season when they are seeking shade, shrub species such as serviceberry in wooded draws can be browsed out of existence (Girard et al. 1987). Grazing management practices that do not allow cool season grasses to recover can degrade habitat quality in foothill shrubland communities. Intensive grazing during the songbird nesting season (April through July) can increase nest loss through trampling, as well as brood parasitism by cowbirds if the grazing occurs near woody habitat (Nicholoff 2003). During late summer, fall, and early winter, browse levels on some shrub species such as mountain-mahogany and bitterbrush can be high and negatively affect plant vigor and health. However, it is also well documented that some level of browsing does prevent stagnation and increases the productivity of many shrub species.

Varying management goals, lacks of consensus on management strategies, and inadequate coordination and monitoring of management actions - Moderate

An evaluation of the effectiveness of management activities such as habitat treatments, big game herd population objectives, and livestock grazing is often hampered by a lack of baseline data, insufficient monitoring, and poorly articulated goals and objectives. There should be better coordination and planning among and between land management agencies, private landowners, and other interested groups prior to implementing management actions, including monitoring of enhancement or treatment projects.

Off-road vehicle use - Moderate

Off-road vehicle use, primarily by all-terrain vehicles (ATVs), continues to increase. Soil disturbance and the transportation of seeds can enhance the spread of invasive species, especially spotted knapweed and cheatgrass. This can lead to greater soil erosion, a reduction in water quality, and impacts to ecological processes within these systems. Wildlife often avoid areas of increased noise and disturbance from outdoor recreational vehicles, and riding off-road can destroy the nests, eggs, and young of ground-nesting birds, and fragment the habitat of area-sensitive species. These impacts can also lead to conflicts with hunting, wildlife viewing, and other forms of nature-based recreation. Off-road vehicle management generally remains controversial and difficult to manage, especially in more open and gentle terrain where new tracks are more easily created relative to forested areas or more rugged terrain. The increase in people collecting shed antlers has also increased off-road vehicle use, particularly affecting soil erosion on moderate to steep slopes as riders criss-cross the terrain to spot and retrieve antlers.

Foothill shrublands often do not accumulate enough snow to support much winter recreation such as skiing and snowmobiling, especially relative to adjacent montane systems. However, they often accumulate just enough snow to preclude road vehicle and foot-based recreation, especially relative to adjacent basin systems. This in-between character that precludes motorized use in the winter likely contributes greatly to the value of foothill shrublands as winter habitat for big game.

Current Foothill Shrublands Conservation Initiatives

Foothill shrublands have not been a primary focus of any statewide initiatives; however, this habitat type has been identified as a target habitat in the Wyoming Game and Fish Department (WGFD) Strategic Habitat Plan (SHP) (2015) and The Wyoming Mule Deer Initiative (2009). Localized management actions and projects, which provide direct or indirect benefits, are more common. The WGFD does some annual monitoring of shrub production and utilization on big game winter ranges within foothill shrublands systems.

Locations of invasive species infestations are often mapped and identified for treatment by the Bureau of Land Management (BLM), County Weed and Pest Districts, and/or private landowners. There are also a number of invasive species management efforts involving multiple land management agencies and landowners. Notable efforts include Weed Management Areas (WMA) organized by the County Weed and Pest Districts and Coordinated Resource Management teams (CRM), which are generally landowner-driven and facilitated by the Wyoming Department of Agriculture. Most of these collaborative efforts focus on managing or eradicating one or more invasive plant species and promoting native vegetation. Project areas are generally along watershed boundaries.

The Southeast Wyoming Cheatgrass Partnership was formed in 2005 to promote education, coordination, and communication between partners about research, monitoring, and cheatgrass control projects in Laramie, Goshen, Platte, Albany, and Carbon counties. Current membership includes representatives from the WGFD, U.S. Forest Service, BLM, Natural Resources Conservation Service (NRCS), various County Weed and Pest Districts, local conservation districts, as well as University of Wyoming and Colorado State University faculty and researchers.

There are continuing efforts from within the agricultural industry and by the BLM, NRCS, conservation districts, county extension, and sage-grouse working groups to promote best livestock management practices to improve rangeland health. Some holders of federal grazing leases are incorporating shrublands monitoring efforts into their grazing operations, in addition to monitoring conducted by agencies.

The use of prescribed burns, mechanical treatments, and chemical treatments are common in foothill shrublands systems to increase shrub production, improve stand age and structural diversity, and treat invasive species. Juniper removal and thinning is often a component of these treatments. Private land treatments to reduce big sagebrush and improve cattle forage within big game winter/spring ranges have locally led to increased amounts of mountain shrubs and more diverse shrub communities. Greater diversity of mountain shrubs may also be achieved on public lands with additional efforts such as the seeding or plantings of desired species. The use of prescribed burns in some locations is being re-evaluated due to the potential to spread cheatgrass, alyssum, or other invasive species. In these locations, tebuthiuron (Spike) is frequently used to avoid increasing invasive species.

The WGFD Mule Deer Working Group (MDWG) was established in 1998 to explore solutions to the many challenges confronting mule deer conservation and management. Crucial habitats for mule deer often encompass foothill shrublands ecosystems. Recent research has provided further evidence that foothill shrub communities provide an opportunity for mule deer to accumulate fat prior to winter thus improving overwinter survival. Beginning in 2016 the Wyoming Game and Fish Commission began allocating $500,000 per year through the Statewide Mule Deer Initiative with the intent of working collaboratively with partners to improve habitat conditions for mule deer as well as furthering knowledge on migration routes, corridors and stopover sites.

Highway underpasses such as the one installed north of Baggs on Highway 789 and those in Nugget Canyon near Kemmerer U.S. Highway 30 are part of on-going efforts to modify fences and improve highway passage for big game. These activities may help reduce animal concentrations and browse-use levels in some areas of crucial winter range. Enforcement of new state laws limiting the time when shed antlers can be collected west of the Continental Divide should help reduce disturbance to big game and foothill shrublands systems when they are prone to erosion in late winter and early spring.

The Wyoming Game and Fish Commission documents *Recommendations for Development of Oil and Gas Resources within Crucial and Important Wildlife Habitats* (Wyoming Game and Fish Department 2010a) and *Recommendations for Wind Energy Development in Crucial and Important Wildlife Habitat* (Wyoming Game and Fish Department 2010b) provide guidelines for reducing the impacts of energy development on wildlife and their habitats. While energy companies are required to perform reclamation and mitigation, these activities are often difficult in arid habitats and during drought conditions.

Conservation easements are being used in some foothill shrublands habitats to maintain the open space, wildlife habitat, and agricultural land uses. Land use plans, such as those developed in Carbon County, promote development close to existing infrastructure, both to maintain open space as well as to provide more cost efficient public services (see Wyoming Leading Wildlife Conservation Challenges – Rural Subdivision and Development).

The BLM and other partners, including the WGFD, will be involved in developing transportation plans for special management areas on BLM lands, many of which were established primarily for wildlife and habitat conservation. The WGFD was a recent state cooperator with the Bridger-Teton National Forest in the development of summer travel management plans.

Recommended Foothill Shrublands Conservation Actions

Increase invasive species control efforts for foothill shrublands communities.
Specific activities to enhance invasive species control include:

- Continue watershed-scale weed management efforts, such as WMA Areas and Coordinated Resource Management teams, and initiate new efforts where they are needed. Larger scale, valley-wide planning and project implementation efforts are needed for effective long-term invasive species management.
- Increase funding of invasive plant management and continue to build partnerships to advance these efforts.
- Conduct inventory of invasive plants and prioritize areas that have the highest risk of shrub community replacement so projects can be directed to these locations.
- Where wildfire could be detrimental to shrub communities, especially where invasive plants that respond well to fire are present, implement projects such as fuel breaks and prescribed grazing to reduce fire risk. Tebuthiuron should be used for sagebrush control, instead of prescribed fire, in these locations.

Provide information, technical, and financial assistance to improve livestock grazing practices in foothill shrublands communities.
The Environmental Quality Incentives Program (EQIP) is a USDA Farm Bill programs administered by the NRCS that can provide resources and assistance to landowners to implement habitat improvement projects and grazing plans. On public lands or areas with mixed private and public ownership, cooperative habitat improvement projects should be established with federal agencies, private landowners, and livestock grazing permittees. The WGFD trust fund, wildlife

conservation organizations, and other sources have been used to fund such projects.

Prescribed fire or mechanical habitat treatments should be used to duplicate historic disturbance regimes to increase plant health, native species composition, structural diversity, and historic ecosystem processes and functions.
Habitat treatments should have clearly stated objectives and monitoring plans. Habitat treatments are particularly needed for true mountain-mahogany and bitterbrush habitats in transition and crucial big game winter ranges to improve habitat diversity and alleviate browsing pressure.

Big game populations should be managed within herd objectives to meet forage utilization levels.
Accomplishing this objective will require greater monitoring of production and utilization of important shrub stands. Utilization objectives for each shrub species should be set and adjustments to big game herd populations made if they are consistently exceeded. Herd population objectives should be set to account for preferred utilization levels, but if herd numbers cannot be reduced to meet utilization objectives, habitat treatments such as prescribed burns should be considered on adjacent habitat to entice animals away from these shrub communities.

Consult wildlife best management practices to improve energy development planning and mitigation design.
Energy-development mitigation plans should stress avoiding biologically sensitive areas within project sites and directing off-site mitigation funds to nearby high-value wildlife locations. WGFD SHP crucial areas can help guide these efforts. The implementation of mitigation measures and/or best management practices detailed within the Wyoming Game and Fish Commission's *Recommendations for Development of Oil and Gas Resources within Important Wildlife Habitats* (Wyoming Game and Fish Department 2010a) and *Recommendations for Wind Energy Development in Crucial and Important Wildlife Habitat* (Wyoming Game and Fish Department 2010b) should be encouraged. Mitigation plans should consider the need to reduce fragmentation of important habitats by using tools such as conservation easements in areas of high biological value. Management actions proposed by state and federal agencies involving foothill shrublands systems should be reviewed, and working closely with the Wyoming Governor's Office, industry, private landowners, and agency staff is recommended during early stages of energy development project plans.

Pursue conservation easements on high-wildlife-value foothill shrublands with willing landowners.
Conservation easements can be an effective and long-term method of securing and enhancing management of foothill shrublands systems on private lands while retaining ranching, outdoor recreation, and other compatible land uses (see Wyoming Leading Wildlife Conservation Challenges – Rural Subdivision and Development). The development of stewardship plans for conservation easement lands can contribute to effective long-term habitat management.

Increase educational effort to agencies, private landowners, and the public about the importance of various shrubs to wildlife and the factors that threaten the integrity of shrub communities.

Foothill Shrublands Monitoring Activities

Continue monitoring foothill shrublands SGCN in order to detect population trends or changes in distribution that may reflect habitat problems. This information should be used to guide future monitoring and research.

More inventory and monitoring work should be conducted to document current locations, habitat conditions, and the effects

of management practices upon foothill shrublands communities.
More intensive mapping of foothill shrublands habitats is needed. Past large-scale mapping efforts often lump foothill shrublands species with sagebrush community types. Voluntary monitoring efforts on private land should be encouraged.

Monitor the landscape distribution and habitat intactness of foothill shrublands through remote sensing.
Remote sensing is useful in tracking the size, distribution, and fragmentation level of this habitat in Wyoming. Information gathered would be helpful in determining the cumulative impacts of activities and events such as energy development, rural subdivision, and wildfire. This technique will require the further development of monitoring protocols and the identification of sample sites.

Monitor the establishment and spread of invasive plant species in cooperation with County Weed and Pest Districts and other federal and state agencies.

In cooperation with state and regional research entities, monitor the effects of climate change including extended periods of drought or pluvial cycles.
All of Wyoming's habitat types may be impacted by changing climate conditions. Wildlife and habitat managers may be better positioned to develop and implement mitigation and/or adaptation strategies with a better understanding of how changing climate factors are impacting the resources and landscapes that they manage.

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Montane and Subalpine Forest

Photo courtesy of WGFD

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Habitat Description

Montane and subalpine forests cover about 22% of Wyoming and generally occur at elevations greater than 7,000 feet where temperature, moisture, and nutrient conditions are sufficient to allow for tree seedling establishment (Comer et al. 2003, Knight 1994). At higher elevations, snow accumulation combined with lower evaporation rates due to cooler temperatures create a more mesic environment than in lowland habitats. While there can be considerable overlap in vegetation zonation, vegetation communities within the montane and subalpine forest habitat type often follow a predictable elevational distribution. Douglas-fir generally can be found at lower elevations; lodgepole pine at mid-elevations; and Engelmann spruce, subalpine fir, and whitebark pine at higher elevations. Ponderosa pine is also found at low elevations, in eastern portions of the state, sometimes in association with Douglas-fir. Limber pine, which grows from low elevations up to treeline, is another subalpine tree species. Both ponderosa pine and limber pine are addressed in the Xeric and Lower Montane Forests section of the SWAP, page III-11-1. Intermingled with these coniferous forests in the montane and subalpine habitat type are mountain grasslands and meadows, aspen groves, wetlands, riparian areas, and mountain shrublands with mountain lakes and streams. Aspen is addressed in the Aspen and Deciduous Habitat Type, page III-1-1. Additional information and descriptions of the 10 ecosystem types listed in Table 9 are available from the NatureServe web site (2010).

Vegetation is largely influenced by temperature, given the short, cool, and often dry growing season which limits photosynthesis, with frosts possible throughout the year. Plant species such as evergreens have a number of adaptations for extended photosynthesis in spring and fall, and for cold tolerance. Additionally, all trees have mycorrhizae root systems to extract nutrients from the upper soil layers where nitrogen is more available in the young nutrient-poor mountain soils. Soil water, often frozen, with frequent freeze-thaw cycles can cause soil disturbance and displacement. Vegetation patterns are heavily influenced by elevation, aspect, soil type, snow accumulation, and major disturbances such as fire, windstorms, insect outbreaks, and human activities such as logging (Knight 1994). Due to solar effects, south slopes are generally warmer and drier, and north slopes are generally cooler and more mesic. Large stands of conifers with greater canopy cover are generally located on slopes with northerly aspects. Persistent aspen stands, low-density conifer stands, and mountain shrublands occur most often on south aspects.

In Wyoming, 53% of the forest land is administered by the U.S. Forest Service; 17% is privately owned, including Indian Trust land; 15% is administered by the National Park Service; 11% is administered by the Bureau of Land Management (BLM); and the remaining 4% is owned by state, county, and other federal agencies (Wyoming State Forestry Division 2009)[1]. Especially at lower elevations, land ownership in Wyoming is often a checkerboard pattern with considerable intermixing of federal, state, and private forested lands. This pattern can complicate management and create land-accessibility issues for management activities.

In 1976, 78% of forest products were derived from public lands, with only 22% derived from private lands. By the year 2000, the volume of materials harvested had declined by 78%, but most significantly, 73% of those materials came from private forests (Wyoming State Forestry Division 2009). The 2000 tree harvest equaled 15.4 million cubic feet, not including trees removed for land clearing or land use conversions (The Conservation Fund 2009). In that year, 66% of the saw log harvest was composed of ponderosa pine with lodgepole pine contributing only 21.3% (Wyoming State Forestry Division 2009).

Aside from its value for raw materials, because of its high wildlife, scenic and recreational qualities, Wyoming's montane and subalpine

[1] Forested lands cover all forests in Wyoming including those associated with the montane and subalpine, aspen and deciduous, xeric and lower montane, and riparian habitat types addressed in this document.

forest habitat type receives significant human use including hiking, camping, hunting, bird-watching, skiing, and snowmobiling. Most water in Wyoming, which is used by agriculture, industry, and municipalities, originates in montane and subalpine forests as snowfall.

Douglas-fir

Douglas-fir makes up 8% of the forested area in Wyoming (Wyoming State Forestry Division 2009). Douglas-fir and ponderosa pine coexist at low elevations, usually below 8,500 feet (Knight 1994). Typically, Douglas-fir is found at slightly higher elevations and more mesic sites than ponderosa pine and is also found on limestone or sedimentary soils. Ponderosa pine is not found in western Wyoming, where Douglas-fir forests usually occur above foothill vegetation and below or intermixed with lodgepole pine forests. Like ponderosa pine, mature Douglas-fir has a thick, fire resistant bark so it can survive many surface fires and it is often a pioneer species post-fire.

Douglas-fir forests can be separated into two groups: 1) cool dry Douglas-fir, and 2) moist Douglas-fir. Cool dry stands generally have scattered to open canopies and typically experience low-to moderate-intensity fires which rarely kill mature Douglas-fir. Fire frequency is usually 30–70 years (LANDFIRE 2007). Cool dry stands of Douglas-fir generally occur on steep, south-to southwest-facing slopes and ridges in the lower parts of drainages. They provide important big-game winter and spring habitat due to an understory of abundant grasses, forbs, and shrubs. Large mature trees provide important roost and nesting sites for raptors and cover for ungulates in winter and early spring.

Moist Douglas-fir sites have more variable fire frequencies and intensities. Lower intensity fires have been documented to occur every 50–100 years and stand-replacing fires at 200–400 year intervals (U.S. Forest Service 2004b). Overstory trees are relatively fire-resistant to low intensity surface fires due to a thick bark. Moist Douglas-fir types are different from the cool dry Douglas-fir types in terms of understory composition, stand structure, the type of sites they occupy, and how they function within disturbance regimes. Common understory species are Rocky Mountain maple, pinegrass, heartleaf arnica, pachistima, white spirea, and blue huckleberry (Steele et al. 1983). Lodgepole pine, aspen, and limber pine may be major secondary species (Bradley et al. 1992).

Lodgepole pine

Lodgepole pine forest is the most abundant forest type in Wyoming, covering over 2.6 million acres (23%) of forest land (Wyoming State Forestry Division 2009). Lodgepole pine is capable of growing over a broad range of environmental conditions including high soil temperatures, low air temperatures, and water-saturated soils (Volland 1984); however, forests dominated by this species occur most commonly at middle elevations of from 5,900 to 10,500 feet in northern Wyoming and 7,000 to 11,500 feet in southern Wyoming (Green and Conner 1989).

Commonly considered a pioneer species, Lodgepole pine displays the characteristics of low shade tolerance, the ability to grow on almost any forest site, quick regeneration following a disturbance, and the rapid growth of young trees (Cole et al. 1985). Without disturbance, lodgepole pine forests often progress to a mixed-conifer community including subalpine fir, Engelmann spruce, Douglas-fir, and whitebark pine (Koch 1996a). Lodgepole pine forests can persist as a climax community on cool, dry, nutrient-poor sites, or where repeated disturbances or inadequate seed sources prevent other trees from becoming established (Cole et al. 1985, Koch 1996b).

Lodgepole pine possesses both serotinous and non-serotinous cones, providing the tree with a unique method of seed dispersal. Serotinous cones can remain closed for many years until opened by intense heat, typically fire or intense sunlight. Following a fire, large numbers of accumulated seeds are able to germinate with the exposure of bare mineral soil and low competition for resources from other plants, which creates favorable conditions for seedling survival. The rapid establishment of lodgepole pine after a disturbance can result in dense, structurally uniform, even-aged stands often referred to as dog-hair stands. Serotinous cones are especially important for the survival of lodgepole pines whose thin bark causes them to be easily killed by fire (Knight 1994).

Non-serotinous cones can release their seeds without the aid of fire, allowing them to regenerate following non-fire disturbance. There is evidence that younger trees, before the age of 20 to 30, tend to produce non-serotinous cones (Lotan 1976). The proportion of serotinous and non-serotinous cones varies between stands. Serotinous cones are in higher proportion in areas where the last disturbance was a stand-replacing fire (Lotan 1973, Tinker et al. 1994, Muir 1985, Nyland 1998).

The mean fire-return interval for lodgepole pine forests ranges from 100 to 300 years (Knight 1994). While most fires cover tens of acres, infrequent fires during dry years can cover thousands of acres and have major impacts on landscape vegetation patterns. With the mountain pine beetle epidemic that has been escalating in magnitude over the past decade, fire intervals and other natural ecosystem processes will likely be altered as the forest landscape changes (see Montane and Subalpine Habitats Threats – Disease and Insects).

Engelmann spruce-subalpine fir

Spruce-fir forests cover 1.8 million acres (16%) of Wyoming and are the second most abundant forest type (Wyoming State Forestry Division 2009). Engelmann spruce and subalpine fir can tolerate low temperatures and have relatively low water-use efficiency (Knight 1994). These attributes restrict their growth to cooler, wetter environments, such as timberline, on north-facing slopes, and along streams and ravines at lower elevations.

Spruce-fir forests are considered a climax community as both species are shade-tolerant and are frequently found in the understory as well as the overstory, meaning vegetation assemblages will progress to the dominance of these species following a disturbance. This attribute results in spruce-fir forests with uneven aged trees. As disturbances occur, lodgepole pine and aspen are often pioneer species and they can coexist with spruce and fir for a century or more (Knight 1994). Successional pathways for spruce-fir forests depend on the nature and intensity of disturbances, prior species composition, and site characteristics (Knight 1994). The rate of succession back to spruce-fir forest is influenced by fire suppression and the moisture level of the site (Romme and Knight 1981).

The proportion of spruce and fir varies. Subalpine fir is more common, and trees are often smaller and younger. Subalpine fir may have 10 to 20 times more seedlings than Engelmann spruce (Knight 1994). Subalpine fir is also capable of vegetative reproduction. When low branches are pressed into the ground by snow they begin to develop roots and the branch grows upright into a new tree (Knight 1994). Engelmann spruce compensate for their lower reproductive rate through longevity. They tend to be the oldest and largest trees and may live 500 years or more (Alexander 1987).

Stand-replacing fires are estimated to occur at intervals of about 300 years in dryer stands and longer intervals of 350 to 400 years for more mesic sites (Romme and Knight 1981). Fires in the subalpine forest are typically stand-replacing, resulting in the extensive exposure of mineral soil and initiating the regeneration of new forests. Modern fire suppression has increased the abundance as well as the homogeneity of these forests in terms of age and structure diversity. There is evidence in the pollen record that suggests a pattern of landscape dominance by spruce-fir alternating with dominance by lodgepole pine through several cycles reflecting climate changes or successional phases (Hanson 1940).

Whitebark pine

Whitebark pine comprises 5% of Wyoming's forests (Wyoming State Forestry Division 2009). Whitebark pine is a slow-growing, long-lived conifer of high-elevation forests and timberlines of the northwestern United States and southwestern Canada. In Wyoming, whitebark pine exists, often in association with limber pine, in the western part of the state from the Commissary Ridge area into Yellowstone National Park. Whitebark pine seeds are largely dispersed by Clark's nutcracker. The tree's multi-stem form results from seeds sprouting from Clark's nutcracker caches, commonly in burned areas or wind-swept ridges. The fire-return interval in whitebark pine communities is between 50–300 years (Arno 1986, Arno and Hoff 1989). Without fire, subalpine fir and Engelmann spruce increase and support fire events which can set back succession, again favoring whitebark pine. While its distribution is small, whitebark pine is considered a keystone species at high elevations throughout the northern Rocky Mountains due to its abundant seed production which is an important food source for wildlife. Recent surveys suggest that the mortality of whitebark pine in the Greater Yellowstone Ecosystem may be as high as 80% as a result of mountain pine beetle and blister rust infestations (see Montane and Subalpine Habitats Threats – Disease and insects, below).

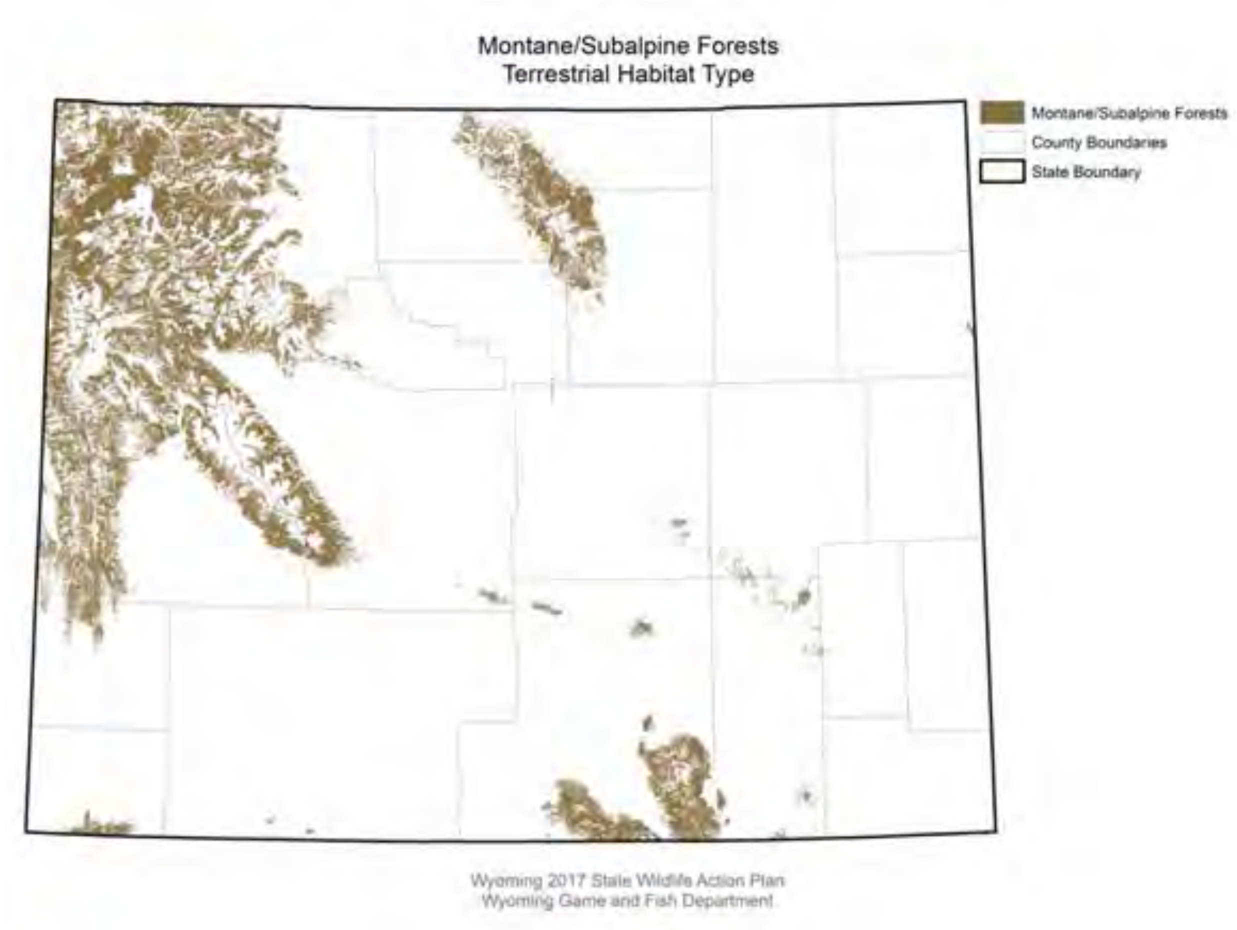


FIGURE 9. Wyoming Montane and Subalpine Forests

TABLE 9. Wyoming Montane and Subalpine Forests NatureServe Ecological Systems[2]

1. Northern Rocky Mountain Subalpine Woodland and Parkland
2. Northern Rocky Mountain Mesic Montane Mixed Conifer Forest
3. Rocky Mountain Lodgepole Pine Forest
4. Rocky Mountain Subalpine Dry-mesic Spruce-Fir Forest and Woodland
5. Rocky Mountain Subalpine Mesic-wet Spruce-Fir Forest and Woodland
6. Middle Rocky Mountain Montane Douglas-fir Forest and Woodland
7. Rocky Mountain Poor-site Lodgepole Pine Forest
8. Recently Burned Forest
9. Harvested Forest-tree Regeneration
10. Harvested Forest-grass Regeneration
11. Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland

[2] Descriptions of NatureServe Ecological Systems which make up this habitat type can be found at: NatureServe Explorer: an online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, VA. http://www.natureserve.org/explorer.

TABLE 10. Wyoming Montane and Subalpine Forests Species of Greatest Conservation Need

Mammals
Abert's Squirrel
Canada Lynx
Dwarf Shrew
Eastern Red Bat
Fringed Myotis
Hayden's Shrew
Long-eared Myotis
Long-legged Myotis
Moose
Northern Flying Squirrel
Northern Long-eared Myotis
Pygmy Shrew
Uinta Chipmunk

Water Vole
Western Small-footed Myotis
Wolverine
Yellow-pine Chipmunk

Birds
American Kestrel
Bald Eagle
Black-backed Woodpecker
Boreal Owl
Calliope Hummingbird
Calrk's Nutcracker
Common Loon
Flammulated Owl
Great Gray Owl
Harlequin Duck
Lewis's Woodpecker
Northern Goshawk
Northern Pygmy-Owl
Red Crossbill
Rufous Hummingbird
Trumpeter Swan
Williamson's Sapsucker

Reptiles
Northern Rubber Boa
Smooth Greensnake

Amphibians
Columbia Spotted Frog
Wood Frog
Western Toad

Montane and Subalpine Forest Wildlife

Montane and subalpine forests in Wyoming contribute to the overall wildlife species diversity of the state, as higher elevation forests form a continuation of subarctic forests that extend across most of Canada and Alaska. A number of bird and mammal species in Wyoming that occur in this habitat type are at or near the southernmost extensions of their ranges. Many wildlife species only occupy this habitat in spring, summer, and fall, such as big game and passerine birds, which migrate to lower elevations and latitudes in the winter.

Because these forests are restricted to mountains they are regionally fragmented, and as a result, forest-adapted wildlife species are often genetically isolated. In fact, several Wyoming montane and subalpine forest mammals have evolved into distinct subspecies. Examples include Bighorn Mountain snowshoe hare (*Lepus americanus seclusus*), Bighorn Mountain montane vole (*Microtus montanus zygomaticus*), Black Hills marmot (*Marmota flaviventris dakota*), and Black Hills red squirrel (*Tamiasciurus hudsonicus dakotensis*).

Subalpine forests that include large components of course, woody debris and have high structural diversity are particularly important to forest carnivores such as pacific marten, wolverine, Canada lynx, and fisher. These habitats create subnivian spaces for thermoregulatory shelter and foraging sites in the winter.

Subalpine conifer forests are usually more diverse and provide more roost sites for bats than high-elevation forests. Some types of mid-elevation stands, especially lodgepole pine, sometimes form pure, dense, dog-hair stands of trees with small diameters and slow rates of growth. Stands in this condition probably do not provide ideal bat habitat (Hester and Grenier 2005).

Coarse, woody debris in the form of standing snags and downed logs is an important physical substrate for many forest species. Much of the primary productivity in forest stands is in the form of wood, which is indigestible to most vertebrates. Thus, wood-digesting invertebrates, fungi, and microbes often represent critical foods for many animals including the southern red-backed voles, red squirrels, and northern flying squirrels, all of which depend on forest fungi in their diets. Snags, which are dead standing trees, are important habitat for many cavity-nesting and insect-feeding birds. They also provide cavities, crevices, and exfoliating bark that serve as maternity colonies and roost sites for bats and may play a central role in determining the distribution and abundance of forest-roosting species (Hester and Grenier 2005). Additionally, dead wood is important in building forest soils.

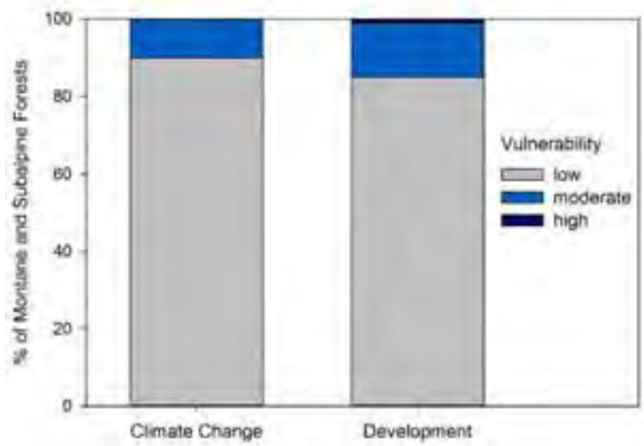
Whitebark pine seeds are an extremely important wildlife food in high mountain ecosystems for grizzly bears, red squirrels, black bears, ground squirrels, chipmunks, woodpeckers, nuthatches, Steller's jay, raven, and pine grosbeak (Kendall and Arno 1990). Whitebark pine also serves an important role as a nurse tree in facilitating the establishment of other types of vegetation. Its growth in alpine areas helps to stabilize soil and accumulate snow which retards spring runoff, reduces flooding, and improves water quality.

Spruce-fir forests provide hiding and thermal cover for moose and elk, forage for wintering moose, and important winter habitat for snowshoe hare, which is the principal prey of Canada lynx. Mule deer often use montane and subalpine forests as summer and transitional ranges.

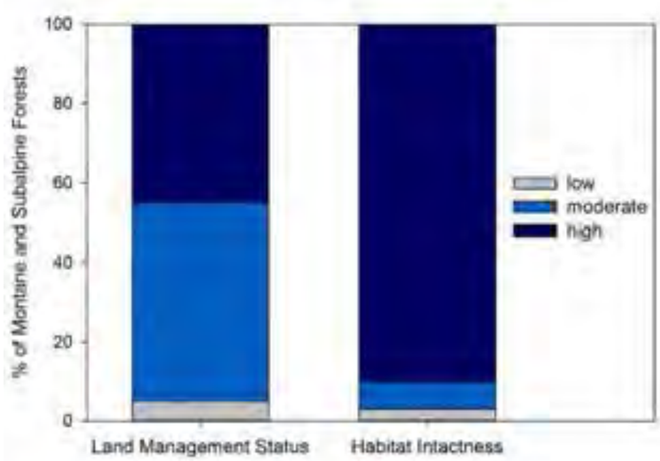
The Rocky Mountain Subalpine Dry-Mesic Spruce Fir Forest and the Rocky Mountain Mesic-Wet Spruce Fir Forest in conjunction with the lower-elevation mixed conifer and lodgepole pine forests are some of the most important ecological systems to Wyoming Species of Greatest Conservation Need (SGCN) occupying the montane and subalpine forest habitat type.

Montane and Subalpine Forest Habitat Threats

Figure 10. Montane and Subalpine Forests Vulnerability Analysis



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high vulnerability to climate change or development, based on classification of scores ranging from 0 to 1 into the following categories: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for climate change or development vulnerability were based on the land area of the habitat type classified as having high vulnerability: low (<10%), moderate (10-33%), or high (>33%). Vulnerability was calculated as exposure minus resilience. Development vulnerability includes existing and projected residential, oil and gas, and wind energy development. Further details are provided in the Leading Challenges section of this report and in Pocewicz et al. (2014).



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high land management status or habitat intactness. For land management status, high corresponds to the percent of the habitat occurring in GAP status 1 or 2, moderate to the percent occurring in GAP status 2b or 3, and low to the percent occurring in GAP status 4. Rankings for land management status were based on the land area of the habitat type classified as having high status or legal protection: low (<10%), moderate (10-33%), or high (>33%). For habitat intactness, scores ranging from 0 to 1 were assigned to categories as follows: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for intactness were based on the land area of the habitat type classified as having high intactness: low (<25%), moderate (25-75%), or high (>75%).

A "perfect storm" of the combined effects of fire suppression, drought, invasive plant establishment, and large-scale bark beetle infestations are currently resulting in landscape-scale changes to the flora in many Wyoming montane and subalpine forests. These threats are interrelated and often magnify the impacts of other disturbances.

Fire suppression – High to Low
Fire-suppression management strategies to protect timber, property, and human safety have been used since around 1890, shortly after European settlement of the West (Crisp, personal communication, 7 July 2010). Fire suppression has had a significant influence on montane subalpine habitat in some locations, although upper-elevation forests with infrequent fire regimes may have experienced variable impacts ranging from significant to negligible. Fire suppression has contributed to a loss of age, structural, and species diversity, increased stand densities, and the buildup of live and dead fuels. Timber patch size has remained unchanged, but due to suppression of surface and moderate intensity fires, forest openings or small breaks have either decreased in size or do not exist (Agee 1998).

These changes have resulted in a more homogeneous forest landscape pattern (Barrett 2004), which has contributed to a number of forest health concerns including intensifying the bark beetle outbreaks (see Montane and Subalpine Habitats Threats – Disease and insects). Tree mortality from bark beetles has occurred on an unprecedented scale within the montane and subalpine forest habitat type. High fuel loads create conditions more favorable to large-scale, high intensity fires. Such fires may cause significant impairment to regeneration, loss of valuable seed trees, loss of relict stands of mature trees and remnant populations of locally uncommon wildlife and floral species, aid in establishment of invasive plants, and further promote homogeneous landscape patterns. In some areas, catastrophic fires may result in the long-term conversion to non-forest landscapes. For some important forest community types, such as whitebark pine and aspen, perpetuation is dependent on occasional disturbance, most commonly by fire.

Disease and insects – High
Montane and subalpine forest habitats are home to a variety of beetles, which under normal circumstances are a natural component of forest ecology and serve the purpose of renewing a forest by killing older trees. However, in recent decades, the populations of several types of beetles have exploded to epidemic levels affecting trees in a variety of age classes.

Continued high population levels of bark beetles have resulted in large-scale tree mortality among several pine species, Douglas-fir, true firs, and Engelmann spruce forests in the Rocky Mountain region (U.S. Forest Service 2004a). Bark beetle-caused tree mortality has significantly affected the Medicine Bow, Shoshone, Uinta-Wasatch-Cache, Bridger-Teton, Bighorn, and Black Hills National Forests. Surrounding state and private lands are also experiencing increasing levels of tree mortality caused by bark beetles (Wyoming State Forestry Division 2009). In some locations, there is a near complete loss of mature forests and considerable mortality in immature stands (U.S. Forest Service 2004a).

Bark beetle outbreaks are believed to be facilitated by a combination of factors. Years of successive droughts have likely weakened some trees. Additionally, many forests consist of significant amounts of aging, denser stands, which are susceptible to bark beetles. Some historic logging practices and large fires, especially fires during the European settlement era 100–150 years ago, contributed to large areas dominated by even-aged stands of lodgepole pine. Activities such as thinning, sanitation, salvage, and regeneration harvest, associated with commercial timber management, have also been discontinued in some areas. Finally, fire suppression can also lead to increased stand densities by allowing understory trees to survive and mature. Adding to these forest conditions are warmer winter temperatures and earlier snow melt, which increases tree moisture demand and may allow bark beetle populations to expand rapidly (see Montane and Subalpine Habitats Threats – Drought and climate change).

Bark beetle-caused tree mortality can provide important habitat for some species of wildlife, provide coarse woody debris to streams, and contribute to nutrient recycling. Mountain pine beetle epidemics could result in increased aspen regeneration in many parts of the state as competition from conifers is reduced (Wyoming State Forestry Division 2009). However, large-scale bark beetle outbreaks may also have negative effects on wildlife, including loss of hiding cover and older tree habitat that is crucial for some species of threatened and endangered wildlife (Samman and Logan 2000).

Lodgepole and ponderosa pine are attacked and killed most often by mountain pine beetle and pine engraver beetles. Mountain pine beetle activity has declined across much of Wyoming after impacting over 3.47 million acres since the late 1990's. The epidemic has run out of suitable hosts in many areas across the state, but remains active in the southern Bridger-Teton and Shoshone National Forests, as well as the Wind River Reservation (2015 US Forest Service). Tree mortality resulting from epidemics can affect water flows and watersheds, future timber production, wildlife habitat, recreation sites, transmission lines, and scenic views. Where succession is more advanced, some beetle-killed stands of lodgepole pine may be replaced mainly by subalpine fir, although future fires may take stands back to lodgepole pine where serotinous cones predominate (Perry and Lotan 1979). If high-intensity fires occur in lodgepole pine stands with low numbers of serotinous cones, the seed source may be lost and it may take decades before lodgepole pines return (Schoennagel et al. 2003).

The most important insect impacting mixed forests of Engelmann spruce and subalpine fir is the spruce beetle. Usually these beetles are restricted to recently wind-thrown trees or trees weakened by root disease, but they can reach epidemic levels if the right stand structure and climatic conditions are present (Romme et al. 2006). There is significant scientific evidence that epidemics of spruce beetles have killed trees over extensive areas in past centuries (Veblen et al. 1991, Veblen et al.1994). Douglas-fir beetle has affected scattered stands that have been stressed by drought, fire, root rot, defoliation by western spruce budworm, or windfall. Noted outbreaks have occurred in the North Fork of the Shoshone River, on the west side of the Bighorn National Forest, and in lower elevations of the North Platte watershed on the Medicine Bow National Forest (Wyoming State Forestry Division 2009).

Mountain pine beetle is killing mature whitebark pine at a high rate similar to the 1930s outbreak which killed most of the mature whitebark pine in Yellowstone National Park (Gibson 2006). Mountain pine beetle usually kills larger cone-producing trees thus reducing regeneration potential (Keane 2001).

White pine blister rust (*Cronartium ribicola*) is either well established or becoming established within almost all Wyoming whitebark pine and limber pine stands. Only five percent of whitebark pine trees have genetic resistance to white pine blister rust (Tomback 2009). Historically, mountain pine beetle mortality would cause an increase in fuel loads and large fires that would create opportunities for natural regeneration. Blister rust has changed this normal progression by killing young whitebark pine and reducing cone crops by killing cone-bearing branches and tops. The U.S. Fish and Wildlife Service was petitioned to list the whitebark pine as a threatened or endangered species due to white pine blister rust, mountain pine beetles, and climate change. However, as of July 2011, the whitebark pine remains a candidate species eligible for protection under the Endangered Species Act, as listing was found to be warranted but precluded.

In combination, white pine blister rust and mountain pine beetle form a decline complex. Both seed production and the opportunity for germination have been reduced. Since whitebark pine regeneration is reduced, less natural selection for blister rust occurs (Waring and O'Hara 2005). Some tactics for decreasing blister rust include blister rust-resistant breeding programs and removal of alternate plant hosts (*Ribes* spp.) However, blister rust is a significant threat because no feasible tactics are available to limit its spread on a broad scale.

The occurrence and severity of fire following an insect infestation will depend on the forest type, intensity of the outbreak, and time since the last outbreak (Black et al. 2010). Although it is widely believed that insect outbreaks set the stage for severe forest fires, the scientific evidence for this is mixed. A few studies that support this idea report only a small effect, while other studies have found no increase in fire following outbreaks of spruce beetle and mountain pine beetle (Black et al. 2010). It has been hypothesized that the risk of fire may increase only during and immediately after outbreaks of bark beetles when the dry red needles are still on the trees, or that two periods of increased fire risk occur, with an additional peak when trees begin to fall in large numbers, which may occur decades after mortality (Romme et al. 2006). Once large amounts of fuel accumulate on the ground, the risk of fire and the resulting damage to other resources such as soils and water are expected to be greater than pre-epidemic risk (Hayes and Lundquist 2009). While there is mixed evidence for insect infestation leading to more fire on a broad scale, there remains ample evidence connecting insect-caused tree mortality and fire dynamics. For more information on bark beetle in the Rocky Mountain Region, visit http://www.fs.fed.us/r2/bark-beetle/index.html.

Drought and climate change – High
Elevated temperatures reduce beetle winter mortality as well as the time needed for beetles to complete a life cycle, both of which allow populations to grow quickly (Bentz et al. 2008). Increasing temperatures associated with climate change may fundamentally alter beetle-forest dynamics through significantly increasing beetle population numbers and enabling beetles to attack healthier trees (Bentz et al. 2008) at higher elevations and latitudes. Some climate models for Wyoming predict a continued trend of warming seasonal temperatures (Christensen et al. 2007), which, regardless of changes in precipitation patterns, may result in more frequent and severe drought and increasing frequency and extent of wildfire (see Wyoming Leading Wildlife Conservation Challenges – Climate Change). Some researchers have predicted that climate warming will increase the scope of mountain pine beetle infestations in whitebark pine (Six 2010, Tomback 2009).

Conflicting timber-harvesting practices and forest-management objectives – Moderate
In some locations, past timber-management practices such as commercial harvest, thinning, post-harvest treatments, and road construction have resulted to varying degrees in the loss and fragmentation of mature and old-growth forest habitats outside of wilderness areas and national parks in Wyoming. Some historic harvesting activities selectively removed the most productive stands of larger trees that were easily accessible and located at lower elevations on moderate slopes, habitat that is preferred by several wildlife species.

Timber-management plans are constructed to take into account numerous natural resource considerations. The effects of timber harvesting vary by method and by wildlife species and can have both negative and positive consequences. Negative consequences that can occur for certain species include: loss of habitat for cover, nesting, denning, and foraging; loss of certain tree and understory species for decades following treatments; decreased patch size of mature and old growth forests; invasion of exotic plant species; increase in more open country and common species that compete or prey on forest species; loss of travel and dispersion corridors; and increased disturbance resulting from the creation of roads that remain open for use in summer and winter.

It is not well understood how most montane and subalpine forest-associated species respond to habitat alteration and fragmentation. Also, it is often difficult to analyze harvest activities using a regional landscape perspective, which is needed for wildlife species that exist at low densities and have large home ranges. Timber-management treatments may result in long-term benefits to wildlife if based on ecological principles and landscape-level analysis. Without proper safeguards, salvage logging following wildfires may negatively affect nutrient recycling and snow retention, and remove and reduce important habitat features that affect some wildlife species including Canada lynx and its prey, and post-fire dependent woodpeckers.

Tree-dwelling bats, forest owls, northern goshawk, red-backed voles, snowshoe hare, Canada lynx, and other wildlife species may be negatively impacted by forest-management practices that favor even-age, monospecific stands, have short rotation times, decrease the proportion or alter the structure of old-growth stands, and selectively remove snags and older, larger trees (Nicholoff 2003, Hester and Grenier 2005).

Current Montane and Subalpine Forest Conservation Initiatives

The Wyoming State Forestry Division completed a Statewide Forest Resource Assessment in 2009 and a Statewide Forest Resource Strategy in 2010. Completion of both the assessment and strategy were requirements of the 2008 Farm Bill in order to receive State and Private Forestry (SPF) funds. Both the assessment and the strategy were to incorporate existing state plans including State Wildlife Action Plans. As states are proceeding with assessments, there is also a national assessment process. The national assessment will be used to establish broad-scale priorities for the future investment of SPF funding and resources.

Required elements of statewide forest resource assessments include an evaluation of forest resource conditions, trends, threats, and priorities. In Wyoming, this was completed largely through GIS analysis and shared with a variety of stakeholders, including the Wyoming Game and Fish Department (WGFD), for input.

The Wyoming Statewide Forest Resource Strategy outlines long-term comprehensive, coordinated strategies for investing state, federal, and local resources in addressing priority landscapes identified in the Statewide Forest Resource Assessment and designated national priorities. National priorities include conserving working forest lands for multiple uses; protecting forest from catastrophic events including fire, insect and disease outbreaks, and invasive species; and enhancing public benefits from forests: including air and water quality, biological diversity, forest products, renewable energy, and wildlife. Threats and conservation actions identified in Wyoming's Statewide Forest Resource Assessment and Forest Resource Strategy were reviewed in developing this habitat section of the SWAP.

Given the impact of the threats discussed above and the ecological, economic, social and cultural importance of Wyoming's forest-lands, Governor Matt Mead created the Task Force on Forests in 2013. The Task Force studied the benefits that forests provide, using their findings to analyze and consider new response strategies and recommendations for proactively managing Wyoming's forests in both the short- and long-term. The final Task Force Report was completed in January 2015 and gave further support to the Wyoming Forest Action Plan as well as 12 major recommendations, comprising 53 sub-recommendations for the Governor's consideration. These fall under three main themes: fire and other disturbance; resource management, and economic opportunities and innovation (GTFOF 2015).

Both the U.S. Forest Service and Bureau of Land Management (BLM) develop multi-resource management plans for the lands they administer including forested habitats. Under the 1976 National Forest Management Act (NFMA) and the 1969 National Environmental Policy Act (NEPA), forest land and resource management plans, generally referred to as forest plans, are to be developed by the U.S. Forest Service for each national forest and/or grassland and are to be revised every 10–15 years. Since forest plans are practical documents with recommendations and actions that are meant to be implemented on national forest land, an Environmental Impact Statement (EIS) is necessary.

Forest plans serve several functions: they establish forest-wide multiple-use goals and objectives, standards and guidelines, and management area direction; they determine areas that may be used for timber production, rangeland uses, recreation, and oil and gas leasing; they establish monitoring and evaluation requirements; and they recommend wilderness designations, wild and scenic river designations, and other special designations.

Forest plans set forth general guidelines and management directives; however, implementing the plan requires both decision-making at a more local level and site-specific analyses to evaluate the potential impacts of specific actions on resources including wildlife. Timber-harvesting on national forest land may be included in the forest plan, but the potential impacts of slash disposal, road construction, and general habitat disturbance must be considered for a range of species that inhabit the harvest area. Similarly, the forest plans allow for the development of recreation projects such as campsite construction, facility buildings, and trail building. Site-specific research is needed to determine the potential impacts of these actions, including increasing numbers of human visitors and subsequent anthropogenic impacts, on local wildlife and habitat.

The BLM is directed to develop land use plans by the Federal Land Policy Management Act (FLPMA) of 1976 and also NEPA. BLM land-use planning is guided by many principles including managing the land for multiple uses and sustained yield, using an interdisciplinary approach to consider all aspects of public land management, and identifying, designating, and protecting areas that are deemed to be areas of critical environmental concern. The agency must balance the use of the land for its economic values such as energy development and recreation, its biological value to wildlife, its physical open-space value, and social values for human enjoyment of natural landscapes and aesthetics. Each of Wyoming's BLM field offices has a resource management plan (RMP) that guides agency land-management activities throughout the state.

In Wyoming, the BLM and U.S. Forest Service, along with state cooperators, utilize the National Fire Plan (NFP) as the overarching plan to guide all fire-management activities. The NFP primarily focuses on ensuring state capacity to address wildfire prevention, fire preparedness and suppression, and post-fire stabilization and rehabilitation. As one of many objectives, the NFP includes elements of both duplicating historic fire regimes and benefitting wildlife habitat (see Wyoming Leading Wildlife Conservation Challenges – Disruption of Historic Disturbance Regimes – Fire). Community Wildfire Protection Plans (CWPP) have been developed at the county level for 20 of Wyoming's 23 counties. The CWPPs identify priority areas for wildfire mitigation and fuel reduction projects and make recommendations for how projects should be implemented.

There is a regional effort involving the U.S. Forest Service, BLM, National Park Service (NPS), Colorado State University, and the Rocky Mountain Research Station to identify and grow white pine blister rust-resistant limber pine and whitebark pine through seed collection and breeding. It is expected that it will initially take five or six years to develop seedlings for planting

Of the approximately 1.9 million acres of private forest lands in Wyoming, 410,295 acres (~22%) have management plans developed through the Assistance Forestry program (Wyoming State Forestry Division 2009). Management plans have been developed as a guide for landowners to help achieve their stated objectives. The information gathered through initiating this program has contributed to the development of the State Forest Resource Assessment. Recently, the U.S. Forest Service has collaborated with the Ruckelshaus Institute of Environment and Natural Resources at the University of Wyoming to develop a Private Lands Conservation Toolkit for Wyoming's public land managers. The toolkit is intended to encourage public land managers to participate, partner, and assist with local and county land-planning processes and voluntary, private land conservation efforts.

The Forest Legacy Program (FLP) was established in the 1990 Farm Bill to identify and protect environmentally important working forests from conversion to non-forest uses through voluntarily acquired conservation easements. The program is administered by the U.S. Forest Service in cooperation with state, regional, and local agencies. Timber harvesting is allowed on properties conserved through the Forest Legacy Program, but must be done in compliance with a State Forest Stewardship Plan and, for this state, Wyoming State Forestry's Best Management Practices for road construction and timber harvesting (The Conservation Fund 2009).

Recommended Montane and Subalpine Forest Conservation Actions

Efforts should be made to maintain, restore, and or duplicate the effects of historic fire regimes.

Increased human and property safety concerns resulting from greater development in and adjacent to forest lands has restricted the use of fire as a forest habitat management tool in many areas. This trend, along with unprecedented high fuel loads, will require forest managers to continue to develop alternative methods to duplicate the desirable effects of fire where appropriate and to be more strategic in the application of the following methods.

- In consultation with appropriate fire authorities and with a fire-use plan approved by all affected parties, utilize natural fires under approved burning conditions to duplicate historic fire regimes. In designated areas, allow surface and moderate severity fires to play their natural role in breaking up homogeneous landscape patterns. In order to maintain stand-replacing dependent ecosystems, including serotinous-cone lodgepole pine stands, large infrequent severe fires should be considered in fire-management plans (Turner et al. 2003).
- Use prescribed fires to reduce fuel loads and increase tree age-class diversity across the landscape. Increasing age- and size-class diversity will reduce the potential for whole landscapes being replaced by a single stand-replacing event such as a bark beetle outbreak or fire. Furthermore, it is desirable to set back succession in some areas to maintain aspen communities. Younger age classes generally produce more herbaceous and browse forage than advanced aged communities, which is needed for maintaining high quality big game transition and winter ranges. Agencies and landowners must work collaboratively to facilitate cross boundary implementation of prescribed fire, including the use of "Good Neighbor Authority."[3] Wyoming's Statewide Forest Resource Strategy (2010) contains recommendations to enhance the use of prescribed fire treatments in Wyoming.
- The wildland-urban interface is expanding in Wyoming, as in most of the West, which reduces opportunities for both natural and prescribed fires. In these circumstances, duplicating the desired effects of historic fire regimes can sometimes be better obtained through mechanical treatments that allow managers to determine residual stand complexity and density as well as species and age selection, including retaining valued stand components such as snags. Thinning can accelerate the development of structural characteristics typically found in old-growth stands, preserve the largest and

[3] Good Neighbor Authority refers to Congress authorizing the U.S. Department of Agriculture's Forest Service to allow the State Forestry Agencies to conduct certain activities, such as reducing hazardous vegetation, on U.S. Forest Service land when performing similar activities on adjacent state or private land. Efforts are being made to expand "Good Neighbor Authority" to other western states including Wyoming.

most valuable roost trees and snags, and create natural gaps in the canopy used by bat species that forage in more open habitats (Hester and Grenier 2005).

Develop and implement bark beetle management strategies.
Most direct bark beetle control efforts, such as spraying and removal of infected trees, have had little effect on the final size of outbreaks, although they may have slowed beetle progress in some cases and prolonged outbreaks in others (Hughes and Dreveri 2001). While control of such outbreaks is theoretically possible, it would require treatment of almost all infected trees (Hughes and Dreveri 2001), which may be possible only for localized areas. Long-term bark beetle management actions that can help restore forests, lessen negative impacts to wildlife, and reduce susceptibility to future beetle outbreaks include:

- Evaluate sites as they regenerate after beetle epidemics to determine appropriate long-term species composition.
- Evaluate future management of regenerated stands, post-beetle epidemic, to determine management strategies to avoid the development of another generation of large-scale, old, even-aged stands.
- Carefully plan the management of residual stands of larger trees to keep those stands healthy. Active management may be needed to achieve overall forest health objectives in those stands.
- Intensively manage younger regenerated stands to accelerate growth into larger size classes and promote long-term diversity.
- Where practical, use artificial regeneration where natural regeneration has failed.
- Reduce beetle-induced fuel loads to protect vulnerable regeneration, seed trees, remnant populations of mature trees, and isolated populations of locally sensitive wildlife species and uncommon flora.
- Manage stands to reduce future tree densities to lessen the risk of future bark beetle epidemics.
- Monitor salvage operations and fuel reduction projects on the landscape level. Road closures or removals would have to be carefully managed to avoid negative impacts on some wildlife species.

Encourage timber-management practices that benefit wildlife.

- Promote active forest management on suitable lands across all ownerships to achieve and/or maintain natural ecological processes and functions and associated appropriate age class, structural distribution, and plant diversity. Manage for vertical and horizontal heterogeneity, multiple layers of native plants, forest floor complexity, and a variety of age classes in forest and woodland habitats to provide for a diverse insect community, nesting and foraging sites, and roosting opportunities needed by birds and bats (Nicholoff 2003, Hester and Grenier 2005).
- For landscape-level planning, incorporate planning for species associated with older forests such as northern goshawk, forest owls, and Canada lynx to make sure that remaining patches of older forests are adequate in size and connectivity to support viable populations of these low-density wildlife species and their prey (Reynolds et al. 1992). Review management actions proposed by federal agencies in mature and old-growth forests and work closely with agency staff during early stages of project planning.
- Retain large-diameter snags and roost trees for cavity-nesting birds and bats. Where possible, it is recommended that all snags used by bats and cavity-nesting birds, all soft snags, and at least six hard snags per 2.5 acres (1 hectare) are retained (Oakleaf et al. 1996). Retain both evenly distributed snags and those in clusters to maximize diversity and mimic historical conditions (Nicholoff 2003). A minimum 500-feet radius buffer

of intact forest around roosts is recommended to avoid altering airflow and thermal regimes at roost sites (Hester and Grenier 2005).

- Research the effects of past logging and increased recreational levels on SGCN species occupying the Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and the Rocky Mountain Mesic Spruce-Fir Forest NatureServe ecological systems.
- Promote species diversity on lands capable of growing multiple tree species.

Conduct direct management and intervention activities to ensure the future persistence of whitebark pine and reverse recent losses.
Management actions that should be considered include:

- Restoration and maintenance of native fire regimes. This recommendation could be the single most important management action to ensure persistence of whitebark pine (Keane and Arno 2001).
- Management of adjacent stands that are being impacted by bark beetles through timber harvest and prescribed or natural fire to reduce the impacts from beetles on whitebark and limber pine stands.
- Collection and archiving of seed from isolated whitebark pine communities that may possess rust-resistance genetics, and planting of rust-resistant seedlings.
- Propagation of naturally rust-resistant trees where possible. Increase natural regeneration for greater selection of possible rust resistance and in areas where cone-bearing trees are at risk.
- Thinning whitebark pine stands to improve individual tree vigor, reduction of interspecies competition, increasing individual tree resistance to white pine blister rust, and decreasing disease transmission.
- Disseminating information on the status and distribution of whitebark pine.
- Selectively retaining whitebark pine in aspen enhancement projects.

Begin preparing for the potential influences of climate change on Wyoming's forests.

- Encourage research and monitoring to better understand the extent and effects of climate change on Wyoming's forests.
- Forest management should focus on maintaining healthy, diverse forests which are naturally resilient to many threats including climate change. Use adaptive management strategies to mitigate impacts resulting from climate change and to account for species adaptation.
- Adapt water-management techniques to accommodate changes in flow and timing as a result of climate change.
    - Manage forests to increase snow capture and retention, as well as to reduce the risk of flooding and excessive runoff. Manage canopy closure to influence snow accumulation. In created openings, maintain sufficient surface roughness to allow snow capture and retention.
    - On currently drier sites, manage for species with the greatest tolerance for dry conditions.
    - Adjust residual stocking levels to promote healthy forest conditions and promote water retention.
    - Adjust slash disposal requirements, utilization standards, and harvest design to accommodate any biomass utilization opportunities.
- Prepare for a likely increase in fire frequency and severity.

Encourage management agencies and research organizations to conduct studies on the ecology of snowshoe hare, forest grouse, tree squirrels, pocket gophers, and other species that form the base of the predator food chain in the montane and subalpine forest habitat type.

Montane and Subalpine Forest Monitoring Activities

Continue monitoring population trends or changes in distribution of montane and subalpine forest SGCN and other obligates in order to infer changes in habitat quality or other threats.
The U.S. Forest Service should be encouraged to survey for northern goshawks, boreal owls, great gray owls, and northern pygmy-owls using systematic survey techniques at least two years prior to proposed timber harvest treatments, prescribed fire, or other large-scale management activities.

Monitor the landscape distribution and habitat intactness of montane and subalpine forests through remote sensing.
Remote sensing is useful in tracking the size, distribution, and fragmentation level of montane and subalpine forest habitat in Wyoming. Information gathered would be helpful in determining the cumulative impacts of activities and events such as insect outbreaks, invasive plant establishment, logging, fires, and forest regeneration and succession. This technique may require the further development of monitoring protocols and identification of sample sites.

In cooperation with research entities, monitor the effects of climate change including extended periods of drought. Special attention should be given to the effects of climate change on hydrologic regimes, insects and disease outbreaks, and fire frequency.

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Mountain Grasslands and Alpine Tundra

Photo courtesy of WGFD

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Habitat Description

Mountain grasslands are defined as grasslands in montane landscapes typically above 6,500 to 7000 feet in elevation and alpine areas above timberline. These grasslands are frequently referred to as parks or mountain meadows, while alpine areas are referred to as turf fellfield or dwarf-shrubland. Within the mountain grassland, and interspersed with montane and subalpine forest types, are small, but unique tall forb communities. Tall forb communities are typically dominated by wild geranium, nettleleaf, arrowleaf balsamroot, western coneflower, asters, fleabanes, yarrow, some sedges, alpine timothy, mountain brome, and a few plants of mountain big sagebrush, or dwarf willows and snowberry. NatureServe (2010) lists and provides descriptions of the five ecosystems characterizing these habitat types (Table 11).

Within mountain grassland types, species composition varies with elevation, moisture, soil depth, and soil type. Bluebunch wheatgrass, needle-and-thread, Junegrass, Sandberg's bluegrass, and fringed sagebrush are common at lower elevations. As elevation increases, Idaho fescue, bearded wheatgrass, green needlegrass, other needlegrasses, bluegrasses, tufted hairgrass, sedges, lupine, sticky geranium, prairie smoke, hawk's-beard, and pale agoseris become more prevalent (Tweit and Houston 1980, Knight 1994). Wet meadows are found along streams and in areas where snow melt provides abundant moisture. Mountain big sagebrush, mountain silver sagebrush, shrubby cinquefoil, and various dwarf willows are common shrubs in mountain meadows.

The absence of trees in mountain grasslands is often the result of fine textured soils and their moisture-holding characteristics. Such soils are often too wet during the growing season to allow for the establishment of conifer seedlings. On steeper south-facing slopes, fine textured soils can be too dry to support trees. In other locations, soils can be too shallow for trees, or persistent snow drifts can preclude tree growth. Competition from established herbaceous plants as well as cold-air drainage or frost pockets may also restrict tree establishment (Knight 1994). Lastly, disturbances such as forest fires, avalanches, and tree blowdowns can create conditions favorable to the establishment and persistence of mountain grasslands. Clearcut timber harvests often regenerate as mountain grasslands for several years before succeeding back into seedling/sapling stage forests.

Alpine tundra exists at the highest elevations where winds are severe and temperatures too low during the growing season to allow for adequate photosynthesis needed to support larger plants (Knight 1994). This often occurs where either the mean July temperature is lower than 50˚ F or the mean July maximum temperature is lower than 52˚ F (Tranquillini 1979, Arno and Hamnerly 1984). In Wyoming, subalpine forests and Krummholz give way to the treeless alpine tundra at elevations ranging from about 11,480 feet in the Medicine Bow Mountains in the south to about 9,840 feet in the Beartooth Mountains in the north (Nicholoff 2003). Alpine soils can be very dry as a result of severe cold, persistent strong winds, intense ultraviolet radiation, low vapor pressure at high altitudes, and reflective solar radiation from snowbanks. These effects can impair photosynthesis and limit growth of woody vegetation (Knight 1994).

Alpine tundra is more diverse than the lower elevation mountain grasslands. Common species include sheep fescue, spike trisetum, kobresia, tufted hair grass, alpine bluegrass, alpine avens, dwarf willows, and numerous cushion plants and sedges. Alpine plants tend to have much more root and rhizome biomass than shoots, leaves, and flowers. This feature not only aids in water and nutrient absorption, but also plays a very important role in over-winter carbohydrate storage (Nicholoff 2003). Reproduction in alpine plants is largely vegetative due to difficulties of seedling establishment in such a harsh environment.

Alpine vegetation generally occurs in a mosaic of small patches with widely differing environmental conditions. Changes in topography of as little as one foot or less may mean the difference between a windswept area and an area of protective snow accumulation, which can have a dramatic effect on the composition and productivity of the local plant community (Nicholoff 2003). Recovery after disturbance in alpine tundra is long, due to a very short, cold growing season and extremely slow soil formation.

The majority of mountain grasslands in Wyoming are under federal management. Roughly 98% of alpine tundra is publicly owned, and 72% is in wilderness areas (Nicholoff 2003). Important human uses of the mountain grassland and alpine tundra habitats include livestock grazing, recreational hiking, hunting, fishing, photography, rock climbing, camping, off-road vehicle travel, skiing, horse-packing, and mining. Mountain grasslands and alpine tundra also play important roles in water collection and storage, mostly through snow accumulation and melting, which is slowly released into Wyoming's streams and rivers throughout the summer in the form of runoff.

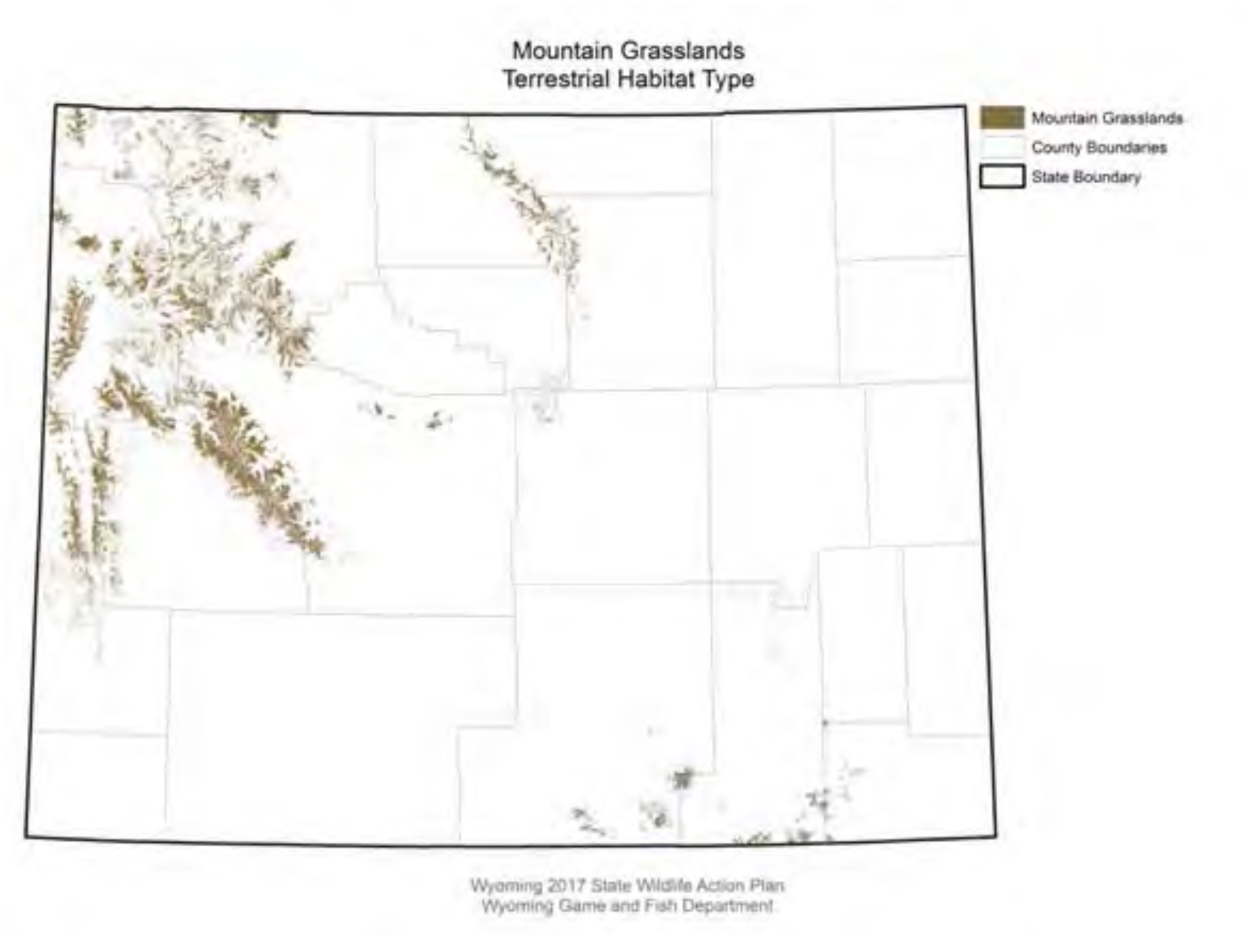


FIGURE 11. Wyoming Mountain Grasslands and Alpine Tundra

TABLE 11. Wyoming Mountain Grasslands and Alpine Tundra NatureServe Ecological Systems[1]

1. Northern Rocky Mountain Subalpine-Upper Montane Grassland
2. Rocky Mountain Alpine Turf
3. Rocky Mountain Alpine Dwarf-Shrubland
4. Rocky Mountain Subalpine-Montane Mesic Meadow
5. Southern Rocky Mountain Montane-Subalpine Grassland
6. Harvested forest-grass regeneration

[1] Descriptions of NatureServe Ecological Systems which make up this habitat type can be found at: NatureServe Explorer: an online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, VA. http://www.natureserve.org/explorer.

TABLE 12. Wyoming Mountain Grasslands and Alpine Tundra Species of Greatest Conservation Need

Mammals
American Pika
Bighorn Sheep
Dwarf Shrew
Moose
Preble's Shrew
Water Vole
Wolverine
Uinta Chipmunk

Birds
American Pipit
Calliope Hummingbird
Black Rosy-finch
Brown-capped Rosy-finch

Reptiles
Northern Rubber Boa
Red-sided Gartersnake
Smooth Greensnake
Valley Gartersnake

Amphibians
Columbia Spotted Frog
Wood Frog
Western Toad

Mountain Grasslands and Alpine Tundra Wildlife

Abiotic conditions in alpine habitats can be both harsh and highly variable. Consequently, animals that live in these environments use several unique adaptations in order to survive. These include food caching, diet-switching, subterranean habitat use, torpor and hibernation. Wildlife in mountain grasslands and alpine tundra is often limited in the winter by deep snowpack. Many species, including big game and passerine birds, migrate to lower elevations and latitudes in the winter, occupying this habitat type only in the spring, summer, and fall.

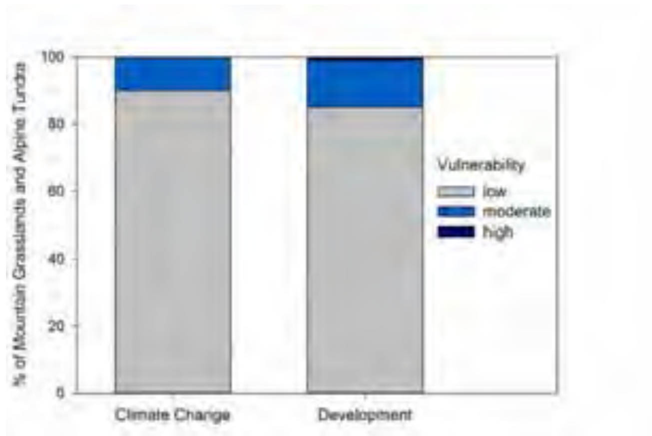
Mountain grasslands and herblands can be characterized as patches of high primary productivity (i.e., forbs and grasses) embedded within a generally low-productive understory contained within the forest matrix. This combination provides critical forage patches in close proximity to tree cover. For example, mountain grasslands and herblands provide important summer forage for elk, mule deer, moose, and bighorn sheep. Mountain goats, which are not native to Wyoming, use this habitat year round. Small mammals found in mountain grasslands and alpine tundra include water vole, montane vole, long-tailed vole, short-tailed weasel, and yellow-bellied marmot. The northern pocket gophers plays a keystone role in this environment through constant soil disturbance and root herbivory, which facilitates nutrient cycling, air and water penetration into the soil, and creates a fine-grained patchwork of understory plant communities in various stages of vegetational succession. In addition to plants, mountain grasslands and herblands are an important source of insects, which further contribute to the forage base for vertebrate wildlife and provide means for pollination and reproduction by vegetation.

Due to the severe climate, few vertebrate species, including birds, are able to breed in the alpine tundra. Although the avifauna of the alpine tundra is small compared to those of other habitats, these species (e.g., brown-capped rosy-finch, black rosy-finch, and American pipit) are typically specialized and endemic, and are not found in other habitats during the breeding season. Both rosy-finch species are SGCN and breed above timberline in barren, rocky, or grassy areas, including cirques, talus slopes, and alpine areas that have cliffs, snowfields, or glaciers nearby. The American pipit is a well known breeder in arctic and alpine tundra, using coastal beaches and marshes, stubble fields, recently plowed fields, mudflats, and river courses during migration and winter. Mountain(Subalpine) grasslands and herblands below the tundra zone support a more diverse avifauna, with many tree-nesting species using adjacent grasslands as foraging patches.

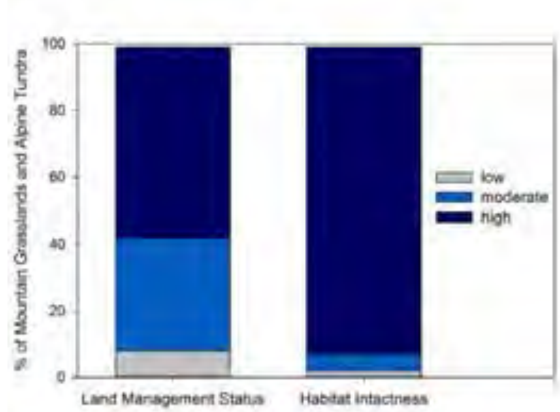
Considerable data gaps exist for many of the SGCN mammals found in these habitats. However, some key habitat components can be identified, such as high structural diversity of alpine meadows, high diversity of invertebrates, and proximity of habitat to water, which increase the value of these habitats for these mammals. Many alpine animals also rely on access to microrefuges, such as rock crevices or grass cover, which can provide immediate reprieve from extreme conditions (Rull 2009 and Shi et al. 2015). The American pika and the wolverine are Wyoming SGCNs that are found in the mountain grasslands and alpine tundra habitat type. They have been petitioned for protection under the Endangered Species Act, most recently regarding concerns that they may be negatively impacted by climate change.

Mountain Grasslands and Alpine Tundra Habitat Threats

Figure 12. Mountain Grasslands and Alpine Tundra Vulnerability Analysis



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high vulnerability to climate change or development, based on classification of scores ranging from 0 to 1 into the following categories: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for climate change or development vulnerability were based on the land area of the habitat type classified as having high vulnerability: low (<10%), moderate (10-33%) or high (>33%). Vulnerability was calculated as exposure minus resilience. Development vulnerability includes existing and projected residential, oil and gas, and wind energy development. Further details are provided in the Leading Challenges section of this report and in Pocewicz et al. (2014).



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high land management status or habitat intactness. For land management status, high corresponds to the percent of the habitat occurring in GAP status 1 or 2, moderate to the percent occurring in GAP status 2b or 3, and low to the percent occurring in GAP status 4. Rankings for land management status were based on the land area of the habitat type classified as having high status or legal protection: low (<10%), moderate (10-33%), or high (>33%). For habitat intactness, scores ranging from 0 to 1 were assigned to categories as follows: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for intactness were based on the land area of the habitat type classified as having high intactness: low (<25%), moderate (25-75%), or high (>75%).

Human disturbances have been of relatively low intensity and localized in the alpine zones because a majority of this habitat type is within designated wilderness. However, any disturbance above treeline may have lasting effects because of harsh growing conditions and low productivity. Because of their generally easier access and higher productivity, montane grasslands and herblands have received greater human-related impacts.

Invasive plants – High

The potential for invasive plant spread in the mountain herblands and grasslands has dramatically increased since the 1960s. This is particularly evident in drier montane habitats dominated by bluebunch wheatgrass and Idaho fescue. Spotted knapweed, leafy spurge, cheatgrass, yellow toadflax, Dalmatian toadflax, orange hawk's-beard, oxeye daisy, and nonnative thistles pose a serious threat to plant diversity and land productivity. In tall forb communities, mule ear and tarweed can increase under improper grazing conditions. Alpine tundra and subalpine areas tend to be more resistant to noxious weed invasion due to harsh growing conditions and fewer vectors.

Lower elevation montane habitats may become threatened by cheatgrass and other invasive species, which are more tolerant to changing climate conditions and varying levels of soil moisture, that currently occur below the subalpine zone.

Climate change – High

Mountain systems are highly sensitive to climate change (Pauli et al. 1996, Gottfried et al. 2012 and Oyler et al. 2015). In the alpine zone, climatologists have recorded increases in spring and winter temperatures (Mote and Redmond 2012), a decline in the ration of precipitation falling as snow (Knowles et al. 2006), and decrease in snow cover (Walther et al. 2002). In Wyoming, the greatest increases in annual temperature during the past 50 years have occurred at high elevations in the Wind River, Gros Ventre, Absaroka, Wyoming, and Salt ranges (Girvetz et al. 2009). There are concerns over long-term persistence of alpine and subalpine habitats under climate warming scenarios. Rising global temperatures may lead to drier environmental conditions in these habitats which could cause shifts in species composition and the loss of high elevation wet meadows, which function as important natural water storage features and hydrological flow regulators. Warming surface temperatures are expected to be most pronounced at high elevations and latitudes. Changes in species diversity may be most apparent in alpine landscapes as warmer conditions encourage lower elevation species to expand their range upward in elevation and northward in latitude (Walther et al. 2002 and Thuiller et al. 2005). The redistribution of vegetation into alpine tundra will depend on a variety of factors, including temperature extremes and water limitations. Subalpine conifers have been documented as infilling these areas—a trend that is suspected to be related to changing climate conditions (Joyce et al. 2007).

Changing dynamics of animal communities linked to changing climate conditions have also been observed and documented in areas of high elevation and/or latitude (Parmesan 2006). Terrestrial species that are associated with alpine tundra and mountain grasslands may be impacted by warmer temperatures, changing precipitation patterns, and mountain snow runoff, which will likely influence climate-sensitive behaviors, animal abundance, and species diversity. These changes may result in functionally fragmented habitats and lead to isolated populations. Similarly, high elevation fisheries may be impacted by changing climate conditions that lead to alterations in water temperature, chemistry, or quality and quantity (see Wyoming Leading Wildlife Conservation Challenges – Climate Change).

Overgrazing by ungulates - Moderate

At proper stocking levels, grazing regimes can be compatible with montane and subalpine habitat function. Alpine habitats are less compatible with livestock grazing practices due to the short snow-free season, low productivity, and slow ecosystem recovery after disturbance. Improper grazing practices can eliminate vegetation, cause soil erosion and compaction, encourage invasion of invasive plants, change vegetation composition, and reduce the availability of cool microclimates that are important to the occurrence of some mountain amphibians and invertebrate species. Historic grazing within tall forb communities has led to loss of soil, stream sedimentation, and changes in plant species in many areas in western Wyoming; and may require decades of rest and management to reverse these trends.

The degraded condition of some subalpine and alpine areas in the West has been the result of uncontrolled grazing, mainly by domestic sheep, which occurred in the late 19th and early 20th centuries (Winward 1998, Belsky and Blumenthal 1997). Early grazing operations herded sheep in tightly grouped bands, continuously bedded them in the same location for several nights, and drove them to and from water. These practices reduced forage through trampling and overgrazing, especially near water, and damaged soil through excessive trailing and compaction. Alpine ranges are still grazed by domestic sheep, but in some instances the intensity is much lower.

Recreational livestock use (i.e., pack stock) can also have detrimental localized effects through soil compaction and overgrazing. Wild ungulates also graze alpine habitats, and overgrazing is not uncommon in localized areas.

Recreation –Moderate

Recreational activities such as camping, hiking, biking, horse-packing, and off-road travel can degrade mountain grasslands and alpine tundra. Recreationists may trample plants, compact the soil, increase soil erosion, and contribute to the establishment of invasive plant species. Human activities may also disturb animals, including birds, especially during breeding season (Nicholoff 2003). Recreational activities appear to be most detrimental when concentrated and repeated on the same ground, such as is found near trails, trailheads, and developed campsites, and they have less effect when dispersed. Road development in mountain landscapes brings more people, livestock, exotic plant species, generalized disturbance, and pollution into the ecosystem. Motorized vehicles, including ATVs and snowmobiles, can have significant impacts on wildlife and plant communities.

Current Mountain Grasslands and Alpine Tundra Conservation Initiatives

Land exchanges and purchases have occurred on some mountain grassland habitats in Wyoming to consolidate land and facilitate more efficient land management for both private landowners and public agencies, or to protect in-holdings or adjacent lands with high ecological and/or recreational value.

The Nature Conservancy (TNC) works in several areas of Wyoming where mountain grassland and alpine meadow landscapes are prevalent. The organization works with private landowners and public land managers to protect the integrity of these areas where important plant and animal alpine species are found. TNC has used conservation easements, land exchanges, and grazing and invasive plant management techniques to conserve high elevation landscapes and species, including the American pika and bighorn sheep, in the Absaroka, Bighorn, and Wind River Mountains.

As part of a larger effort to reduce invasive species, certified weed-free hay is required for livestock producers and recreational horseback riders using many federal lands, including National Parks and U.S. Forest Service lands. Early Detection and Rapid Response strategies to prevent the establishment of invasive species are being developed for both public and private lands.

Additionally, the PlayCleanGo campaign was initiated by Weed and Pest Districts across the state. The concept of cleaning gear, before and after recreating to prevent the spread of weed seeds has gained many partners across the state.

The Wyoming Natural Resources Conservation Service (NRCS) is working with the Wyoming Association of Conservation Districts (WACD) to use Light Detection and Ranging (LiDAR) technology to acquire statewide elevational data that will benefit Wyoming's natural resource managers. LiDAR has the potential to provide state resource managers with high resolution Digital Elevation Models (DEMs) that cover large areas with highly accurate data. This effort will have many positive implications for effectively modeling and monitoring state hydrology, vegetation, soil, and other surface features, which could be particularly useful as changing climate conditions alter high elevation landscapes.

NRCS, Bridger Teton National Forest and Wyoming Game and Fish Department have been collaborating to develop an Ecological Site Description for Tall Forb Communities (Loamy Vertic, 20"+ precipitation). This will include plant community phases, species lists, soils data, production tables, state and transitional models, and other climatic references to help managers make better decisions for this community in the future.

Recommended Mountain Grasslands and Alpine Tundra Conservation Actions

Grazing plans for mountain grasslands and alpine tundra should be developed and evaluated on a case-by-case basis to address specific site conditions.
Leaving 70–80% residual herbaceous for major species is recommended for alpine tundra grazing strategies (Nicholoff 2003). The fall date of removing livestock from alpine areas should be carefully monitored. Monitoring helps to avoid trampling damage to soil that has been moistened by snow, but is not yet solidly frozen; damage to preformed flower buds, which could influence plant growth the following growing season; and livestock losses to early fall snowstorms. Big game grazing impacts should be considered when setting herd population objective levels.

Appropriate grazing guidelines that will allow restoration of tall forb communities should be established. An initial attempt to establish grazing guidelines for tall forb communities through species composition of five key plant species and ground cover has been made (O'Brien et al. 2003). This work needs to be refined to include additional species and focus on species composition by occurrence versus canopy cover. Tall forb sites with low amounts of remnant species may restore themselves, providing grazing management is such that seedlings can be sustained. Where no remnant desirable species remain, artificial reintroduction of native forb species will be required (Winward 1998).

Use minimum impact fire suppression tactics in mountain grasslands and alpine tundra.
Although fire is an important successional influence in montane and subalpine elevations, it is not usually as influential as in the alpine zone. In general, alpine communities are usually too wet to burn, or the plants are too widely spaced to carry a fire. Wildfire management at montane and subalpine elevations, however, can have profound effects on non-forested habitat. Some fires should be allowed to burn unless they pose a significant risk to human lives or structures. When fighting fires the use of fire retardants, fire/dozer lines, and other tactics which may damage fragile vegetation and soils should be limited.

Create recreation plans for mountain grasslands habitats.
Consider potential disturbances to wildlife and plant communities when planning or locating trails, camping sites, picnic areas, and other sites of concentrated human activity within subalpine habitat and alpine tundra. In recreational use plans for alpine habitats, considerable attention should be given to the kinds of vegetation and soils present and their susceptibility to change and destruction. Buffer zones should be established between roads and recreational

facilities. Road networks in general are the main vector of disturbance into these habitats; thus, travel plans and road maintenance/retirement plans will figure largely in their future distribution and quality.

Rehabilitate degraded sites, including heavily-used recreation sites.
Where possible, restore disturbed sites to native plant communities. Revegetation minimizes erosion and associated reduced water quality and aids in reestablishing native plant communities. Seed mixes should reflect local plan diversity. Local seed stock is preferred and nonnative plants should be avoided. Revegetate alpine disturbances in the fall. Most high-elevation areas remain inaccessible in the spring until large snowdrifts melt. By the time access and site conditions are suitable, the optimum conditions for seed germination and seedling development may be passed (Nicholoff 2003). Fall revegetation ensures that seeds and amendments will be in place when conditions are ideal for germination the following spring as snowmelt occurs (Nicholoff 2003).

Mountain Grasslands and Alpine Tundra Monitoring Activities

Continue monitoring mountain grasslands and alpine tundra SGCN in order to detect population trends or changes in distribution that may reflect habitat problems.
Implement mountain grasslands and alpine tundra monitoring programs to establish baseline data and identify changes in habitat quality (both positive and negative) over time. This information should be used to guide future monitoring and research, as well as to identify and address habitat conservation needs. Important information gaps include the ability of montane SGCN to adjust to climate change, and whether modification in behavior and habitat use will allow SGCN to keep pace with changing conditions.

Continue to monitor the distribution and condition of mountain grasslands and alpine tundra through remote sensing and ground surveys.
Remote sensing is useful in tracking the size and distribution of this habitat in Wyoming. Information gathered would be helpful in determining the cumulative impacts of activities and events such as road and trail building, effects of adjacent forest fires and beetle outbreaks, and the possible effects of climate change.

Monitor the effects of individual grazing strategies in mountain grasslands and alpine tundra to check progress toward established objectives.
Record how key alpine plant species and the overall alpine tundra and mountain grassland ecosystems respond to grazing management (Nicholoff 2003). Collecting basic range analysis data is essential to be able to evaluate the effects of natural and human activities on habitat conditions over time. Annual photographs taken from the same point are helpful (Nicholoff 2003).

In cooperation with research entities and the Wyoming State Climatologist, monitor the effects of climate change.
Changing climate conditions, including warming temperatures and changing precipitation patterns, may cause observable impacts to high elevation and high latitude landscapes. These impacts will affect both the terrestrial and aquatic species that inhabit alpine tundra and montane grassland habitat. Efforts should be made to monitor changes in seasonal temperatures, temperature extremes, season length, precipitation variability, and snow pack.

Monitor the effects of human recreation on wildlife behavior and population dynamics and stability of alpine grassland habitat.

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Prairie Grasslands

Photo courtesy of WGFD

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Habitat Description

In Wyoming, prairie grasslands are typically below 7,000 feet in elevation and are predominantly located in the eastern portions of the state, although they are also common in basins of south central and southwestern portions of Wyoming. In eastern Wyoming, prairie grasslands have among the warmest and longest growing seasons of Wyoming's habitat types, as well as relatively deep and well developed soils. Their location in eastern Wyoming allows them to receive relatively high summer precipitation, ultimately derived from weather systems originating in the Gulf of Mexico which are blocked by the mountains from the basins of western Wyoming. These factors result in grasslands having high primary productivity when compared to other Wyoming habitat types.

Most of Wyoming's grasslands are classified as either shortgrass prairie or mixed-grass prairie. Shortgrass prairie occurs mainly in the southeast corner of the state and extends south into Colorado. Buffalo grass and blue grama are the two predominant grass species in shortgrass prairie. Mixed-grass prairie is common across much of eastern Wyoming. It typically receives more moisture and has greater plant species diversity than shortgrass prairie. Common mixed-grass prairie plant species include needle-and-thread, western wheatgrass, blue grama, Sandberg's bluegrass, prairie Junegrass, upland sedges, and Indian ricegrass (Knight 1994).

Grasslands are characterized by frequent and occasionally intense natural disturbances including drought, fire, grazing, and occasionally short growing seasons (Nicholoff 2003). These factors have encouraged the predominance of perennial grasses with a substantial number of sedges and herbaceous forbs. These types of plants have their buds at or just below the surface, making them less susceptible to damage by surface fire and grazing (Knight 1994). Historically, regular disturbances created patches of vegetation in various stages of recovery. The size and location of patches often shifted across the landscape through time resulting in a mosaic of habitat diversity (see Wyoming Leading Wildlife Conservation Challenges – Disruption of Historic Disturbance Regimes). In addition to disturbances, water availability, often related to the location of snow drifts, influenced the local composition of prairie plant communities.

Prior to European settlement, fires on the Great Plains occurred at intervals of approximately 2–25 years (Wright and Bailey 1980). Wyoming grasslands likely burned less frequently because they are more arid than the mesic grasslands of the Great Plains and thus did not accumulate fine fuels as quickly (Knight 1994).

Much of Wyoming's prairie grasslands are unsuitable for farming; however, the abundant grazing resource led to the establishment of cattle and sheep ranches. Today, the majority of Wyoming's prairie grasslands are incorporated within privately owned ranches. The predominance of large ranches and Wyoming's relatively low population density have allowed grasslands to persist in a relatively intact state when compared to other regions of the country. Properly managed, livestock grazing can duplicate the natural influences of native species like bison. The future of this habitat type in Wyoming will be closely tied to the ability of organizations to engage private landowners in conservation efforts and the persistence of ranching as an economically viable land use within the state. In addition to ranching, wildlife habitat, oil and gas extraction, wind power, recreation, and housing development are important land uses in the grasslands habitat type.

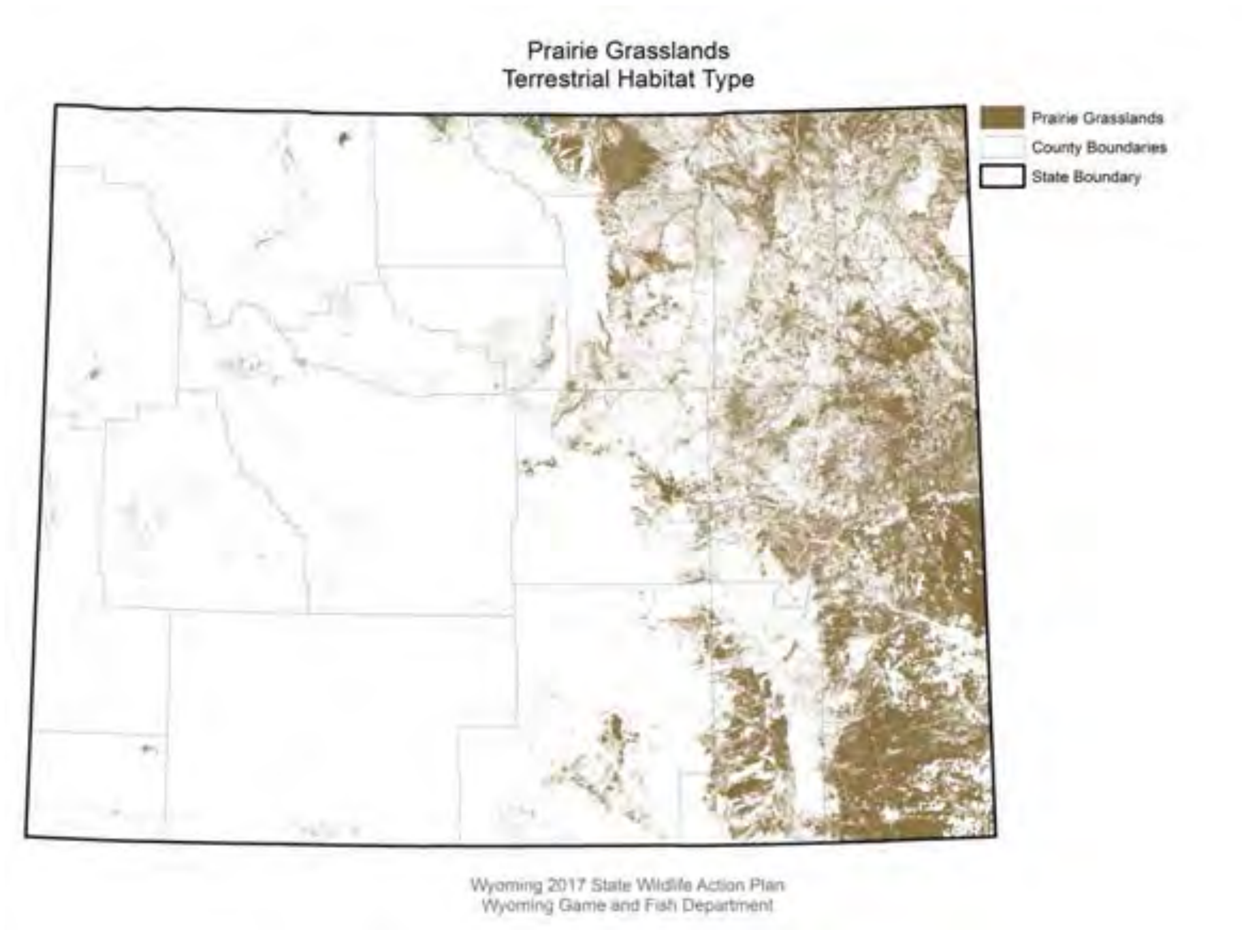


FIGURE 13. Wyoming Prairie Grasslands

TABLE 13. Wyoming Prairie Grasslands NatureServe Ecological Systems[1]

1. Inter-Mountain Basins Semi-Desert Grassland
2. Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland
3. Northwestern Great Plains Mixed-grass Prairie
4. Western Great Plains Foothill and Piedmont Grassland
5. Western Great Plains Sand Prairie
6. Western Great Plains Shortgrass Prairie
7. Introduced Upland Vegetation – Forbland
8. Introduced Upland Vegetation – Annual Grassland
9. Introduced Upland Vegetation – Perennial Grassland
10. Recently burned grassland

[1] Descriptions of NatureServe Ecological Systems which make up this habitat type can be found at: NatureServe Explorer: an online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, VA. http://www.natureserve.org/explorer.

TABLE 14. Wyoming Prairie Grasslands Species of Greatest Conservation Need

Mammals
Black-footed Ferret
Black-tailed Prairie Dog
Hispid Pocket Mouse
Olive-backed Pocket Mouse
Plains Harvest Mouse
Plains Pocket Mouse
Sand Hills Pocket Gopher
Silky Pocket Mouse
Spotted Ground Squirrel
Swift Fox
White-tailed Prairie Dog

Birds
Baird's Sparrow
Bobolink
Burrowing Owl
Chestnut-collared Longspur
Dickcissel
Ferruginous Hawk
Grasshopper Sparrow
Long-billed Curlew
McCown's Longspur
Mountain Plover
Short-eared Owl
Swainson's Hawk
Upland Sandpiper

Reptiles
Great Plains Earless Lizard
Greater Short-horned Lizard
Northern Many-lined Skink
Ornate Box Turtle
Plains Black-headed Snake
Plains Hog-nosed Snake
Prairie Lizard
Prairie Racerunner

Amphibians
Great Plains Spadefoot
Great Plains Toad
Plains Spadefoot

Prairie Grasslands Wildlife

Grasslands are known to support large numbers of wildlife. They are sometimes described as grazer systems, because photosynthesis entrains solar energy into grass, which is digestible by a wide range of animals. In contrast, forests are sometimes described as decomposer systems, where solar energy is directed towards wood production, which is digestible only by specialized fungi, microbes, and insects.

Historically, a number of animal species had a significant influence on shaping the plant and animal composition of prairie grassland habitats. Estimated bison numbers prior to European settlement vary considerably, from 15–20 million (Cushman and Jones 1988, Shaw 1995) to 30–60 million (Samson et. al 1996). Certainly, large numbers of bison altered grasslands by grazing some areas intensively, which contributed to patches of open habitat and reduced encroachment by trees.

Prairie dogs, often thriving in areas recently grazed by bison, lived in large colonies, digging burrows and cropping vegetation. These burrows and the open patches of ground resulting from the colonies create habitat for other wildlife species, including the black-footed ferret, burrowing owls, long-tailed weasel, mountain plover, and swift fox (Kotliar et al. 1999, Kotliar 2000). Prairie dogs also provide a prey base for carnivores including black-footed ferrets, ferruginous hawks, and golden eagles.

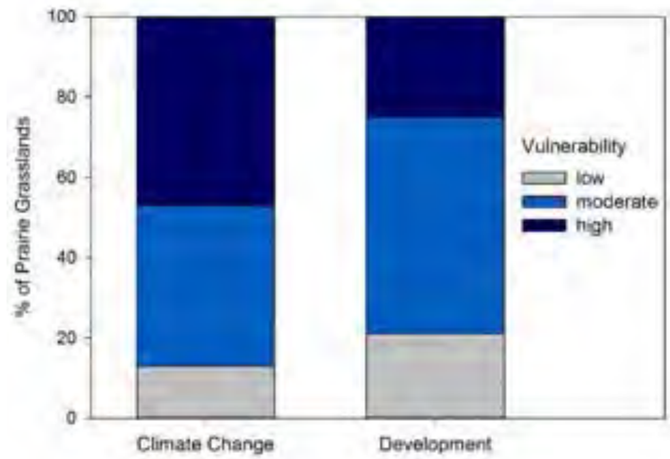
Burrowing mammals, such as prairie dogs, increase the structural diversity of grassland habitats by providing subterranean cover from the elements. Soil burrows are warmer in winter, cooler in summer, more humid year-round, and essentially windless compared to the ground surface. This burrowing activity is parallel to the function that primary cavity excavators such as woodpeckers provide in forest habitats. Most Wyoming prairie grasslands have a strong shrub component in addition to grasses. Shrubs also contribute to the structural diversity of prairie grasslands habitat by providing sites for perches, snow-capture structures, wind breaks, nest cover, and an additional forage base for ungulates. Key habitat components, such as high structural diversity of grasslands, high diversity of invertebrates, and diversity of seed crops, will increase the value of these habitats for these mammals, especially pocket mice.

Prairie grasslands are home to some of Wyoming's best known wildlife species including the pronghorn and the western meadowlark, Wyoming's state bird. Prairie sharp-tailed grouse are a popular game species found in grasslands. Many birds such as rough-legged hawk, hoary redpoll, Lapland longspur, snow bunting, and even the occasional snowy owls and gyrfalcons, which breed in the Arctic or boreal Canada, winter on Wyoming grasslands. Prior to European settlement, elk were commonly found in prairie grasslands, but then retreated to more mountainous habitats with human encroachment. In some areas of Wyoming this trend is now reversing.

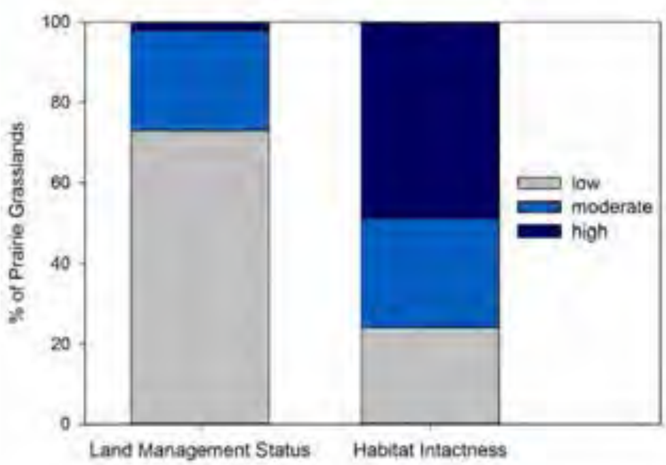
Wyoming once represented the western periphery of many species' continental ranges (e.g., mountain plover, swift fox, ferruginous hawk, and pronghorn). Intensive conversion of grassland in the Great Plains resulted in the loss of these habitats outside of Wyoming. Consequently, populations in Wyoming have remained largely intact, and the core of these species' distributions is now considered to be in Wyoming.

Prairie Grasslands Habitat Threats

Figure 14. Prairie Grasslands Vulnerability Analysis



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high vulnerability to climate change or development, based on classification of scores ranging from 0 to 1 into the following categories: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for climate change or development vulnerability were based on the land area of the habitat type classified as having high vulnerability: low (<10%), moderate (10-33%), or high (>33%). Vulnerability was calculated as exposure minus resilience. Development vulnerability includes existing and projected residential, oil and gas, and wind energy development. Further details are provided in the Leading Challenges section of this report and in Pocewicz et al. (2014).



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high land management status or habitat intactness. For land management status, high corresponds to the percent of the habitat occurring in GAP status 1 or 2, moderate to the percent occurring in GAP status 2b or 3, and low to the percent occurring in GAP status 4. Rankings for land management status were based on the land area of the habitat type classified as having high status or legal protection: low (<10%), moderate (10-33%), or high (>33%). For habitat intactness, scores ranging from 0 to 1 were assigned to categories as follows: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for intactness were based on the land area of the habitat type classified as having high intactness: low (<25%), moderate (25-75%), or high (>75%).

Energy development – High
Coal mining, oil, natural gas, and wind are common forms of energy development in Wyoming grasslands (see Wyoming Leading Wildlife Conservation Challenges – Energy Development). Wyoming is the nation's leading producer of coal (National Mining Association 2008). About 96% of Wyoming's coal originates in northeastern Wyoming[2] where grasslands predominate (Lyman and Jones 2005). Wyoming is also ranked fifth in natural gas production, eighth in crude oil production (Lawrence 2007), and, after factoring in land status and environmental constraints, seventh in wind-power generating potential (Elliott et al. 1991).

Based on a recent compendium of public land statistics, 175,980 acres of public lands are currently leased for coal extraction, and oil and gas leases total more than 8.8 million acres in Wyoming (BLM 2008).

Energy development in grasslands results in direct removal of native vegetation and habitat fragmentation through road building, well pad drilling, power line construction, buried pipelines, booster stations, and facility buildings. In addition to habitat loss and fragmentation, wildlife is impacted by increased traffic, human activity, and noise. Broken or bare ground and greater vehicle traffic associated with the construction and production phases of energy development can also contribute to the spread of invasive plant species.

Wind-energy development is a growing industry in Wyoming and will likely affect significant acreage in the near future. Wind development, individually and cumulatively, can impact food, cover, and special habitat needs for native grassland species. The location of sage-grouse core areas (see Terrestrial Habitat Types – Sagebrush Shrublands – Current Sagebrush Shrublands Conservation Initiatives) and the state strategy to place wind development east and north of I-25 have increased wind development pressures on portions of the state occupied by grasslands.

Little research has been conducted to quantify wind-energy development impacts on grasslands wildlife species. Bird and bat strikes are commonly known to occur in wind-energy facilities, but the behavioral responses and resulting population performance are largely unknown for species such as pronghorn and sage-grouse that preferentially inhabit open landscapes, area-sensitive species such as the grasshopper sparrow, dickcissel, and bobolink, and species that perform aerial displays during courtship such as the long-billed curlew, upland sandpiper, chestnut-collared longspur, and McCown's longspur. Some researchers have proposed similar impacts on wildlife from wind-energy infrastructure and associated human activity as those documented for oil and gas development (Becker et al. 2009).

Invasive plant species – High
Noxious and invasive plants can spread aggressively and dominate plant communities (see Wyoming Leading Wildlife Conservation Challenges – Invasive Species). This can reduce native plant diversity, which in turn decreases food and cover for wildlife.

Cheatgrass, the most prevalent invasive plant species in Wyoming's prairie grasslands, is an annual brome from Eurasia whose abundance has dramatically increased in the Intermountain West over the last several decades. Cheatgrass rapidly expands in areas with bare ground and soil disturbance (Mack 1981, Bradford and Lauenroth 2006). These conditions can be facilitated by drought, overgrazing, and road development. Cheatgrass dominance eventually creates uniform annual grasslands perpetuated by large, frequent fires and void of patches of native plant communities (Paige and Ritter 1999).

Notable invasive forb species include Dalmatian toadflax, Canada thistle, leafy spurge, Russian knapweed, spotted knapweed, kochia, and Russian thistle. Canada thistle, which is typically found in riparian areas, is the most widespread

[2] Campbell, Converse, and Sheridan Counties.

weed in Wyoming grasslands. Leafy spurge is an important weed because it is easily spread and difficult to eliminate. It is found on tens of thousands of acres statewide, covering the most acreage in Weston, Johnson, Crook, Sheridan, Lincoln, and Fremont counties (Wyoming Pest Detection Program 2009). Although leafy spurge has generally proliferated across the state in recent years and continues to increase in some counties, it is starting to decline in some counties, namely Lincoln, Park, Sheridan, Johnson, Converse, Crook, and Weston counties. Russian knapweed is present throughout Wyoming, covering the most acreage in Fremont, Park, Big Horn, Hot Springs, Washakie, and Weston counties (Wyoming Pest Detection Program 2009). The occurrence of Russian knapweed has generally been increasing across the state, but in recent years has remained static or even declined in some counties. Spotted knapweed is not as concentrated in Wyoming as leafy spurge or Russian knapweed, but has been steadily increasing in some counties and is now found throughout the state. This weed is reportedly declining, or has been eradicated, or nearly eradicated in a few places (Wyoming Pest Detection Program 2009). Spotted knapweed currently covers the most acres in Teton and Park counties.

Continued construction from energy and rural development, increased interstate travel, and potentially shifting weather conditions associated with climate change are likely to intensify the spread of invasive plants species. Additionally, while there are some effective treatment methods, particularly in grasslands with a predominance of alkaline and sodic soils, the re-establishment of native plant species can be difficult.

Off-road vehicle use – Moderate/Locally High

Off-road vehicle use, primarily by all-terrain vehicles (ATVs), is increasing in grassland habitats. Vehicle use off established roads can enhance the spread of invasive species including halogeton, alyssum, pepperweed, and cheatgrass. Tires can damage biological soil crusts leading to decreased organism diversity, soil nutrients, stability, and organic matter. This can result in greater erosion and reduced water quality. Wildlife often avoid areas of increased noise and disturbance from outdoor recreational vehicles, and riding off-road can destroy the nests, eggs, and young of ground-nesting birds. These impacts can also lead to conflicts with hunting, wildlife viewing, and other forms of nature-based recreation. Managing off-road vehicle use can be difficult and controversial in grassland habitats where new trails are relatively easy to create and where some off-road vehicle users place less importance on what appears to be an endless, open landscape.

Reduced vegetation structure and species diversity due to altered disturbance regimes – Moderate

Prior to European settlement, frequent fires, shifting grazing patterns by bison and other large ungulates, and extensive prairie dog colonies created grasslands with more diversity in plant structure and composition than exists today (see Wyoming Leading Wildlife Conservation Challenges – Disruption of Historic Disturbance Regimes). Most current livestock management practices emphasize the even distribution of livestock across the landscape. This strategy leads to uniform grazing intensities, which has pros and cons to habitat management, and may further contribute to grasslands with reduced habitat diversity. Reduced diversity diminishes habitat for some grassland wildlife species, particularly those which require either early or late successional stages following habitat disturbances. Other grassland habitats are negatively impacted by continuous heavy grazing, commonly associated with excessive livestock numbers, which can reduce residual plant cover needed by many wildlife species for nesting and avoiding predators.

Drought and climate change – Moderate

Drought can reduce plant vigor, decrease the abundance of cool and warm season grasses, and increase non-native plants, especially cheatgrass (Smith and Enloe 2006). Drought can also lead to outbreaks of grasshoppers and

Mormon crickets, which can further diminish the amount of available forage for wildlife and livestock.

During drought times, livestock producers are often faced with either reducing stocking rates by selling livestock or continuing to graze at the current levels, hoping that moisture will improve. Postponing decreasing stocking rates for one season often results in little damage; however, repeated use of this option can significantly reduce the health of grasslands.

While the development of livestock drought management plans will not eliminate all issues associated with drought, well developed plans can diminish negative ecological impacts for the habitat and financial impacts for the producer. At least several months' lead time is needed for land managers to respond in making preparations for drought.

Wyoming's climate is naturally semi-arid, and drought is a natural and historical feature of the state's climate. However, some climate models that project future climate conditions suggest that Wyoming's climate will become even drier as a result of warming seasonal temperatures leading to increased evaporation of surface waters and increased water loss from plants during transpiration. Warming trends have been documented in the Northern Great Plains region, while annual precipitation has been documented as decreasing in eastern Wyoming (Joyce et al. 2000). Climate patterns in the West are naturally variable, but continued warming of seasonal temperatures will likely lead to decreased soil moisture regardless of changes in precipitation (Joyce et al. 2000). For grasslands, decreasing soil moisture might mean the loss of some native species whose current growth is limited by annual precipitation and the establishment of new vegetative communities that may favor more tolerant invasive species. Changes in the structural diversity of Wyoming's grasslands may impact grazing practices and also impact disturbance regimes, such as the frequency and severity of wildfire. The alteration of prairie grasslands will also have direct implications for grassland obligate species (see Wyoming Leading Wildlife Conservation Challenges – Climate Change).

Rural subdivision and development – Moderate

Rural subdivision and development can reduce, degrade, and fragment grassland habitat (see Wyoming Leading Wildlife Conservation Challenges – Rural Subdivision and Development). Houses, outbuildings, and lawns directly replace native wildlife habitat. Wildlife commonly abandons or alters use of habitats with greater human and pet activity. Increased energy expenditures in avoiding people or greater use of lower quality habitats can decrease animal health and reproductive capacity. Greater road densities and traffic volume can increase wildlife–vehicle collisions. Predation on wildlife can increase with greater numbers of domestic dogs and cats, as well as increases in generalist predatory species such as ravens and human-commensal species such as raccoons (U.S. Department of Agriculture 2007). Soil disturbance from construction, year-round grazing of horses and other hobby livestock, and the use of non-native plants as ornamentals can facilitate the establishment of invasive species (Maestas et al. 2002). Subdivision and housing development is a greater problem for grasslands habitats near Wyoming's larger towns and cities such as Cheyenne, Glenrock, Douglas, Gillette, and Sheridan.

Conversion to agriculture – Low

Approximately 5% of Wyoming's land area is in agricultural production (Census of Agriculture 2007). Dryland agriculture accounts for just under half of all agricultural activities, while irrigated farming constitutes the remainder. In addition to lands currently being farmed, there have been numerous unsuccessful attempts over the years to bring grasslands into agricultural production. Very few of these failed attempts have returned to native conditions.

Reduced plant diversity associated with farmland, as well as previously cultivated fields, supports a lower variety of wildlife than is found in native habitats (Knopf 1994). In addition to reductions in habitat and habitat quality, some farming and haying practices, especially during the nesting season, can lower the reproductive success of grassland birds (Dale et al. 1997, Dechant et al. 2002).

Conversely, some wildlife species have adapted to use agricultural fields during various phases of their life cycle. Sub-irrigated native hay fields provide valuable nesting habitat for many wetland birds such as Wilson's phalarope, or grassland birds such as the long-billed curlew. This is especially true for fields that have not been leveled and are not under intensive management with machinery and chemical treatments. Pronghorn and mule deer use these areas during certain times of the year too. Dryland cultivated fields with low vegetation and little topographical variation can provide nesting habitat for the mountain plover in parts of its range (Knopf 1994).

United States Department of Agriculture (USDA) Farm Bill programs, such as the Conservation Reserve Program (CRP)[3], has provided incentives for planting farmland back into permanent cover. Wyoming has approximately 190,000 acres enrolled in CRP, with the vast majority occurring in the southeast Wyoming counties of Goshen, Laramie and Platte. In addition to the acreage enrolled under the general CRP sign-ups, there are several hundred acres that have been enrolled under the Continuous CRP, which targets smaller, environmentally sensitive areas, such as those found along Wyoming's riparian zones Natural Resources Conservation Service - Wyoming While this has benefited many grasslands species of wildlife, the heavy use of non-native grasses, including bromes and tame wheatgrasses, along with the lack of forb species in reseeding mixes, have reduced the wildlife value of some CRP lands. Additionally, the fate of many CRP lands whose contracts are set to expire is uncertain.

Improper use of pesticides and herbicides – Low

The over-application of herbicides, such as Tordon for cactus control and 2, 4-D for sagebrush control, can result in a loss of perennial forbs, which reduces plant and associated wildlife diversity. Pesticide used to control prairie dogs, grasshoppers, and Mormon crickets can reduce prey availability for grassland birds such as the mountain plover and small mammals such as the swift fox and black-footed ferret as well as diminish important habitat created by prairie dogs that is used by numerous wildlife species.

[3] CRP was authorized by the 1985 Farm Bill as a voluntary, long-term cropland retirement program with a soil conservation orientation. The USDA pays producers an annual rental payment plus half the cost of establishing a conserving land cover in exchange for retiring highly erodible or other environmentally sensitive lands from crop production. Ninety-three percent of CRP land is planted to grass or trees under 10-year contracts.

Current Prairie Grasslands Conservation Initiatives

The Wyoming Game and Fish Department (WGFD) published *A Plan for Bird and Mammal Species of Greatest Conservation Need in Eastern Wyoming* in 2006. The overarching goal of this plan is to formalize proactive strategies that will help the WGFD work cooperatively with landowners, other agencies, and the public to address conservation needs of Wyoming's grassland and associated wildlife. The plan reviews the ecology, land uses, and threats to Wyoming's grasslands. Recommendations are presented to conserve Wyoming grasslands including information on the life histories, threats, conservation actions, and monitoring strategies for 22 grassland species designated as Species of Greatest Conservation Need (SGCN) in Wyoming's 2005 Comprehensive Wildlife Conservation Strategy (the previous name of Wyoming's SWAP).

A number of USDA Farm Bill Programs have targeted, or secondarily provide benefit to, grasslands habitats and wildlife species. The most notable programs include the Conservation Reserve Program (CRP), the Environmental Quality Incentive Program (EQIP), and Agricultural Conservation Easement Program. Grasslands were identified as one of six priority habitats to enhance or maintain within the WGFD's Strategic Habitat Plan (SHP). First created in 2001 and revised in 2009 and 2015, the purpose of the SHP is to strategically guide WGFD habitat improvement and protection activities. Regional priority areas for conservation work are identified, including crucial areas, necessary for maintaining terrestrial and aquatic wildlife populations, and enhancement areas, where there is the potential to enhance or improve important wildlife habitats that have been degraded. Narratives for both crucial and enhancement areas describing the location, boundaries, values, issues, species, and solutions/actions were prepared (https://wgfd.wyo.gov/Habitat/Habitat-Priority-Areas/Statewide-Maps).

A number of wildlife agency programs focus on implementing projects and management plans with private landowners to benefit wildlife. These include technical and financial assistance from WGFD's Terrestrial and Aquatic personnel, Public Lands/Private Wildlife Program, as well as the U.S. Fish and Wildlife Service Partners for Fish and Wildlife Program. These programs often form partnerships with local communities and other conservation organizations in accomplishing their mission. Grasslands habitat enhancements commonly include the development of grazing systems that benefit wildlife and livestock. Payments to offset management costs, invasive plant treatments, water developments, fencing, and cattle guards are among incentives used to encourage participation from landowners.

Landscape Conservation Cooperatives (LCCs) have been established by the U.S. Fish and Wildlife Service to provide science support to enhance conservation actions in the face of climate change and other regionally shared conservation priorities. Wyoming includes portions of five LCCs. The Plains and Prairie Potholes and Northern Great Plains Landscape Conservation Cooperative encompass significant amounts of Wyoming's grasslands and have the conservation of grasslands and grassland species among their principal focuses.

Among the most notable partnerships between landowners, natural resource agencies, and non-profit organizations is the Thunder Basin Grasslands Prairie Ecosystem Association. The Association was established in 1999 as a landowner-driven effort to develop an ecosystem management plan for species of concern while balancing these needs with sustainable economic and social activities. Members in the association include private property owners within a designated 931,192-acre landscape in eastern Wyoming. Areas of interest include management activities related to ranching, coal, coal-bed methane, oil, and gas production.

The Shirley Basin-Laramie Rivers Conservation Action Plan (CAP) was completed in 2008 by The Nature Conservancy in cooperation with the Medicine Bow and Laramie Rivers Conservation Districts. The plan describes important species and habitats in the area, threats to their persistence, and strategies and actions to abate those threats. Participants included local ranchers and individuals representing the WGFD, U.S. Fish and Wildlife Service, Albany and Carbon County Weed and Pest, County Commissioners, Audubon Wyoming, Trout Unlimited, Wyoming Natural Diversity Database, Sonoran Institute, Natural Resources Conservation Service (NRCS), BLM Rawlins Field Office, University of Wyoming Cooperative Extension Service, and the Shirley Basin-Bates Hole Sage-Grouse Working Group.

A number of land trusts in Wyoming including the Jackson Hole Land Trust, The Nature Conservancy, and the Wyoming Stock Growers Agricultural Land Trusts are actively involved in negotiating conservation easements on grassland habitats.

Recommended Prairie Grasslands Conservation Actions

Improve planning and mitigation design for wind and other types of energy development.

Coal, oil, natural gas, and wind development are likely to intensify on Wyoming grasslands. Landscape level planning and mitigation is needed to offset the potential cumulative negative impacts from these activities. Mitigation plans should stress avoiding biologically sensitive areas within project sites and directing off-site mitigation funds to nearby high value wildlife locations. Energy development planning and mitigation efforts could specifically benefit from:

- Continued research on the effects of energy development on prairie grasslands wildlife species and ecosystems. In 2014, the Wyoming Natural Diversity Database and Wyoming Cooperative Research Unit completed research evaluating the vulnerability of Wyoming terrestrial SGCN to oil, gas, and wind development. Vulnerability was investigated by evaluating each species' potential exposure and sensitivity to energy development. Exposure was evaluated through a GIS analysis that overlays distribution maps of SGCN with areas of known and projected energy development. Sensitivity was determined by examining habitat and behavioral attributes of SGCN as well as reviewing existing impact studies. Research results give an indication of which species and taxonomic groups are potentially vulnerable to development, as well as helps to direct future research to address information gaps. The project was jointly funded by the U. S. Geological Survey, Wyoming Landscape Conservation Initiative (WLCI), and WGFD, and can be found at:: http://www.nature.org/media/wyoming/wyoming-wildlife-vulnerability-assessment-June-2014.pdf.
- Use spatially-explicit grassland habitat priority areas such as those found within the SHP to help guide energy planning and mitigation activities. This work should include continued inventory of grassland habitats for SGCN.
- Where appropriate, encourage the implementation of mitigation measures and/or best management practices detailed within the Wyoming Game and Fish Commission documents *Recommendations for Development of Oil and Gas Resources Within Important Wildlife Habitats* (WGFD 2010a) and *Wildlife Protection Recommendations for Wind Energy Development in Wyoming* (WGFD 2010b).
- Reviewing management actions proposed by state and federal agencies involving grassland systems, and working closely with the Wyoming Governor's Office, industry, private land owners, and agency staff during the early stages of energy development project plans.

Support efforts to reduce the spread and establishment of invasive plant species.
The spread of invasive plant species can be reduced by improving mitigation and restoration of disturbed sites associated with construction including roads, well pads, pipelines, and windmill towers. The establishment of livestock grazing and drought contingency plans also helps to reduce the spread of invasive species. Weed management programs, including those targeting rural acreage owners, can be promoted through local County Weed and Pest Control Districts. Some counties already have local spray days where the public can obtain chemicals and equipment for treating weeds at little to no cost. In areas of recent invasion, cooperative efforts to control cheatgrass through herbicide application, re-seeding, and livestock grazing management should continue.

Create new and more incentives for landowners to incorporate multiple natural disturbances into grasslands management plans.
Most of Wyoming's grasslands have traditionally been managed for sustainable livestock production. Today, increasing interest is being placed on coordinating livestock production with other services provided by grasslands including wildlife diversity, carbon sequestration, water quality and quantity, and aesthetics. Meeting these goals requires a diverse suite of grassland habitats with a range of vegetation structure and composition (heterogeneity). This can be achieved by incorporating multiple disturbances into land management plans such as grazing with fire, grazing with prairie dogs, and grazing and selective brush management. This approach uses livestock grazing as a tool to create desired habitat conditions in addition to a method of food production. Increasing vegetation heterogeneity provides the needed habitat complexity for a diverse array of wildlife species as well as land uses. Voluntary financial incentives may also be required to encourage retaining more residual plant cover for wildlife or supporting sufficient acres of prairie dogs to facilitate sensitive species recovery efforts.

Provide incentives, planning, and technological improvements to increase flexibility in grazing plans, including stocking rates.
Range conditions can be improved by developing and increasing awareness about forage reserve options. Options include, but are not limited to, assisting livestock operators with moving grazing to other areas during times when habitat improvement projects are being implemented or when areas are affected by wildfires, droughts, or other natural events. These measures can reduce habitat damage through overuse and speed the recovery of grasslands after natural or human disturbances. Grassbanks, where access to grazing land is provided in exchange for conservation actions on another property, are an example of a forage reserve strategy that has been used successfully.

Included in this recommendation is the development of proactive, adaptive drought management plans. This will require improvements in the accuracy of drought forecasts and greater technical assistance to support the implementation of drought management plans. More incentives should be placed on rewarding land managers for effective drought management as opposed to solely relying on drought disaster declarations.

On a landscape scale, grazing should be used as a tool to achieve a variety of grassland cover and height conditions to benefit wildlife species with different needs. For example, mountain plovers, burrowing owls, and McCown's longspurs require short vegetation and open ground, while upland sandpipers, grasshopper sparrows, and chestnut-collared longspurs require grasslands in a climax successional stage.

Encourage grasslands conservation partnerships among natural resource agencies and non-profit conservation organizations.
The vast majority of Wyoming grasslands are under private ownership. This necessitates the ability to work effectively with private landowners as an essential element of any effective grassland conservation strategy. There

are numerous USDA Farm Bill programs that can be applied to grassland conservation efforts (see Current Grasslands Conservation Initiatives in Wyoming). Partnerships with the USDA, NRCS, Farm Service Agency, and conservation districts help to ensure the benefits of these programs are maximized for grasslands wildlife.

Additionally, Farm Bill grassland conservation projects are often established and administered by non-profit conservation organizations such as Ducks Unlimited, The Nature Conservancy, or Wyoming Stock Growers Agricultural Land Trust. These organizations are often very experienced in utilizing these programs and working with private landowners. Furthermore, the development of partnerships often increases the likelihood of grants being awarded and allows resources to be pooled to increase the size of projects and their chances for success.

Particular actions that have been identified to facilitate partnerships and focus grassland conservation activities include:

- Improve communications between private landowners, conservation districts, the WGFD, NRCS, and private conservation organizations to ensure all available Farm Bill programs are being utilized and that agricultural practices recommended under programs reflect the most current knowledge of those that benefit wildlife. Regular partnership meetings, and active participation in Wyoming's NRCS Technical Committee, could help to advance this goal.
- Increase active management of CRP lands including incorporating fire, grazing, disking to promote the health and diversity of plant communities. CRP reseeding mixes should include native grasses and forbs. In order to meet habitat needs of specific SGCN or where native species cannot be established, diverse mixes that include well researched nonnative species should also be considered, as well as consideration for the suitability of vegetation under future climate conditions. Contracts should be renewed and new incentives provided to prevent the conversion of CRP lands back to cropland after existing contracts expire.

A variety of entities have been successful in mediating conflicts when differences in grassland management perceptions occur. These include the Wyoming Agricultural and Natural Resource Mediation Program, University of Wyoming Cooperative Extension program, conservation districts, and local Coordinated Resource Management teams.

Pursue conservation easements on high-wildlife-value grasslands with willing landowners.
Most of Wyoming's prairie grasslands habitat type is found on private land. Conservation easements along with long-term stewardship plans are one of the most effective and long-term methods of limiting environmentally destructive development and management activities on private lands while retaining ranching, outdoor recreation, and other compatible land uses.

Enhance educational opportunities for landowners, managers, and the public relative to grassland wildlife, ecology, and management techniques.
Efforts should be made to increase educational opportunities for land managers to learn about managing grasslands for a diversity of values including but not limited to livestock productions. Educational efforts for small acreage owners should be increased through workshops, programs, and training.

Prairie Grasslands Monitoring Activities

Monitor all forms of energy development to identify and avoid potential individual and cumulative impacts and enhance future planning and mitigation.
Given a lack of existing research and the speed of wind development in Wyoming, emphasis should be placed on additional research and monitoring about its potential impacts on

wildlife (see Wyoming Leading Wildlife Conservation Challenges – Energy Development).

Continue monitoring prairie grasslands SGCN in order to detect population trends or changes in distribution that may reflect habitat problems. This information should be used to guide future monitoring and research.

Monitor the landscape distribution and habitat intactness of prairie grasslands through remote sensing.
Remote sensing is useful in tracking the size, distribution, and fragmentation level of this habitat in Wyoming. Information gathered would be helpful in determining the cumulative impacts of activities and events such as insect outbreaks, energy development, rural subdivision, and the spread of invasive species. This technique may require the further development of monitoring protocols and identification of sample sites.

In cooperation with research entities, monitor the effects of climate change, including extended periods of drought.
Research should be conducted on the potential effects of climate change on native and nonnative prairie plants and their composition. Prairie grasses, shrubs, and invasive weedy species may have different responses to changing levels of atmospheric carbon dioxide. Additionally, decreasing soil moisture resulting from increasing temperatures may also impact the current structure of prairie grasslands.

Increase monitoring of multiple ecological outcomes of habitat disturbances and treatments and how these interact with one another.
Research on natural and human-caused habitat disturbances and treatments should be enhanced and an effort made to understand how historic disturbance regimes interact with human activities, such as residential and energy development.

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Riparian Areas

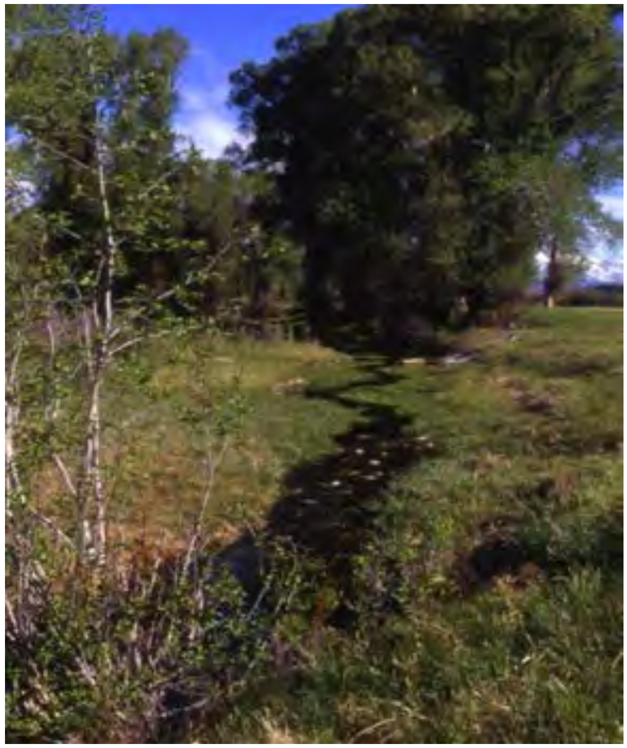

Photo courtesy of WGFD

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Habitat Description

Riparian areas are lands immediately adjacent to creeks, streams, and rivers. They are the interface between aquatic ecosystems and terrestrial ecosystems. Functionally, they are bounded on their outer edge by the limits of flooding and at their upper edge by the extent of the canopy vegetation (Swanson et al. 1982). While riparian definitions can be extensive and complex (e.g., Karr and Schlosser 1978, Cowardin et al. 1979), the riparian area is simply the distinct ribbon of green demarcating streams from uplands across much of the West. They are vital zones of ecosystem processes that provide linkages across landscapes, supporting diverse plant and animal communities (Gregory et al. 1991). The importance of riparian habitat to wildlife far exceeds its abundance. Less than 2% of the surface area of Wyoming, Nevada, and Montana consists of wetland and riparian systems, yet a majority of species depend upon them (McKinstry et al. 2004).

The identification, classification, and management of riparian zones received increasing attention in the 1980s and 1990s, and numerous workshops, conferences, and symposia were devoted to the topic (e.g., Johnson et al. 1985). Federal agencies formed interdisciplinary work groups to develop consistent approaches for classifying riparian areas (Gebhardt et al. 1990). For example, the Ecological Site Inventory was developed to classify riparian areas (Leonard et al. 1992), and the practice of assessing Proper Functioning Condition (PFC) followed (Prichard et al. 1998). Today, an extensive body of literature describes the ecological functions and habitat values of riparian areas (Naiman et al. 2005).

A habitat map produced for the Wyoming Gap Analysis program indicates that riparian areas cover approximately 1.2% of Wyoming (Merrill et al. 1996). In this State Wildlife Action Plan (SWAP), the eight NatureServe Ecological Systems comprising the riparian habitat type are listed in Table 15 and are fully described online (http://www.natureserve.org/explorer) (NatureServe 2009). These are diverse systems represented by well over 100 different community associations. The riparian habitat type is a sub-component of the broader wetland habitat type (i.e., wet meadows, prairie potholes, bogs, seeps, flood-irrigated fields, and the vegetative shoreline of lakes and other types of open water). Wetlands and their associated species assemblages, threats, and conservation actions are covered in a separate habitat chapter of this SWAP and in Copeland et al. (2010).

The eight NatureServe (2009) riparian ecological systems in Wyoming can be broadly segregated into mountain and lowland habitats. Mountain riparian habitats vary considerably from those found in lowlands because of steeper stream gradients, cooler temperatures, and less soil deposition (Knight 1994), with the exception of mountain areas where the topography flattens into broad meadows. Mountain riparian vegetation is often characterized by sedges and short willow shrublands (Winward 2000). As elevation decreases, alder and tall willows become common, together with Engelmann spruce, narrowleaf cottonwood, lodgepole pine, and aspen, and occasionally blue spruce and balsam poplar (Knight 1994).

Lowland riparian areas in the West are often characterized by narrow bands of trees and shrubs surrounded by uplands of vegetation of lower stature (Knopf et al. 1988, Montgomery 1996). Historically, cottonwoods have been the dominant lowland riparian tree species (Braatne et al. 1996). For seedling establishment, cottonwoods must receive full sunlight and be free from competing vegetation (Rood and Mahoney 1990, Friedman et al. 1997). Such sites often occur along river and stream banks after high spring flows that deposit or expose alluvial soils (Friedman et al. 1997). Boxelder, lanceleaf cottonwood, peachwood willow, and occasionally American elm are also common riparian tree species, particularly in eastern Wyoming (Jones and Walford 1995). Understory shrubs include chokecherry, hawthorn, rubber rabbitbrush, silver buffalo berry, silver sagebrush, skunkbush sumac, wild rose, and various species of willow (Knight 1994).

Riparian areas provide critical ecological functions (Gregory et al. 1991, Annear et al. 2004). Healthy riparian areas buffer water loss from upland drainages and recharge aquifers. The dense, diverse, and complex vegetation of healthy riparian areas filter chemical and organic wastes, trap sediment, build and maintain stream banks, reduce soil erosion, and moderate stream temperatures. The vegetation offers high quality foraging and nesting habitat, creates movement corridors for wildlife, and provides niches to a multitude of species. Riparian plant communities provide direct and indirect organic inputs to support stream ecosystems (Vannote et al. 1980), and terrestrial invertebrate inputs are often a key component of stream food webs (Saunders and Fausch 2006). Woody debris contributions from riparian areas to streams can provide habitats for fish and invertebrates and influence stream channel stability and dynamics.

Riparian areas are among the habitat types most used and altered through human activity and development. Wildlife abundance, water availability, vegetation diversity, soil productivity, and an often gentle topography attracted both Native Americans and early Europeans settlers to riparian zones. Today, accordingly, a high percentage of riparian areas are privately owned. In addition, riparian areas are used for agriculture, recreation, travel, water development, and housing. Most communities in Wyoming occur in conjunction with riparian zones.

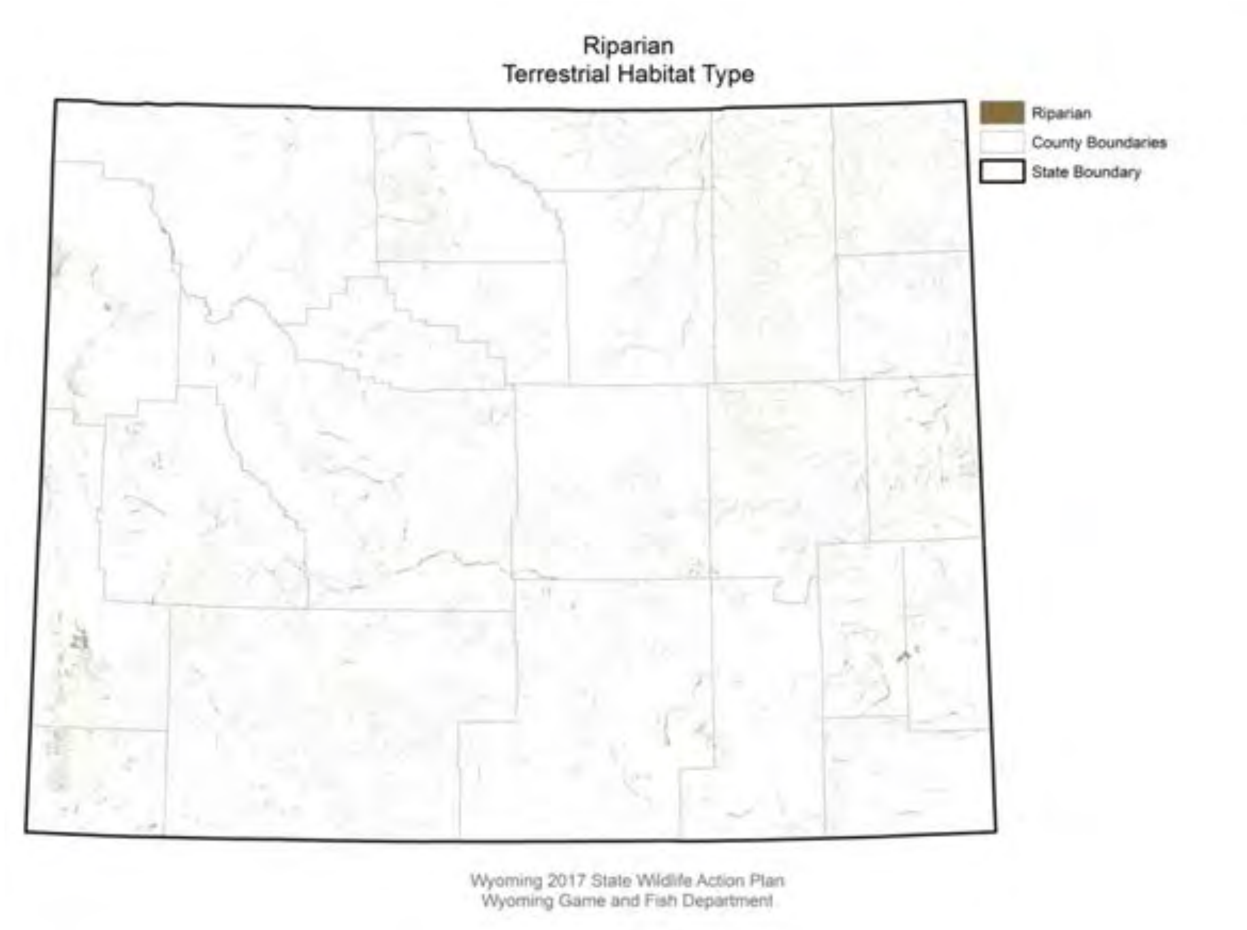


FIGURE 15. Wyoming Riparian Areas

TABLE 15. Wyoming Riparian NatureServe Ecological Systems[1]

1. Western Great Plains Floodplain
2. Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland
3. Rocky Mountain Lower Montane Riparian Woodland and Shrubland
4. Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland
5. Rocky Mountain Subalpine-Montane Riparian Woodland
6. Rocky Mountain Subalpine-Montane Riparian Shrubland
7. Northwestern Great Plains Riparian
8. Western Great Plains Riparian Woodland and Shrubland

[1] Descriptions of NatureServe Ecological Systems which make up this habitat type can be found at: NatureServe Explorer: an online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. http://www.natureserve.org/explorer.

TABLE 16. Wyoming Riparian Species of Greatest Conservation Need

Mammals
Fringed Myotis
Hayden's Shrew
Little Brown Myotis
Long-eared Myotis
Long-legged Myotis
Meadow Jumping Mouse
Moose
Northern Long-eared Myotis
Pallid Bat
Preble's Meadow Jumping Mouse
Preble's Shrew
Pygmy Shrew
Northern River Otter
Spotted Bat
Townsend's Big-eared Bat
Water Vole
Western Spotted Skunk
Yuma Myotis

Birds
Bald Eagle
Black-billed Cuckoo
Black-chinned Hummingbird
Calliope Hummingbird
Ferruginous Hawk
Golden Eagle
Great Blue Heron
Harlequin Duck
Lewis's Woodpecker
MacGillivray's Warbler
Red-headed Woodpecker
Rufous Hummingbird
Swainson's Hawk
Trumpeter Swan
Willow Flycatcher
Yellow-billed Cuckoo

Reptiles
Eastern Spiny Softshell
Plains Gartersnake
Red-sided Gartersnake
Smooth Greensnake
Valley Gartersnake
Western Painted Turtle

Amphibians
Columbia Spotted Frog
Great Plains Toad
Northern Leopard Frog
Plains Spadefoot
Great Basin Spadefoot
Western Tiger Salamander
Western Toad
Wood Frog
Wyoming Toad

Riparian Area Wildlife

Riparian areas account for less than 1% of the western landscape, but have a disproportionately high value as wildlife habitat (Knopf et al. 1988, Montgomery 1996). Within Wyoming, 61% of 445 terrestrial vertebrate species are believed to show preference for riparian habitats (Olson and Gerhart 1982). This is especially true for birds. In Wyoming, approximately 73 avian species have been identified as using riparian habitats (Nicholoff 2003). Bird diversity in riparian habitats has been linked to the complex vertical structure of these habitats compared to adjacent grasslands or shrubland habitats (Slater 2006). Some riparian bird species, such as the yellow-billed cuckoo and willow flycatcher, are among the most imperiled migratory species in Wyoming (Nicholoff 2003).

Elk, moose, mule deer, white-tailed deer, pronghorn, and small mammals, as well as their predators, all have strong seasonal or year-long associations with riparian habitats (Buskirk 1991). Riparian corridors and the rivers they bound play an essential role in river otter distributions (Rudd et al. 1986). The value of riparian corridors increases for shrews and jumping mice with the presence of grassy vegetation (i.e., forage and cover) and prey (i.e., seeds and insects). Riparian areas provide crucial habitat for wildlife in the form of wildlife movement corridors and migration habitats. The forage, cover, and water of riparian areas allow birds and mammals to move across otherwise harsh prairies and desert landscapes. Bats, in particular, use riparian habitats for commuting, migrating, roosts, and foraging habitat.

Many species of birds are excellent indicators of the condition of riparian vegetation in Wyoming and the West. Some are considered riparian obligates because they build greater than 90% of their nests in riparian vegetation or because 90% or more of their abundance occurs in riparian vegetation during the breeding season. Others are considered riparian dependent species either because 60–90% of their nests are built in riparian vegetation or because 60–90% of their abundance occurs in riparian habitat during the breeding season. All riparian species use one or more of the vegetation layers present in a healthy riparian system (i.e., understory, mid-story, and canopy).

Beaver are a fundamental factor influencing riparian landscapes. They create meadows and broaden the floodplain as they create dams. This increases sedimentation and encourages growth of riparian vegetation (Knight 1994). Beaver ponds provide important habitat for native fish species including Colorado River cutthroat trout, Yellowstone cutthroat trout, Bonneville cutthroat trout, and Snake River cutthroat trout. These ponds provide overwintering fish habitat, while supporting numerous aquatic mammals such as river otter, mink, and muskrat. Water held behind beaver dams and in surrounding banks enhances year-round stream flow and is especially important for helping maintain late season flows in many small streams. Bird densities among some beaver-influenced riparian areas have been found to be three times those of adjacent riparian habitats (Collins, 1993). Over the centuries, beaver ponds have trapped tens to hundreds of billions of cubic meters of sediment that would otherwise have been carried downstream (Naiman et al. 1988) so that today the physical character and vegetation of many meadowlands is the result of historic beaver activity.

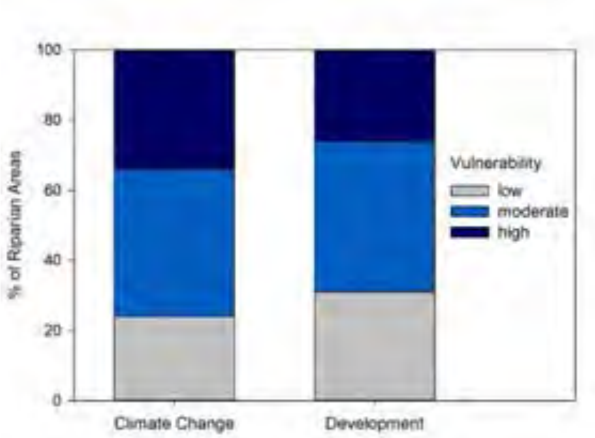
Riparian habitat is required by many Wyoming amphibian and reptile assemblages. Amphibians rely on aquatic habitat for a portion of their life, and frogs, toads, and salamanders depend on riparian areas for breeding, prey, thermoregulation, and cover. Amphibians can be found inhabiting side channels, oxbows, sloughs, and other aquatic features. A number of reptiles are also dependant on riparian habitat. Aquatic turtles utilize loose soils within riparian areas for nesting. This habitat type is also of particular importance to native gartersnake populations.

Riparian areas provide important direct and indirect influences on Wyoming fish populations and their habitat. At higher elevations, the four native cutthroat trout subspecies and non-game species such as mountain sucker and longnose dace, depend on cool water with low sediment supply from streams with healthy riparian vegetation. Streams like Huff Creek in western Wyoming harbor native fish populations that have fluctuated through time in response to changes in the extent and function of riparian willow communities (Chaney et al. 1991, Binns 1981). Riffle-dwelling species such as longnose dace and riffle-spawning salmonids require relatively smaller, fine sediment levels associated with healthy riparian vegetation. Cottonwood gallery forests, such as those along the Powder River and its tributaries, periodically contribute logs and branches to the river channel which provides cover for fish species such as channel catfish. Woody debris accumulations provide juvenile salmonid habitat and adult overwintering habitat. In the relatively low-productivity waters of the upper Wind River drainage, higher Yellowstone cutthroat trout concentrations are consistently found associated with woody debris.

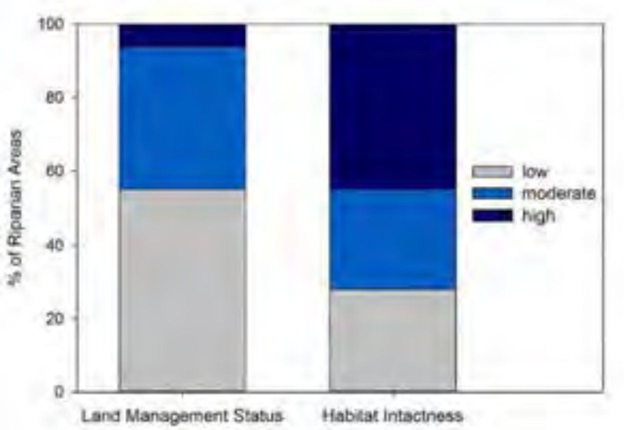
Riparian areas play a critical role in maintaining continuous flow and providing year-round aquatic habitat for fish and other species that occupy the wetted stream channel. Overbank flooding during snow melt in most years saturates riparian soils and elevates adjacent water tables. This underground water storage sustains riparian vegetation during periods when precipitation is scarce and releases water slowly into the stream (Ewing 1978). Though these flows are often small, they maintain water temperatures in suitable ranges for fish, improve water quality, and sustain isolated pools critical for fish survival (Winters et al. 1998).

Riparian Area Threats

Figure 16. Riparian Areas Vulnerability Analysis



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high vulnerability to climate change or development, based on classification of scores ranging from 0 to 1 into the following categories: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for climate change or development vulnerability were based on the land area of the habitat type classified as having high vulnerability: low (<10%), moderate (10-33%), or high (>33%). Vulnerability was calculated as exposure minus resilience. Development vulnerability includes existing and projected residential, oil and gas, and wind energy development. Further details are provided in the Leading Challenges section of this report and in Pocewicz et al. (2014).



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high land management status or habitat intactness. For land management status, high corresponds to the percent of the habitat occurring in GAP status 1 or 2, moderate to the percent occurring in GAP status 2b or 3, and low to the percent occurring in GAP status 4. Rankings for land management status were based on the land area of the habitat type classified as having high status or legal protection: low (<10%), moderate (10-33%), or high (>33%). For habitat intactness, scores ranging from 0 to 1 were assigned to categories as follows: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for intactness were based on the land area of the habitat type classified as having high intactness: low (<25%), moderate (25-75%), or high (>75%).

Water development/altered flow regimes - High

Natural flow regimes in stream segments around the state have been altered by human activities including irrigation diversions and water developments for enhanced water supply, hydropower, and flood control. No comprehensive national inventory of riparian conditions or trends exists, but it has been suggested that a minimum of 95% of all western riparian habitats have been altered in some way during the past century (Ohmart 1994). In Wyoming, altered flow regimes are also a consequence of broad-scale changes in land use and management associated with agriculture, grazing, timber harvest, and housing development (see Wyoming Leading Wildlife Conservation Challenges – Disruption of Historic Disturbance Regimes). Flow regimes have been substantially altered in significant portions of major Wyoming waterways including the North Platte River, Green River, Wind River, Bighorn, and Snake River. The Powder River's flow regime, by contrast, is much less altered (Peterson et al. 2009, Hubert 1992).

While water development can threaten native species, some introduced species, including popular sport fisheries, have thrived in the face of water development. The simplification of natural systems by human development tends to favor species with generalized and broad habitat requirements. For example, the walleye fisheries in the North Platte River reservoirs and Boysen Reservoir depend on the consistent deep water and forage production inherent in these man-made water bodies. Stable stream flow releases from dams, with relatively low peak flows and relatively high base flows, perpetuate productive sport fisheries. The famous "Miracle Mile" trout fishery below Kortes Dam and the "Grey Reef" fishery below Alcova Dam are examples.

Water development commonly results in decreased flood frequencies, lower peak flows, and shifts in peak flow timing. In almost all cases, dams reduce peak flows associated with spring runoff and change the timing, duration, and magnitude of the natural hydrograph. Auble et al. (1994) noted that substantial changes in riparian vegetation can occur without changing the mean annual flow because riparian vegetation is especially sensitive to changes in minimum and maximum flows. Bovee and Scott (2002) also observed this phenomenon and noted that changes in peak flows can reduce seedling recruitment and lead to gradual decline of certain riparian woodlands. Mahoney and Rood (1998) described how recruitment of cottonwood seedlings is limited to a narrow zone adjacent to the river—the zone is defined at its upper margin by the limit of overbank flow and at the bottom by the potential for subsequent scouring and deposition. They noted that river water volume must decline gradually so the seedling root growth can keep pace with the capillary fringe above the water table. In Wyoming, cottonwood declines have been noted to follow closely after flow alterations on the North Platte River (Miller et al. 1995) and Bighorn River (Akashi 1988, Bray 1996).

Riparian impacts associated with the loss of high spring flushing flows on dammed rivers greatly reduce the natural cycle of sediment transport and deposition. In addition, levees and bank stabilization structures can also adversely impact riparian systems by confining water to the main stream channel. Levees and other structures that constrain natural stream channels reduce not only floodplain inundation and maintenance but also the channel processes of aggradation and degradation that promote colonization and establishment of native willows and cottonwood trees.

Conditions that restrict or limit the establishment and maintenance of native cottonwoods and willows can cause the riparian vegetative communities to transition toward communities dominated by non-native Russian olive and tamarisk (see Wyoming Leading Wildlife Conservation Challenges – Invasive Species). Though these invasive, non-native tree species provide habitat for some organisms, their structure and ecological function are different from native riparian vegetation communities. As in most cases, when the core habitat changes, the animal species and other community components change as well. Reduction in the size and structural complexity of cottonwood stands, through a lack of tree regeneration, has been associated with declines in riparian bird species diversity (Slater 2006).

Reductions in seasonal flooding, whether by storage of high flows in dams, diversion of flow for out-of-channel purposes, or levee construction, often leads to establishment of homes, businesses, and recreational areas in the floodplain. Land-use practices associated with human development, such as removal of permanent cover, grazing, row crop agriculture, and urbanization, can accentuate high and low flows and reduce habitat diversity and length of the lateral edge between the terrestrial and aquatic environments (Schlosser 1991). Wetland drainage can increase peak flows and decrease base flows by reducing bank storage (Moore and Larson 1979). Creation of channels and dikes can increase peak flows (Gordon et al. 1992) and accentuate low flows (Karr and Schlosser 1978).

The reduction in beaver number and distribution is another major contributor to altered stream flows. Fur trapping in the 19th century greatly reduced beaver number and extirpated them from many areas. Now, in the early 21st century, beavers have re-occupied most of their historic range, but only at roughly 10% of pre-European-contact densities (Naiman et al. 1988). Beaver ponds accumulate sediment, improve water quality, reduce stream velocities, raise water tables, and increase the size of the riparian zone. These effects create and maintain both terrestrial and aquatic riparian habitats.

The need for additional water for human use will intensify in the immediate future, and that trend will be especially evident in the western U.S. Wyoming Governor Matt Mead has called for additional water development over a ten-year period beginning in 2015 (Wyoming Water Strategy 2015.) Such water development could influence riparian vegetation. The water strategy also includes an initiative to foster stream restoration throughout the state which could yield positive effects on riparian vegetation. The trend in water demand has multi-faceted consequences for fish and wildlife and the habitats upon which they depend. In Wyoming, efforts have already begun to consider trans-basin water diversions. Energy diversification, including hydropower development, may increase as the nation's energy demands rise. Warmer conditions with more erratic precipitation—which some predict for Wyoming's future climate—may heighten the need for additional water development (water storage) for municipal and agricultural purposes. The likely trend will be water development projects closer to the delivery point and conveyance via pipelines instead of stream channels. Additional emphasis will likely be placed on lining irrigation ditches and other practices to more efficiently use water for consumptive purposes. The net effect of all such water management practices will be to reduce intra- and inter-annual variability in Wyoming's streams and associated riparian corridors (see Wyoming Leading Wildlife Conservation Challenges – Climate Change).

Drought and climate change - High

Changes in precipitation patterns under various climate change scenarios are predicted to produce peak flows earlier in the yearly cycle and to lower base flows (Barnett et al. 2004). Such drought conditions can be stressful to riparian habitats. Drought can increase browsing and grazing pressure on riparian areas from-ungulates, thus reducing the vigor and structural diversity of riparian vegetation. Drought lowers water tables, leading to reduced plant growth and reproduction. Lower water levels increase water temperatures and reduce the living space available to fish and other aquatic wildlife. All these conditions can be detrimental to the health and reproductive success of all riparian wildlife species.

In riparian habitats, climate change may increase air and surface water temperatures, alter the magnitude and seasonality of precipitation and run-off, and shift the reproductive phenology and distribution of plants and animals (Seavy et al. 2009) (see Wyoming Leading Wildlife

Conservation Challenges – Climate Change). Riparian habitats will likely play a leading role in wildlife conservation adaptation strategies to climate change by providing travel corridors, including along altitudinal gradients; linking aquatic and terrestrial ecosystems; providing thermal refugia for wildlife; and providing resilience to natural disturbances (Seavy et al. 2009).

In an attempt to mitigate the effects of drought on water supply to users in the lower Colorado River Basin, the System Water Conservation Program was initiated on a pilot basis in 2015 (Wyoming State4 Engineers Office 2015). This program provides payments to water right holders in the Green River Basin that voluntarily reduce water diversions on a temporary basis. In its first year, payments were made to five applicants that chose not to divert during late-season, fallowing their hay fields or pasture. The additional late-season flows may positively affect riparian plant communities, largely comprised of willow and sedges.

Invasive species – High

Tamarisk (commonly known as *saltcedar*) and Russian olive are the two invasive plant species that currently have the most significant negative impact on Wyoming's riparian habitats (see Wyoming Leading Wildlife Conservation Challenges – Invasive Species). Tamarisk is an aggressive colonizer that often outcompetes and can completely replace willows, cottonwoods, and other native riparian vegetation. The stems and leaves of mature tamarisk plants secrete salt which forms a crust above and below ground that inhibits other plants (Sudbrock 1993). Infestations of tamarisk have a detrimental impact on wildlife, as although it provides some shelter, its foliage and flowers provide little food value for native wildlife species.

The problems associated with Russian olive are similar. It can outcompete native riparian vegetation, interfere with natural plant succession and nutrient cycling, and tax water reserves. The spread and establishment of Russian olives has been accelerated by water development projects. These projects have reduced flushing flows and the associated formation of point bars necessary for the regeneration and establishment of native vegetation such as willows and cottonwoods. Although Russian olives can provide food and cover, they typically replace native vegetation favored by many wildlife species. Studies indicate that Russian olives harbor fewer bird species than native vegetation (Brown 1990, Knopf and Olson 1984).

Where Russian olive or tamarisk occurs, the risk of wildfire can increase their detrimental impact. Both species are vigorous sprouters and usually gain the upper hand over native species after a fire. The expansion of Russian olive and tamarisk has reached a point in many Wyoming riparian habitats, especially the low elevation larger stream systems, that expensive restoration efforts are needed to re-establish native riparian shrub communities.

Other invasive species also impact riparian areas including leafy spurge, Dalmatian toadflax, whitetop, Canada thistles, black henbane, and spotted knapweeds. Options to control Russian olive and tamarisk and other invasive species can also negatively impact native vegetation and complicate management of riparian forests.

Ungulate grazing and browsing – High

Proper grazing management can be effective habitat management tools and compatible with riparian area maintenance and improvement. However, improper grazing in riparian areas can eliminate vegetation and associated wildlife, widen stream channels, cause soil erosion, increase water sediments loads, raise water temperature, encourage the spread of invasive species, change stream bank configuration, and lower surrounding water tables (Chaney et al. 1991, Nicholoff 2003). Uncontrolled livestock can congregate in riparian areas where they find water, succulent forage, and favorable microclimates including shade, wind reduction, and higher humidity (Clary and Webster 1989, Belsky et al. 1999).

Overbrowsing by wildlife, especially native ungulates, can negatively impact riparian vegetation. The most notable impacts are from elk, moose, and white-tailed deer. As with livestock grazing, impacts tend to be site-specific, where herd numbers exceed management objectives, or where animals congregate to escape hunting and other forms of predation, or as a result of other causes. For Wyoming's riparian SGCN, special attention needs to be given to grazing management to ensure that adequate understory vegetation and mid-story shrubs are present. Cottonwood regeneration is important for providing nesting trees including mature decadent trees for cavity nesters.

The WGFD sets big game herd unit population objectives based on a variety of factors including habitat condition within the herd unit, hunter demand, landowner input, and biological potential. These considerations result in mixed opinions as to what the objective should be. All objectives are taken to the public for review and approved by the Wyoming Game and Fish Commission. Although the Wyoming Game and Fish Department (WGFD) collects habitat data across the state, seldom is it specific enough to tie the habitat condition directly back to a specific number of animals. Such data is useful; however, in understanding whether big game populations are within the limits of what the habitat can support. The WGFD strives to have populations that are in balance with the majority of the habitats within the herd unit.

Rural subdivision and development – Locally High / Moderate

The high visual and recreational appeal of riparian habitats results in these habitats being desirable locations for home construction and other forms of human development. Houses, outbuildings, and lawns directly replace native wildlife habitat. Wildlife commonly abandon or alter their use of habitats with greater human and pet activity. Increased energy expenditures or greater use of lower quality habitats in order to avoid people can decrease animal health and reproductive capacity. Greater road densities and traffic volume can increase wildlife–vehicle collisions. Predation on wildlife can intensify with greater numbers of dogs and cats, as well as increasing numbers of generalist predatory species such as ravens. Soil disturbance from construction, the year-round grazing of horses and other hobby livestock, and the use of non-native plants as ornamentals can facilitate the establishment of invasive species (Maestas et al. 2002). Pesticide and herbicide concentrations may increase in runoff from nearby lawns. Loss of agricultural operations to rural residential development can result in a loss of irrigated meadows that are important to many wildlife species (see Wyoming Leading Wildlife Conservation Challenges – Rural Subdivision and Development).

Due to the limited size and distribution of riparian habitats relative to other landscape features and their critical role as corridors for both aquatic and terrestrial species, fragmentation of this habitat can severely compromise its value for wildlife. Maintaining the integrity of riparian areas will become increasingly important in preparing for the possible influence of climate change to enable species to travel to more suitable habitats as ecosystems change (see Wyoming Leading Wildlife Conservation Challenges – Climate Change). Riparian areas in relatively lower elevation areas in Wyoming (e.g., around Cheyenne, Star Valley, and the Snake River) are at greatest risk for future change due to rural development (Copeland et al. 2010).

Incompatible energy development practices - Moderate

Energy development can result in the direct removal of native vegetation and habitat fragmentation through road building, well pad drilling, power line construction, buried pipelines, booster stations, and facility buildings. Habitat fragmentation and loss also occurs indirectly through increased traffic and noise. Greater amounts of disturbed or bare ground, as well as greater vehicle traffic associated with the construction and production phases of energy development, can contribute to the spread of invasive plant species (see Wyoming Leading Wildlife Conservation Challenges – Energy Development).

Energy development can have a variety of effects on stream and lake hydrology and water quality. There can be drawdowns of streams and ponds by tanker trucks for water use at well sites. Surface discharge of poor quality ground water, as a byproduct of coalbed methane (CBM) extraction, can raise salinity levels and negatively impact riparian and aquatic organisms. Salts from CBM-produced water can accumulate in the roots of riparian vegetation and upper soil layers, stunting plant growth. CBM discharge water can also negatively affect the movement of water into and through soils and limit plant hydration. Changes in flow regimes and soil salinity may facilitate the replacement of native species by invasive species including tamarisk, Russian olive, and leafy spurge.

Runoff from roads and construction sites can reduce water quality through higher sedimentation and contamination from spills. Riparian areas in southwest and northeast Wyoming are at a relatively higher risk from future oil and gas development (Copeland et al. 2010).

Current Riparian Conservation Initiatives

Some habitat improvement programs, which can apply to riparian habitats, are covered in the 2017 SWAP wetlands habitat type.

Collectively, several ongoing activities in Wyoming are maintaining or improving riparian areas. Individual habitat protection and restoration projects, provide significant benefits. Federal Farm Bill programs and the agencies that implement them are actively working to benefit riparian areas. All of these efforts are possible only through the interest and cooperation of private landowners. Water management actions, both by individual irrigators and by federal and state agencies, are at times benefitting riparian areas. Instream flow water rights provide an ancillary riparian protective benefit. Comprehensive water planning efforts through the Wyoming Water Development Office are ongoing and include riparian elements. Finally, protection of existing riparian areas through careful development practices is promoted through the consistent and thorough environmental commenting practices of the WGFD.

In 2015, Wyoming Governor Matt Mead unveiled a Water Strategy that includes a river restoration initiative (Mead 2015). This initiative is to develop strategies, financial tools, technical expertise, and collaborative agreements that further stream restoration efforts throughout Wyoming. Cooperating agencies include the WGFD, Wyoming Department of Agriculture, Wyoming Wildlife and Natural Resource Trust Fund, and the Wyoming Department of Environmental Quality. Recommendations, agreements, education, outreach, and guidelines will be developed under this effort and undoubtedly benefit riparian resources.

Many riparian habitat improvement, management, and protection projects have been conducted in recent years under the direction of the WGFD's Strategic Habitat Plan (SHP). For example, the WGFD, working with conservation partners, completed 14 projects on 309 acres in 2014 specifically focused on riparian habitat protection, enhancement, and management (Wyoming Game and Fish Department 2014). On average, every year WGFD is involved in 18 projects protecting or enhancing over 760 acres of riparian habitat. Projects often entail establishing woody plants like cottonwood and willows (Anderson 2009). In 2014, six beavers were transplanted to augment and improve riparian function. On average, 10 beavers are moved annually to promote riparian benefits. In 2015, a pilot effort began to test a Beaver Restoration Assessment Tool (BRAT; Wheaton and McFarlane 2014) in the Green River Basin. The tool uses GIS data to model historic and current day beaver habitat to identify best locations to move beaver. This approach has been used extensively in Utah and may be applied across Wyoming pending the outcome of the pilot work.

Annual WGFD habitat reports, such as Wyoming Game and Fish Department 2014, have been produced since 2003 and highlight hundreds of projects completed to benefit riparian and other habitats. Many of these projects contain a component funded by the Wyoming Game and Fish Department Trust Fund, established in the late 1980s and now yielding over $1 million annually for habitat restoration work.

Another and more significant funding source is the Wyoming Wildlife Natural Resources Trust (WWNRT). Beginning with the first allocation of project dollars in June 2006, the WWNRT has funded 538 projects in all 23 counties of the state (Wyoming Wildlife and Natural Resource Trust 2015). Over $58 million has been allocated from WWNRT funds, with a total project value on the ground in excess of $343 million. A substantial portion of these WWNRT-funded projects protect and enhance riparian habitats across Wyoming.

The WGFD's SHP recognizes riparian habitat maintenance, protection, management, and restoration priorities (Wyoming Game and Fish 2015) with specific goals and objectives. Regional priority areas for conservation work are identified, many of which include a specific focus on riparian areas and issues (https://wgfd.wyo.gov/Habitat/Habitat-Plans/Habitat-Priority-Areas). For example, in the Cody region, riparian areas were prioritized as *crucial* areas and *enhancement* areas. These priority areas encompass broad portions of the Bighorn River and tributaries, and actions to maintain or improve riparian values and issues are identified in specific narratives (e.g., https://wgfd.wyo.gov/Habitat/Habitat-Priority-Areas/Statewide-Maps/Cody).

The Environmental Quality Incentives Program (EQIP) is the United States Department of Agriculture (USDA) Farm Bill program which provides resources and assistance to landowners to implement riparian habitat improvement projects and grazing plans. The Continuous Conservation Reserve Program (CRP) program administered by the Farm Service Agency (FSA) and Natural Resources Conservation Service (NRCS) creates buffer zones along riparian areas that exclude grazing on a 10–15-year contract basis. Regional Conservation Partnership Program (RCPP) is a new program under the 2015 farm bill to promote coordination between NRCS and its partners to deliver conservation assistance to producers and landowners. In Wyoming, three RCPP projects were initiated in the first year of the program and all will benefit riparian resources (NRCS 2015; https://www.nrcs.usda.gov/wps/portal/nrcs/detail/wy/programs/farmbill/rcpp/?cid=nrcseprd373042).

The U.S. Army Corps of Engineers (Corps) and an interagency review team (IRT) recently developed a Wyoming Stream Mitigation Procedure (USACE 2013). This procedure describes a method for quantifying stream losses (debits) and the acceptable compensatory mitigation (credits) for permitted projects in Wyoming. The method has been applied in the 2015 development of the first stream mitigation bank in Wyoming. The bank includes riparian restoration and protection along several miles of the Sweetwater River. The IRT is further developing a tool to quantify functional improvements, including those in the riparian zone, associated with stream restoration projects. It is anticipated this tool will become widely used beyond the permitting arena to formulate objectives, compare restoration proposals, and communicate benefits associated with stream restoration. The key four functional attributes to be measured include riparian, floodplain connectivity, lateral stability, and channel diversity.

Together with the Bureau of Reclamation, State Engineer's Office, and Wyoming Water Development Commission (WWDC), the WGFD has worked to develop formal and informal water management strategies for managing some reservoirs. These agreements benefit aquatic wildlife, including sport fisheries, while still serving the project's legislatively authorized purposes. Examples include the Snake River below Jackson Lake Dam; Shoshone River below Buffalo Bill Dam; Green River below Fontenelle Reservoir; Bighorn River below Boysen Reservoir; and the North Platte River below Kortes, Pathfinder, Grey Reef, and Glendo Dams. Any benefits to riparian areas that accrue; however, are secondary to a traditional focus on flow releases to benefit sport fisheries and recreation. Release schedules specifically tailored for riparian habitat have not been identified or implemented.

Water management associated with traditional agricultural flood irrigation practices is often cited by ranching interests as beneficial for riparian zone maintenance. There is no doubt that riparian areas in some areas are locally created and maintained through irrigation practices though a formal and systematic evaluation of such riparian areas has not been conducted. Riparian vegetation communities can be strongly influenced by the type, timing and extent of irrigation. Conversion from flood to center pivot has been known to change riparian characteristics. Technological changes like side role systems and gated pipe deliver water more efficiently to agricultural crops and have the potential to conserve water for other uses like maintaining stream flows. The influence of improved irrigation efficiency on riparian characteristics is complex and dependent on site characteristics.

Instream flow water rights provide some certainty that the state can protect natural flow regimes up to designated base levels for fisheries and, by association, may benefit riparian corridors along instream flow segments. The WGFD began evaluating various methods and quantifying instream flow needs for fish in 1979. In 1986, the state legislature enacted a statute (41-3-1001 to 41-3-1014) that formally recognizes opportunities to maintain or improve instream flow as a "beneficial use." Because water rights can only be issued for uses that have been officially recognized as "beneficial", this designation is of critical importance. Since inception of the water right program, the WGFD has employed two (and at times three) full-time biologists to identify priority areas and quantify instream flow regime needs for fish habitat. Additionally, the WGFD has assisted in developing more than 140 instream flow water rights applications through the WWDC. A plan guiding instream flow efforts is at (https://wgfd.wyo.gov/WGFD/media/content/PDF/Fishing/ISF_WATERMGMTPLAN.pdf). Under this plan, instream flow water rights will continue to be pursued to protect fisheries.

The state has undertaken a comprehensive water planning effort that, while not focused directly on riparian habitats, closely relates to the fate of riparian areas in Wyoming. The 1999 Legislature approved the recommended planning framework and authorized the Bear and Green River Basin Plans (Wyoming Water Development Office 2010). In the years that followed, the Legislature authorized funding for the five remaining river basin plans. The Platte River Basin Plan was the last plan completed in May 2006. Anticipating completion of the individual river basin plans, the 2005 Legislature authorized funding for the Statewide Framework Water Plan. The purpose of this plan was to summarize the results of all seven river basin plans and provide recommendations for future updates. The plan includes an inventory of the state's water resources and related lands, a summary of the state's present water uses, a projection of future water needs, and an identification of alternative decisions to meet the indicated future water needs. It also provides future water resource planning direction to the State of Wyoming. Since the 2010 SWAP, river basin plans have either been updated or are in the process of being updated in all seven Wyoming river basins.

Mapping of invasive species is ongoing throughout much of the state by county, state, and federal agencies along with private landowners. County cost-sharing programs are available to help landowners control invasive plant species. A number of large, multi-agency cooperative projects are focused on controlling Russian olive and tamarisk and replacing them with native vegetation. Notable projects include Yellowtail, Shoshone River, Shell Valley, and Grass Creek Coordinated Resource Management Teams (CRMs). Along the North Platte River near the communities of Glenrock and Torrington, and along the medicine Bow River, similar large treatment projects have occurred to treat tamarisk and Russian olive with partnerships including conservation districts and weed and pest districts. In another example, the WGFD is working with Seedskadee National Wildlife Refuge, the Wyoming Landscape Conservation Initiative, the community of Green River, landowners, and others, to map and treat Russian olive and tamarisk infestations along the Green River below Fontenelle Reservoir in southwest Wyoming. Riparian issues and efforts along the North Platte River are highlighted in a 2011 documentary (McMillen 2012).

The WGFD has an environmental protection role to maintain wildlife habitats, including riparian areas, and the Department provides comments on the anticipated effects of proposed developments. A WGFD document outlines Best Management Practices (BMPs) and monitoring practices to detect sediment and runoff issues from the roads and stream crossings associated with wind energy development (2010a). Similar approaches for avoiding or mitigating impacts to riparian zones associated with oil and gas development were also developed (2010b). For example, no surface occupancy and a 500-foot buffer zone around riparian areas are recommended. Under the Commission's mitigation policy, riparian habitats are recognized under the mitigation category "High" and the Department promotes measures to result in no net loss of habitat function (WGFD 2012).

The success of ongoing and enhanced riparian conservation and restoration work in Wyoming will depend on the interest and commitment of private landowners. European settlers were attracted to riparian areas to develop farms, ranches, and town sites because of the rich soils and relatively flat topography. Today, some of the most extensive riparian areas, especially in eastern Wyoming, occur on privately held lands. With continued cooperation and communication, projects that benefit riparian areas and their host of wildlife species, while at the same time benefiting the landowner's interest, can continue or even accelerate.

Recommended Riparian Conservation Actions

Continue implementing riparian habitat management, treatment, and protection projects.

- Treat decadent stands to promote regeneration and re-establish lost species and cover through planting and seeding.
- Promote or mimic natural disturbances such as seasonal flooding, erosion, and deposition.
- Encourage riparian buffers to promote regeneration.
- Remain actively involved with various partners, CRMs, initiatives, and programs.

Enhance efforts to control riparian area invasive species.

Specific actions to more effectively control riparian invasive plant species include:

- Increase coordination between agencies and private landowners, especially Weed and Pest Districts, to better align goals and priorities.
- Coordinate with water management agencies such as the WWDC and the Bureau of Reclamation to identify and implement water management strategies to create, maintain, or restore riparian vegetation communities along streams below existing dams. Special effort should be employed to include favorable flow regimes as part of the annual operating plans for new dams or diversion projects in the future.
- Increase legislative funding for removing riparian invasive plant species and re-establishing native willow and cottonwood stands through Weed and Pest Districts and Conservation Districts.
- Improve mapping of the location and spread of invasive species infestations to assist in prioritizing sites for treatment. This information should be captured centrally through GIS and should be made available publicly.
- Enhance landowner, agency, and public awareness and knowledge about riparian invasive species and control techniques. Focus special attention on communicating:
  - the value of seasonally appropriate flood irrigation in riparian corridors
  - the importance of protecting native willow and cottonwood stands
  - the negative impacts of Russian olive and tamarisk and the need to control those species whenever possible
- Follow WGFD Russian olive management guidelines and project ranking scheme to direct project funding and activities to important riparian areas where the greatest benefits will accrue.

Support research on instream flow and overbank flow regimes.

Research on instream flow and overbank flow regimes is needed to facilitate the management of native willow and cottonwood communities. Additionally, research on water uptake and bank stability characteristics of riparian plant species, especially tamarisk and Russian olive, would be beneficial for riparian area management.

Increase GIS mapping of riparian areas.

- Update and make available through online sources spatially explicit riparian priority sites found in WGFD's Strategic Habitat Plan. Long-term riparian inventory and mapping as to the quality and vulnerability of riparian habitats will help managers prioritize future habitat protection and improvement projects and target SGCN conservation activities. Emphasize designing mapping efforts to support maintaining the connectivity of riparian habitats. Retaining the role of riparian habitats in providing travel corridors for wildlife will become an increasingly important component of effective mitigation plans for human development as well as climate change. Riparian corridors are critical to supporting the seasonal migration of wildlife and to retaining the future ability of wildlife to relocate to more suitable habitats. The WGFD will continue to work with the Wyoming Geographic Information Science Center (WyGISC) on various modeling and mapping efforts associated with riparian systems.

Continue developing techniques that minimize negative impacts of energy development and reward the implementation of existing best management practices to maintain or restore riparian communities and habitat.

- In mitigation plans, stress avoiding biologically sensitive areas within project sites and direct off-site mitigation funds to nearby high-value wildlife locations.

- Continue researching behavioral and population responses of riparian species to energy development, including wind.
- Encourage implementation of mitigation measures and/or best management practices as detailed in the Wyoming Game and Fish Commission documents *Recommendations for development of oil and gas resources within crucial and important wildlife habitats* (Wyoming Game and Fish Department 2010c) and *Wildlife protection recommendations for wind energy development in Wyoming* (Wyoming Game and Fish Department 2010b).
- Review and update riparian setbacks and buffer recommendations and identify specific buffers for sensitive fish, amphibians, reptiles, birds, or mammal species as outlined in the WGFD *Recommendations for development of oil and gas resources within crucial and important wildlife habitats* (2010c). Compare Wyoming buffer recommendations to those used in other western states and consider new approaches for addressing buffer width for energy development.
- Review management actions proposed by state and federal agencies involving riparian habitats, and work closely with the Wyoming Governor's office, industry, private land owners, and agency staff during early stages of energy development project planning.

Provide incentives, planning, and technological improvements to enhance livestock management in riparian habitats.

- Additional incentives, including financial, planning, and technical assistance, should be provided to encourage private landowners to participate in projects to improve the natural function and wildlife habitat values of riparian habitats. The Environmental Quality Incentives Program (EQIP) is a USDA Farm Bill programs which already provide some resources and assistance to landowners to implement riparian habitat improvement projects and grazing management plans. The WGFD trust fund program and Fish Wyoming program also provide assistance.
- Research should be conducted to enable federal grazing lease regulations to be more outcome-oriented as opposed to prescriptive in achieving desired riparian habitat conditions. This would encourage greater innovation and adaptation to local site conditions.
- Develop more forage reserves to assist in implementing habitat improvement projects. Forage reserves operate by providing ranchers access to substitute land or forage in order to allow rest from grazing, or the establishment of habitat improvement projects, on land they currently own or rent for grazing.
- Implement riparian grazing recommendations in the *Wyoming Bird Conservation Plan, Version 2.0* (Nicholoff 2003).

In cooperation with land management agencies and private landowners, reintroduce beavers into stream systems where they have been extirpated or occur at low densities and have appropriate food, security, and dam-building vegetation.

- Beaver dam-building activities can increase the size and quality of riparian habitats for both terrestrial and aquatic species (see Wyoming Leading Wildlife Challenges – Disruption of Natural Disturbance Regimes).
- Use the Beaver Restoration Assessment Tool (BRAT) in the Green River basin to evaluate this method for identifying restoration options. Apply the BRAT statewide if deemed appropriate.
- Update WGFD Habitat Extension Bulletin 38, "The Role of Beaver in Riparian Habitat."

- Participate in a Beaver Restoration Project consisting of regional dialogue about beaver best practices and applications hosted by the Association of Wetland Managers and the Association of Fish and Wildlife Managers.

Continue efforts to manage native ungulate populations to avoid overbrowsing of riparian habitats.

- Continue and enhance local efforts to identify sustainable stocking rates of native ungulates and keep populations within established herd objectives. High concentrations of elk, moose, and white-tailed deer, in particular, can cause damage to riparian areas. Accomplishing this goal will include maintaining hunting opportunities, especially on private land, and increasing educational efforts about the importance of doe and cow harvest for population management.
- Maintain or increase landowner cooperation in managing big game herd numbers since animals can congregate on lands where hunting is prohibited or limited. Specialized hunting seasons with weapons that have reduced trajectories, including archery, muzzleloader, and shotgun seasons, may be needed in some areas. Public education about the purpose and value of these seasons in locations close to residential areas may be needed.

Increase educational efforts about the ecological, economic, and social values of riparian habitats and associated conservation tools and management techniques.
Enhance educational efforts in the following key areas:

- Increase awareness among natural resource agency employees about the importance of historic flow regimes to properly functioning aquatic systems, riparian habitats, and riparian wildlife species.
- Increase knowledge levels about the threat of invasive plant species, particularly Russian olive and tamarisk, to riparian habitats and wildlife.
- Continue to improve private landowner awareness of opportunities to jointly improve livestock, water, and wildlife habitat management. Marketing programs could:
  - Survey, on a regular and systematic basis, specific target audiences to determine their views, values, and knowledge of riparian issues and opportunities.
  - Maintain an up-to-date website with regular, focused messages about riparian issues and opportunities.
  - Develop targeted audience email lists to provide needed information (based on surveys) about riparian issues, funding opportunities, and WGFD assistance.
  - Develop reference materials for managers and landowners.

Enhance coordination among natural resource agencies, private landowners, and nonprofit conservation organizations to identify and implement shared riparian habitat management objectives.

- Use the existing workgroup assembled to implement the River Restoration Initiative under the Governors Water Strategy to retain a focus on riparian benefits associated with river restoration.
- Enhance coordination through development of an interagency riparian management task force made up of at least one representative from each state and federal agency with an interest or responsibility for managing riparian habitats.
  - At a minimum, this task force should consist of representatives from each federal land management agency, the Bureau of Reclamation, U.S. Fish and Wildlife Service, State Land Board, Parks and Recreation, State Engineers Office,

Weed and Pest District(s), Wyoming Department of Agriculture, Conservation District(s), private landowner representatives, and appropriate NGO representatives including the Wyoming Stock Growers and Wyoming Wool Growers Associations.

- This group should meet at least annually to discuss riparian trends, priority areas, identify effective management practices, present the results of current research, and share information on the availability of financial assistance for riparian management.
- A critical function of this team should be identifying funding assistance opportunities for private landowners.

- Support and promote research through the University of Wyoming Fish and Wildlife Cooperative Research unit on:
  - Instream flow and overbank flow regimes needed to manage for native willow and cottonwood communities, and
  - water uptake and bank stability characteristics of riparian species, especially tamarisk and Russian olive.

Increase conservation easement acquisition with willing landowners on riparian habitats.

- Increase conservation easement acquisition. A high proportion of Wyoming's riparian habitats are privately owned. Conservation easements are one of the most effective long-term methods of limiting environmentally destructive development and management activities on private lands while retaining ranching, outdoor recreation, and other compatible land uses (see Wyoming Leading Wildlife Conservation Challenges – Rural Subdivision and Development). Land values for riparian habitats are typically the highest of any habitat type. Increased funding for conservation easements will be needed to conserve riparian habitats on a broad scale.

Evaluate avoidance and mitigation options for riparian habitat associated with new water development proposals.

- Coordinate WGFD personnel (Water Management, Statewide Wildlife and Habitat Management, and Habitat Protection) who work with WWDC or other water development interests to specifically quantify riparian habitat impacts and mitigation needs for all new water development projects.

Riparian Monitoring Activities

Continue monitoring riparian SGCN in order to detect population trends or changes in distribution that may reflect habitat problems. This information should be used to guide future monitoring, conservation, and research.

Conduct additional inventory and monitoring work to document the locations of riparian habitats, habitat conditions, and the effects of management actions. Include the following recommended specific inventory and monitoring activities:

- Monitor the establishment and spread of invasive plant species, particularly Russian olive and tamarisk, in cooperation with Weed and Pest Districts, local conservation districts, private landowners, and other state and federal agencies
- Track the number, type, and location of water development projects on Wyoming rivers and streams and their influence on historic flow regimes and wildlife movement.
- Establish monitoring sites and protocols to evaluate the potential effects of climate change, including its potential influences on flow regimes and assemblages of riparian plants and animals.
- Document sites of vestigial diversity and promote their protection and expansion.

- Establish the probable state, extent, diversity and complexity of pre-settlement riparian forest to provide guidance for restoration efforts.
- Record the location, size, and type of riparian habitat enhancement and conservation projects.
- Quantify grazing and browsing levels by livestock and wild ungulates in key areas of known impact. Target this monitoring to key locations in riparian corridors where disruptions in the riparian corridor affect wildlife movement opportunities over relatively high distances in larger river systems like the Green River, Bighorn River, and Powder River.
- Monitor dam-building success, pond characteristics, riparian vegetation community patterns, and water retention associated with beaver reintroduction efforts.

These monitoring activities can help prioritize sites for habitat improvement and conservation projects, assist with refining riparian management techniques, and contribute to quantifying current successes.

Monitor the landscape distribution and habitat intactness of riparian habitats through remote sensing.
Remote sensing is useful in tracking the size, distribution, and fragmentation level of riparian habitats in Wyoming. This information could help determine the cumulative impacts of activities and events such as rural subdivision, energy development, historic flow regime alteration, and the spread of invasive species. This technique will require the further development of monitoring protocols and the identification of sample sites.

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Sagebrush Shrublands

Photo courtesy of WGFD

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Habitat Description

Sagebrush is an icon of Wyoming's landscape and open spaces. Sagebrush habitats are found in cold, semi-desert climates across the Intermountain West, and Wyoming has more sagebrush than any other state. Estimates vary on the amount of sagebrush dominated communities, but range from 23.5 million acres (Knight 1994) to approximately 37 million acres (Beetle and Johnson 1982). NatureServe (2009) lists seven ecological systems associated with this habitat in Wyoming (Table 17). Scores of different associations have been identified within these ecological systems. In sagebrush dominated areas, winters can be long, summers are hot and dry, and winds are persistent. A defining attribute of sagebrush ecosystems is a high proportion of annual precipitation occurring in the winter as snow or as early spring rain (Knight 1994). Summer storms can be brief and intense, and most precipitation runs off or evaporates (Paige and Ritter 1999).

The distribution of sagebrush on the landscape depends upon the response of individual species and subspecies to soil moisture, salinity, depth, and texture, as well as to climatic factors. Species/subspecies location patterns are accentuated over short distances by wind, topography, and abrupt changes in soil conditions (Knight 1994). Sagebrush communities may range from less than 4,000 to over 9,500 feet in elevation, with annual precipitation varying from a minimum of approximately 6 inches to over 20 inches. Sagebrush occurs on a variety of aspects from basins and valley bottoms, to undulating terraces and foothills, to steep slopes and mountainous areas. Likewise, it is found in a variety of mostly xeric soil types and a variety of soil textures and depths.

Natural disturbances also play an important role in determining the pattern, age structure, and species composition of sagebrush stands. Fire has played a role in shaping the sagebrush communities in Wyoming since the last ice age (Bohne et al. 2007). The historic ecological role and frequency for fire in sagebrush communities is debated. Research indicates that fire frequency in big sagebrush community types may range from 10 to over 110 years (Wyoming Sage-Grouse Working Group 2003); while others contend that in many Wyoming big sagebrush communities the time frame maybe closer to 100 to 240 years (Baker 2006, Cooper et al. 2007), and in more xeric types, such as low sagebrush, 325 to 450 years (Baker 2006). Rates of sagebrush canopy recovery following fire also greatly vary across the landscape and between different sagebrush community types ranging from 100 to 120 years (Baker 2006) to as few as 10 years (Sturgis 1994). Patchy fires appear to have been common in many sagebrush communities while larger fires at lower frequencies occurred in other areas, depending on climate, topography, plant composition, and aridity. In addition to fire, herbivory from wild ungulates, insects, rodents, and rabbits; precipitation, particularly drought; plant disease; and the effects of burrowing animals are important natural disturbances in sagebrush habitats.

Sagebrush stands can vary from large patches dominated largely by a single species or subspecies of sagebrush to a mosaic of multiple species where sagebrush is intermixed with other shrubs, such as rabbitbrush, antelope bitterbrush, greasewood, shadscale, winter-fat, and spiny hop-sage (Paige and Ritter 1999). Stands of sagebrush can be dense, patchy, or sparse. In tall sagebrush types, sagebrush cover commonly ranges from 5–30% or greater on some sites (Dealy et al 1981). Sagebrush communities often contain three or four vegetative layers: 1) a shrub layer, 12–40 inches tall; 2) forbs and caespitose grasses, 8–24 inches;3) low-growing grasses and forbs of less than 4–8 inches tall; and 4) a biological soil crust (Miller and Eddleman 2000). The biological soil crust is composed of blue-green algae, bacteria, fungi, mosses, and lichens. Research indicates the crust may play an important role in some dry regions through stabilizing soils from wind and water erosion, contributing to soil productivity, influencing nutrient levels, retaining moisture, altering soil temperature, and aiding seedling establishment (Paige and Ritter 1999).

Other plant communities such as aspen, mountain shrubs, salt desert shrubs, and open conifer occur in association with sagebrush communities (Wyoming Interagency Vegetation Committee 2002). Major sagebrush species that dominate or co-dominate sagebrush systems in Wyoming include big sagebrush, including Wyoming, subalpine, mountain and basin subspecies/varieties; two varieties of silver sagebrush; low sagebrush; black sagebrush; two varieties of three-tip sagebrush; early sagebrush; birdsfoot sagebrush; spiked sagebrush; bud sagebrush; sand sagebrush; and fringed sagewort. Unlike other plants, most varieties of big sagebrush lack the ability to sprout from roots or root crowns and thus are killed when the crown is removed by fire or mechanical treatments such as mowing. This attribute increases the importance of longevity and seed production for the species. Big sagebrush seedlings only become established during favorable precipitation years or following a disturbance that reduces competition from neighboring plants (Knight 1994). While the subspecies/varieties of big sagebrush have some common characteristics, they also present characteristics unique to each taxon (Winward 2004). Wyoming big sagebrush grows on the most xeric sites of all the big sagebrush taxa. Basin big sagebrush, the tallest of the western sagebrushes, is found on deep, well-drained soils, often alluvial soils. Mountain big sagebrush grows on mid-to-upper elevation (6,800–8,500 ft.) mesic sites, and subalpine big sagebrush grows at high elevations (8,500–10,000 ft.) (Winward 2004). Understanding the differences between these taxa is important to management; an issue further complicated by varying degrees of hybridization.

Silver sagebrush is a common species in the lowlands (Knight 1994). Silver sagebrush often occurs in ravines or on floodplains in areas where Wyoming big sagebrush dominates the uplands. Silver sagebrush and three-tip sagebrush resprout from the root stock when the crown is removed, and they are fire tolerant (Adams et al 2004, Winward 2004). Black sagebrush often occurs on ridge tops on drier, coarser-textured, and shallower soils than either silver or big sagebrush (Knight 1994). Low sagebrush is usually less than 10 inches tall and is only found in the western part of the state such as the lowlands of Jackson Hole and Grand Teton National Park.

In addition to wildlife, sagebrush habitats are important landscapes for people. Agriculture, energy development, outdoor recreation, and residential housing are important land uses in sagebrush habitats. About 45% of the potential sagebrush habitat in the West is no longer sagebrush due to habitat conversion to cropland or pasture, development, conifer encroachment, and conversion to annual grasslands as a result of wildfire and exotic weed infestations (Connelly et al. 2003). A large percentage of sagebrush habitats are administered by public land management agencies, particularly by the Bureau of Land Management (BLM). Throughout the West, less than 30% of all sagebrush lands are privately owned (Raphael et al. 2001). Consequently, public land use policies and decisions will have a significant influence on the future of sagebrush habitats and associated species.

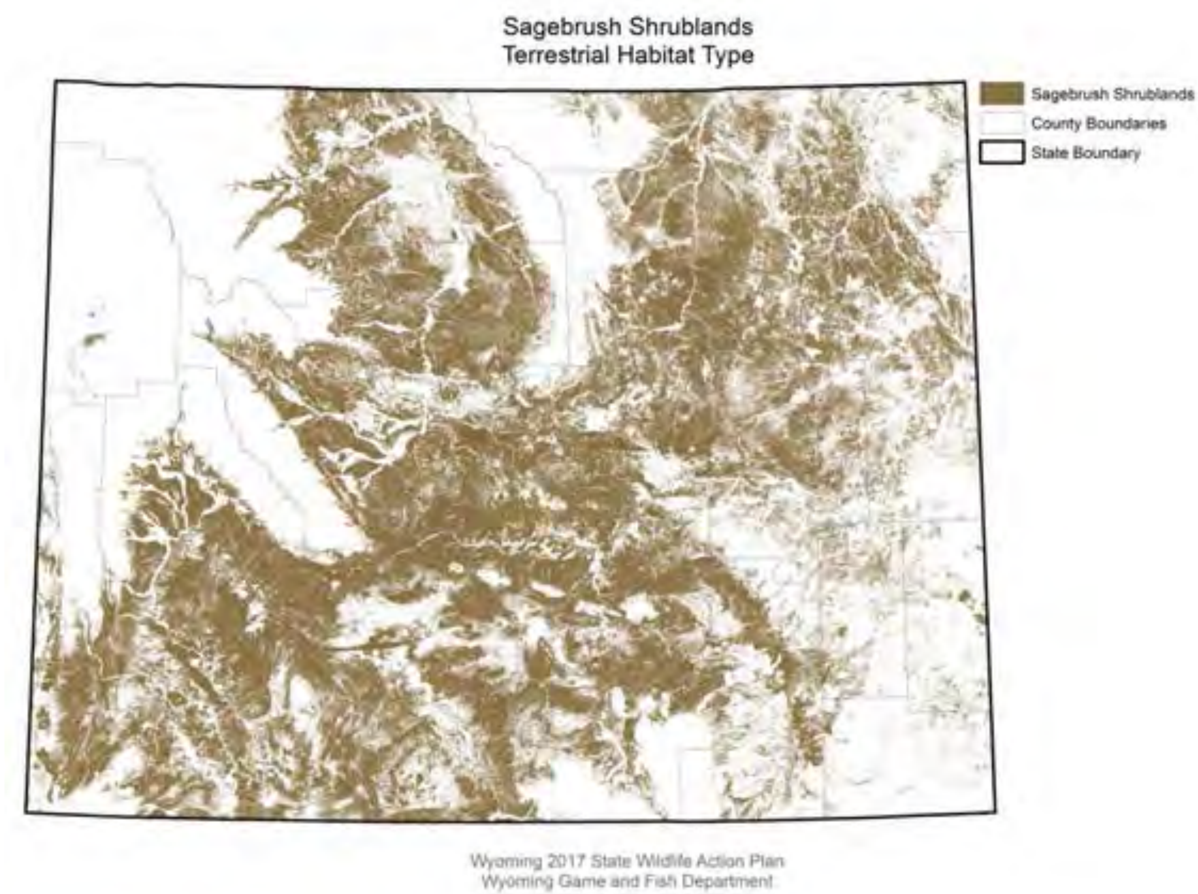


FIGURE 17. **Wyoming Sagebrush Shrublands**

TABLE 17. Wyoming Sagebrush Shrublands NatureServe Ecological Systems[1]

1. Great Basin Xeric Mixed Sagebrush Shrubland
2. Inter-Mountain Basins Big Sagebrush Shrubland
3. Columbia Plateau Low Sagebrush Steppe
4. Inter-Mountain Basins Big Sagebrush Steppe
5. Inter-Mountain Basins Active and Stabilized Dune
6. Wyoming Basins Dwarf Sagebrush Shrubland and Steppe

[1] Descriptions of NatureServe Ecological Systems which make up this habitat type can be found at: NatureServe Explorer: an online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, VA. http://www.natureserve.org/explorer.

TABLE 18. Wyoming Sagebrush Shrublands Species of Greatest Conservation Need

Mammals
Black-footed Ferret
Black-tailed Prairie Dog
Eastern Red Bat
Great Basin Pocket Mouse
Idaho Pocket Gopher
Olive-backed Pocket Mouse
Pallid Bat
Pygmy Rabbit
Sagebrush Vole
Sand Hills Pocket Gopher
Spotted Bat
Spotted Ground Squirrel
Swift Fox
White-tailed Prairie Dog
Yuma Myotis

Birds
Burrowing Owl
Brewer's Sparrow
Columbian Sharp-tailed Grouse
Greater Sage-Grouse
Ferruginous Hawk
Loggerhead Shrike
Mountain Plover
Sagebrush Sparrow
Sage Thrasher
Short-eared Owl
Swainson's Hawk

Reptiles
Great Basin Skink
Great Basin Gophersnake
Greater Short-horned Lizard
Midget Faded Rattlesnake
Northern Tree Lizard
Plains Hog-nosed Snake
Prairie Rattlesnake

Amphibians
Plains Spadefoot
Great Basin Spadefoot

Sagebrush Shrublands Wildlife

Sagebrush-associated vegetation types provide habitat for approximately 87 species of mammals; 297 species of birds; and 63 species of fish, reptiles, and amphibians (Wyoming Interagency Vegetation Committee 2002). Sagebrush ecosystems in Wyoming not only support crucial habitats for some of the largest migratory populations of ungulates in North America, but also offer the best chance to sustain healthy populations of sage-grouse and other sagebrush dependent species (Wyoming Game and Fish Department 2010a). In Wyoming, sagebrush obligates include the sage sparrow, Brewer's sparrow, sage thrasher, sage-grouse, pygmy rabbit, sagebrush vole, and sagebrush lizard (Paige and Ritter 1999).

Sagebrush itself is a keystone plant. Sagebrush ecosystems provide important food and cover, especially winter habitat, for big game species and other wildlife. Elk, mule deer, and pronghorn are the primary wild ungulates that utilize sagebrush habitat. Pronghorn attain their highest population densities in these ecosystems. Wyoming big sagebrush is also regarded as a crucial food item for sage-grouse, black-tailed jackrabbits, and pygmy rabbits, and mature sagebrush cover is important for sage-grouse broods.

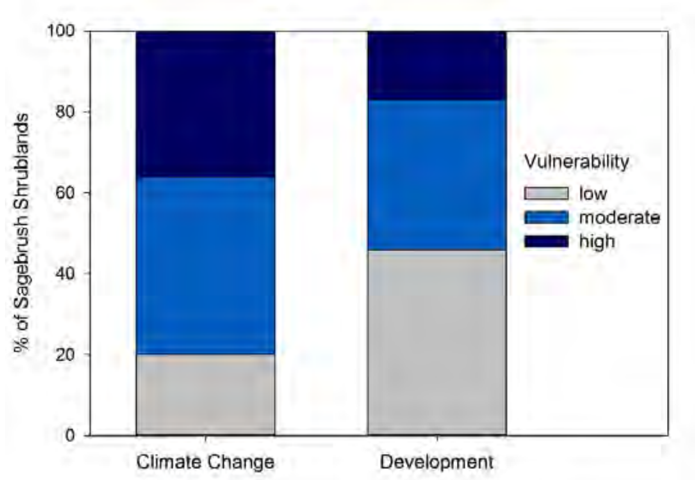
The protein level and digestibility of sagebrush are typically greater during winter than other shrub and herbaceous plants (Peterson 1995). During this time, sagebrush is commonly the only green vegetation that rises above the snow. Not only does this increase its forage value for wildlife, but the comparatively tall stature of sagebrush and stiff twigs capture snow, which increases ground water content throughout the summer. The characteristic smell of sagebrush is the result of volatile oils such as terpenes, which serve as a chemical-defense mechanism to limit herbivory. Consequently, wildlife species such as pronghorn and sage-grouse that ingest large quantities of sagebrush have developed efficient digestion systems to cope with these defenses.

In addition to sagebrush dependent species, Wyoming sagebrush shrublands with lower shrub stature and density, such as Wyoming Basins Dwarf Sagebrush Shrubland and Steppe, are used by many grasslands wildlife species. Wyoming grasslands SGCN, including swift fox, mountain plovers, McCown's longspur, as well as other grasslands species often extend their ranges west into such sagebrush habitats. For many birds, the height, density, cover, and patchiness of sagebrush stands have been determined to be the best indicators of species composition and abundance (Paige and Ritter 1999).

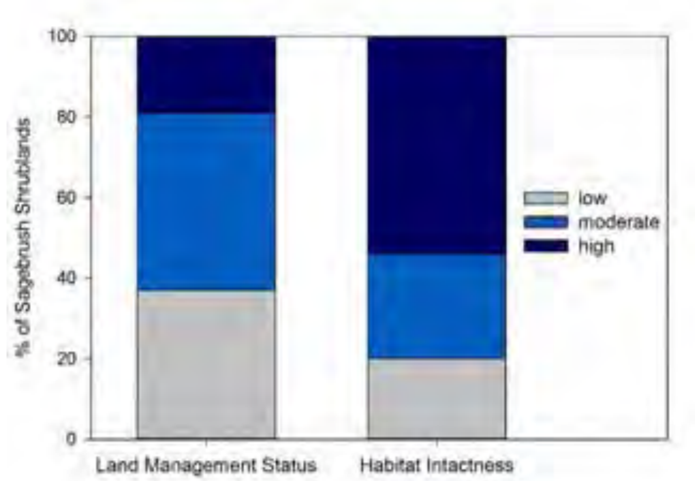
Invertebrate communities in sagebrush are not well understood, but may be critical to its effectiveness as wildlife habitat. Invertebrates represent high-protein forage, especially in spring and early summer, when plant protein is not yet available and vertebrates are generally protein-starved. Insect forage is known to be key to survival of sage-grouse chicks during the first few weeks after hatching, which in turn is key to increasing sage-grouse populations. Similar scenarios likely apply to other sagebrush-occupying wildlife. In addition to the numerous vertebrate and invertebrate animal species that depend on sagebrush for food and cover, there are several plant species primarily found only in association with sagebrush.

Sagebrush Shrublands Habitat Threats

Figure 18. Sagebrush Shrublands Vulnerability Analysis



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high vulnerability to climate change or development, based on classification of scores ranging from 0 to 1 into the following categories: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for climate change or development vulnerability were based on the land area of the habitat type classified as having high vulnerability: low (<10%), moderate (10-33%), or high (>33%). Vulnerability was calculated as exposure minus resilience. Development vulnerability includes existing and projected residential, oil and gas, and wind energy development. Further details are provided in the Leading Challenges section of this report and in Pocewicz et al. (2014).



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high land management status or habitat intactness. For land management status, high corresponds to the percent of the habitat occurring in GAP status 1 or 2, moderate to the percent occurring in GAP status 2b or 3, and low to the percent occurring in GAP status 4. Rankings for land management status were based on the land area of the habitat type classified as having high status or legal protection: low (<10%), moderate (10-33%), or high (>33%). For habitat intactness, scores ranging from 0 to 1 were assigned to categories as follows: low (<0.34), moderate (0.34-0.66), and high (>0.67). Rankings for intactness were based on the land area of the habitat type classified as having high intactness: low (<25%), moderate (25-75%), or high (>75%).

Invasive plants – High

It has been estimated that nonnative invasive plants are overtaking many wildland areas at the rate of about 4,600 acres a day on BLM-administered public lands alone (Bureau of Land Management 2000a). In Wyoming, there is a gradient of nonnative plant species invasion. In the higher and cooler sagebrush habitats of southern and western Wyoming, invasive plants are primarily established on disturbed sites such as roadways and well pads (Bergquist et al. 2007), whereas in the lower and warmer elevations of northern Wyoming, invasive plants are widespread throughout the understory of Wyoming big sagebrush communities.

The establishment of invasive plants can lead to loss of water and soil nutrients, increased erosion, and reduced productivity of native vegetation (see Wyoming Leading Conservation Challenges – Invasive Species). These effects reduce habitat quality for sagebrush-associated species including antelope, mule deer, elk, greater sage-grouse, pygmy rabbits, and sagebrush passerines. Ecological function deteriorates as hydrological processes are impacted, litter accumulation and organic matter breakdown decreases, and soil surfaces become denuded of native plants. Once invasive plant species become established, a seed source is developed for invasive species to expand into adjacent habitats such as riparian areas.

Cheatgrass, in particular, is a growing threat for Wyoming sagebrush habitats. Cheatgrass invasion fundamentally alters fire and vegetation patterns in sagebrush habitats by creating a bed of continuous, fine fuel that readily carries fire. Where cheatgrass has invaded the Snake River Plains of Idaho, the natural fire cycle has shortened from 30–100 years to 3–5 years (Whisenant 1990). Because sagebrush may take several years to mature before producing seed, repeated fires can eliminate sagebrush entirely. Cheatgrass dominance eventually creates uniform annual grasslands, perpetuated by large, frequent fires and void of any patches of native plant communities (Paige and Ritter 1999). Among other impacts on wildlife, increased fire frequency can decrease spring insect availability for birds.

The Wyoming Cooperative Agricultural Pest Survey (2010) data housed on the University of Wyoming website showed cheatgrass increasing in 21 of 23 counties in the state between 2003 and 2007 (updated March 2009). The survey also reported that 11 of 23 counties have more than 20,000 acres of surface dominated by cheatgrass. Notable recent increases in cheatgrass have occurred in the Bighorn Basin, the Laramie Mountains of southeastern Wyoming, as well as the foothills of the southern Wind River Mountains. Cheatgrass has also been invading more undisturbed big sagebrush communities at higher elevations, especially on south-facing slopes, as well as in ponderosa pine communities. Increased temperatures and more variable precipitation predicted for Wyoming's climate by some climate models could favor cheatgrass expansion (Bradley 2009).

Leafy spurge, spotted knapweed, Russian knapweed, hound's-tongue, halogeton, Dalmatian toadflax, Canada thistle, mustk thistle, black henbane, and white-top are other invasive species that pose a threat to sagebrush communities. Weed invasions often originate in areas of disturbed or bare soil frequently associated with construction and overgrazing.

Incompatible energy development and mining practices – High

Wyoming is one of the top energy producing states in the country (see Wyoming's Leading Wildlife Challenges – Energy Development). It is the nation's leading producer of coal (National Mining Association 2008), ranked fifth in natural gas production, and ranked eighth in crude oil production (Lawrence 2007). Wyoming ranks seventh nationally for wind-power generating potential when factoring in land status and environmental constraints (Elliott et al. 1991). Uranium, bentonite, trona, and gypsum are also mined.

Energy development can result in direct and indirect impacts to wildlife species and their habitat. Direct impacts include the removal and fragmentation of sagebrush communities, introduction and spread of invasive species, and increased soil loss and erosion resulting from activities such as mine excavation and the building of roads, drill pads, fences, power lines, and pipelines. Soil disturbance from roads and other types of construction and increased vehicle traffic are significant contributors to the establishment and spread of invasive weed species in sagebrush communities.

Indirect impacts include increased human activity, noise, and predator intrusion into previously unbroken habitats (Bui 2009). These impacts can displace animals and decrease reproductive success if animals are forced to use less productive habitats or expend more energy avoiding people and predators. For example, the density of sagebrush-obligate birds within 328 feet of roads constructed for natural gas development in Wyoming was 50% lower than the density at greater distances (Ingelfinger 2001). The increase in the number of roads providing greater access into sagebrush habitat may also increase both the legal and illegal harvest of wildlife.

Direct mortality of wildlife from energy development can be associated with higher wildlife–vehicle collision rates from increased traffic. Sage-grouse and bats have been known to drown in water evaporation ponds and production pits (Adams 2003, Wyoming Sage-Grouse Working Group 2003). An increase in the amount of standing water associated with some energy development techniques (Zou et al. 2006) may facilitate the breeding of mosquitoes that spread West Nile virus, which is lethal to many bird species including sage-grouse (Marra et al. 2004).

Produced water from oil and gas wells may be considered for enhancement of fish and wildlife habitats. For example, the creation of more mesic sites using produced waters may improve brood-rearing areas for species such as sage-grouse that tend to favor sites with abundant, succulent forbs (Aldridge and Boyce 2007). Utilization of produced waters can also increase forage and water reservoirs for other wildlife including ungulates. The Wyoming Game and Fish Department (WGFD) has several programs that can provide funds for the development of water resources located by oil and gas drilling (Wyoming Game and Fish Department 2010c).

Some habitat impacts from energy development can be minimized by mitigation strategies, reclamation projects, and adequate planning efforts. Often these impacts are short-term and related to specific periods of activity which can be managed with timing stipulations to avoid conflicts with wildlife use of specific sites. Other impacts have yet to be thoroughly researched and associated rehabilitation and reclamation can be problematic and may take many years to achieve the complete recovery of a functioning sagebrush habitat (Monsen et al. 2004).

Little research has been conducted to quantify the impacts of wind-energy development on sagebrush-dependent wildlife species. Bird strikes and bat mortality are commonly known to occur at wind energy facilities, but the effects on species that inhabit open landscapes, such as pronghorn and sage-grouse, are largely unknown. Some researchers have proposed similar impacts on wildlife from wind-energy development as those documented for oil and gas development (Becker et al. 2009).

Rural subdivision – High

Rural subdivision and development can reduce, degrade, and fragment sagebrush habitats (see Wyoming Leading Wildlife Conservation Challenges – Rural Subdivision and Development). Houses, outbuildings, and lawns directly replace native wildlife habitat. Soil disturbance from construction, year-round grazing of horses and other hobby livestock, and the use of nonnative plants as ornamentals can facilitate the establishment of invasive species (Maestas et al. 2002).

Wildlife commonly abandons or alters use of habitats with greater human and pet activity. Increased energy expenditures in avoiding people or greater use of lower quality habitats can decrease animal health and reproductive capacity. Greater road densities and traffic volume can increase wildlife–vehicle collisions. Predation on wildlife can intensify with greater numbers of domestic dogs and cats, as well as increases in generalist predatory species such as ravens and human-commensal species such as raccoons (U.S. Department of Agriculture 2007).

Off-road vehicle use – Moderate
Off-road vehicle use, primarily by all-terrain vehicles (ATVs), is increasing in sagebrush habitats. Driving vehicles off established roads can enhance the spread of invasive species, especially spotted knapweed and cheatgrass (Rooney 2005). Tires can damage biological soil crusts leading to decreased organism diversity, soil nutrients, soil stability, and organic matter, as well as increased erosion, which may negatively impact water quality. Managing off-road vehicle use can be difficult and controversial in sagebrush ecosystems where new trails are relatively easy to create and where some off-road vehicle users have little value for what appears to be an unproductive and barren landscape. Wildlife frequently avoids areas of increased noise and disturbance from outdoor recreational vehicles, and this type of activity may impact sage-grouse use of leks, nesting sites, and brood-rearing habitat.

Varying management goals and conflicting views about sagebrush ecosystem ecology and wildlife habitat management – Moderate
An existing lack of knowledge and agreement among scientist and natural resource managers regarding sagebrush ecosystem ecology and wildlife habitat management is an obstacle to advancing coordinated sagebrush conservation actions.

Due to disruption of natural disturbance regimes, particularly fire, it is felt by many that sagebrush in Wyoming is in late successional stages dominated by plants of relatively even age classes and older than 50 years of age (Winward 1991, Miller et al.1994, Wyoming Interagency Vegetation Committee 2002). These stands are commonly believed to display reduced vigor, productivity, diversity, and nutritional quality (Wyoming Interagency Vegetation Committee 2002). It is also believed that a mosaic of sagebrush age classes are required to best meet wildlife forage, and cover needs. As a consequence, sagebrush habitats have been subjected to a variety of treatments including burning, chemical control, and mechanical manipulation to improve wildlife habitat and livestock forage production. In addition to treatments, the widespread removal and conversion of sagebrush habitats to grasslands to increase livestock production was common in the past. (Vale 1974).

However, there is no widespread agreement on what constitutes decadence and poor vigor, particularly among wildlife biologists and range managers. Prescribed fire programs and other sagebrush habitat treatments are often based on the assumption that fire suppression has substantially reduced the frequency of fire in sagebrush vegetation; however, this assumption is very hard to prove (Baker 2006). While fire suppression is most often associated with the perceived decadence of sagebrush systems, drought stress over the past decade has likely played a role. As a result of these uncertainties, it is difficult for natural resource managers to quantify the size and scope of the problem, determine its cause, and apply appropriate management actions.

Furthermore, there is often little systematic monitoring following habitat treatments to document their extent and effectiveness. The Wyoming Governor's Sage-grouse Implementation Team identified the potential positive or negative effects of various habitat treatment practices (e.g., mowing/burning sagebrush, interseeding, grazing) and recommends that additional monitoring and research be conducted.

Incompatible grazing management practices – Moderate
Excessive grazing by domestic livestock during the late 1800s and early 1900s, coupled with severe drought, significantly impacted sagebrush ecosystems (Yensen 1981, Young and Sparks 2002). Since this time, livestock management

has improved with the adaptation of practices to control the intensity, interval, and season of use for grazing. However, in some areas grazing techniques could still be improved to benefit wildlife. Grazing has an influence on sagebrush density, canopy cover, and re-establishment rates as well as herbaceous composition (Wyoming Interagency Vegetation Committee 2002). Grazing may also reduce fine fuels and alter fire regimes (Beck and Mitchell 2000). Spring developments, water pipelines, and fencing have distributed livestock and wildlife use over areas that were formerly only occasionally or lightly grazed by large herbivores. Grazing practices that do not promote cool season grasses, especially bunchgrasses, and lead to a loss or alteration of forbs and shrubs, can interfere with ecological process, increase the spread of invasive weeds, and reduce habitat quality for wildlife. Managing the timing and intensity of grazing is particularly important for retaining residual grass cover, which has a strong influence on nesting success for sage-grouse and ground-nesting birds by providing cover to hide nests and hatchlings from predators.

Valuable biological soil crust in ephemeral riparian areas can be damaged by livestock hoof action during wet periods and soil compaction is common during dry periods. This can limit seedling establishment for forbs and grasses in areas with little to no growing season rain. Excess browsing by wild ungulates can damage sagebrush plants, which can lead to mortality. Winter range in some areas has been damaged by drought and big game herd numbers that exceeded management objectives.

Conifer encroachment – Moderate
In certain areas of Wyoming, Wyoming big sagebrush communities and mountain big sagebrush communities have been impacted by encroachment from juniper, ponderosa pine, and limber pine. This expansion has been documented by repeat photography, discussions with long-time residents, and fossil packrat-midden studies (Jackson et al. 2005). Suppression of wildfire is thought to be a primary reason for coniferous species invading sagebrush habitats, but changes in grazing and climate may also play a role. Conifer encroachment into sagebrush communities reduces shrub density and cover and herbaceous species diversity and production, and it lowers water yield. Cheatgrass invasion can be greatly enhanced if juniper densities reach a point where crown fires can be sustained. Suitable habitat for sage-grouse, pronghorn, mule deer, and other species that depend upon sagebrush habitats may decline. Sage-grouse, in particular, are known to avoid juniper communities (Commons et al. 1999, Doherty et al. 2008, Freese 2009). While juniper thinning projects are common in the state, it is important to balance these projects with the need to provide locations of adequate habitat for juniper obligate species (see Habitat Terrestrial Type – Xeric and Lower Montane Forests).

Drought and climate change – Moderate
Studies of age-class structure in sagebrush communities suggest that the establishment of new sagebrush plants is episodic and in many cases depends on above-average precipitation either during the first or second year of growth (Cawker 1980, Maier et al. 2001). Some climate models predict that Wyoming's climate will become drier (Christensen et al. 2007). More frequent and severe dry years could decrease the establishment of new sagebrush plants and slow or prevent recovery of sagebrush stands following fire, habitat enhancement treatments, or other disturbances that kill adult shrubs.

Many sagebrush communities exist in areas of low annual precipitation, and some communities may be at the limit of their range due to water availability. Drought causes a decrease in the production of herbaceous cover and forb availability which may affect the abundance of many species of wildlife. The difference between sagebrush production in drought versus non-drought years can be as much as 900% (Wyoming Interagency Vegetation Committee 2002). Loss in production can lead to increased competition between livestock and wildlife for food and cover.

Current Sagebrush Shrublands Habitat Conservation Initiatives

Increasing levels of energy development and declines in sage-grouse and mule deer numbers have greatly increased attention toward conserving sagebrush habitats. Sagebrush habitat management and conservation have been a priority for the WGFD since it embarked on the development of the statewide *Wyoming Greater Sage-grouse Conservation Plan* in 2000. Completed in 2003, this plan considers sagebrush conservation challenges and offers recommendations to address issues such as conflicting wildlife and wild horse management goals, invasive weeds, livestock grazing, energy development, recreation, residential development, vegetation management, and weather. The *Wyoming Greater Sage-grouse Conservation Plan* recommendations were also the genesis for the establishment of eight sage-grouse local working groups that direct on-the-ground habitat enhancement, population monitoring, and planning projects. Subsequently, each working group has developed a local sage-grouse conservation plan to guide these efforts.

A similar, more regional effort, the *Conservation Assessment of Greater Sage-grouse and Sagebrush Habitats* (Connelly et al. 2004), was completed by the Western Association of Fish and Wildlife Agencies (WAFWA) in 2004. As a follow-up document, WAFWA produced the *Greater Sage-grouse Comprehensive Conservation Strategy* in 2006 (Stiver et al. 2006).

In 2007, in response to the possibility of listing the greater sage-grouse under the Endangered Species Act, Governor Freudenthal formed two sage-grouse working teams: the Sage-grouse Implementation Team and the Science Technical Team. These teams were to develop recommendations for conserving greater sage-grouse across land ownership boundaries in Wyoming. First, the implementation team recommended extensive statewide mapping of sage-grouse habitat and habitat enhancement efforts. In April of 2008, Governor Freudenthal issued Executive Order 2008-2 which set forth Wyoming's Core Area Strategy. This strategy directs state agencies to focus sagebrush and sage-grouse conservation efforts within Core Population Areas developed by the Governor's Sage-grouse Implementation Team. New development within Core Population Areas would be authorized when it is demonstrated that the activity will not cause declines in greater sage-grouse populations. Incentives would be provided to encourage development outside Core Population Areas and to enhance reclamation in habitats adjacent to Core Population Areas. The sage-grouse Executive Order has been modified and reissued by Governor Freudenthal in 2010, and by Governor Mead in 2011 and 2015.

Also in response to a potential listing decision, the U.S. Fish and Wildlife Service in coordination with state and federal partners developed the Greater Sage-Grouse Candidate Conservation Agreement with Assurances for Ranch Management (CCAA). The Greater Sage-Grouse CCAA is a voluntary agreement between a private landowner and the U.S. Fish and Wildlife Service that utilizes a suite of habitat conservation measures to benefit both sage-grouse and the landowner's existing agricultural operation. The CCAA addresses the primary threat to sage-grouse identified by the U.S. Fish and Wildlife Service, which is loss of habitat. Subsequently, the BLM and U.S. Forest Service developed a Candidate Conservation Agreement (CCA) to apply to federal lands. As of June 2016, Wyoming has completed 40 CCAAs and 24 CCAs, enrolling over 1.5 million acres in these conservation agreements.

In 2008, WAFWA, U.S. Forest Service, BLM, U.S. Fish and Wildlife Service, U.S. Geological Survey, Natural Resources Conservation Services (NRCS), and the Farm Service Agency entered into a memorandum of understanding to increase cooperation in the conservation and management of greater sage-grouse, sagebrush habitats, and sagebrush-dependent wildlife. This would be accomplished through the implementation of WAFWA's *Greater Sage-grouse Comprehensive Conservation Strategy* and conservation actions for other sagebrush-dependent species, adopting an adaptive management approach that recognized current uncertainties, and establishing partnerships with agencies, organizations, communities, and private landowners.

Sagebrush was also identified as one of eight priority habitats to enhance or maintain within the WGFD Strategic Habitat Plan (SHP). First created in 2001, revised in 2009, and most recently in 2015, the purpose of the SHP is to strategically guide WGFD habitat improvement and protection activities. Regional priority areas for conservation work are identified including crucial areas, necessary for maintaining terrestrial and aquatic wildlife populations and enhancement areas, where there is the potential to enhance or improve important wildlife habitats that have been degraded. Narratives for both crucial and enhancement areas describing the location, boundaries, values, issues, species, and solutions/actions were prepared (http://gf.state.wy.us/habitat/PriorityAreas/index.asp).

The WGFD Mule Deer Working Group (MDWG) was established in 1998 to explore solutions to the many challenges confronting mule deer conservation and management. Crucial areas for mule deer often encompass sagebrush habitat, particularly on mule deer winter range. In 2007, the MDWG drafted the *Wyoming Mule Deer Initiative* which was adopted by the Wyoming Game and Fish Commission. Among other topics, the initiative addresses habitat issues pertaining to crucial mule deer habitat improvement, the implementation of strategies to minimize negative impacts of energy development, and habitat monitoring to ensure that deer populations do not negatively impact plant species on which they browse. Beginning in 2016 the Wyoming Game and Fish Commission began allocating $500,000 per year through the Mule Deer Initiative with the intent of working collaboratively with partners to improve habitat conditions for mule deer as well as furthering knowledge on migration routes, corridors and stopover sites.

There are several efforts in Wyoming focused on reducing the negative effects of energy development on sagebrush habitats through planning and mitigation. The Wyoming Landscape Conservation Initiative (WLCI) is a multi-stakeholder initiative in southwest Wyoming focused on data collection, monitoring, research, and facilitating land management actions to protect or enhance wildlife habitat and other resource values. The Jonah Interagency Office (JIO) is a $24-million mitigation fund that has been established to support projects to maintain important biological areas in the vicinity of natural resource development near Pinedale. Similar mitigation activities are underway for other oil and gas fields, including the Continental Divide-Creston, Hiawatha, and Pinedale Anticline.

Since 1975, Coordinated Resource Management (CRM) teams have used a collaborative, stakeholder-based approach to address land management issues in Wyoming. Currently, there are approximately 40 CRM teams composed of ranchers, land and wildlife management agency personnel, conservation organizations, and sportsmen in Wyoming, many of whom are focused on improving management techniques to benefit wildlife and livestock in sagebrush habitats. In partnership with the BLM and U.S. Forest Service, some federal grazing permittees are incorporating private sagebrush monitoring and best management practices into their ranching operations.

Prescribed burning and mechanical treatments are commonly used in sagebrush habitats to improve forage, increase age and structural diversity, and reduce encroachment by conifers. Treatments include targeting individual junipers or treating large patches with prescribed fire, mastication with heavy equipment, and hand cutting administered by seasonal fire crews. Aerial spraying to control cheatgrass has been initiated in many areas following guidance from the State Weed and Pest Plan, Wyoming Cheatgrass Task Force, and more recently by the Wyoming Cheatgrass Task Force. Public land and wildlife agencies including the BLM, U.S. Forest Service, WGFD, and Wyoming State Land Board have worked on initiating road closures in sensitive sagebrush habitats. Conservation easements held by a variety of land conservation organizations and the Wyoming Game and Fish Commission are being negotiated with willing landowners in sagebrush habitats.

Recommended Sagebrush Shrublands Conservation Actions

Increase research and develop plans to address the establishment and spread of cheatgrass and other invasive species in sagebrush habitats.
A literature review and discussions with researchers and land managers should occur to develop a comprehensive understanding of recent changes in cheatgrass abundance and density in Wyoming, and to determine the likely causes of this increase. Climatologists should be included in these discussions to develop a better understanding of how potential changes in future temperature and precipitation patterns in Wyoming may influence the spread of cheatgrass. This information could be used to identify regions of Wyoming which will likely be susceptible to significant increases in cheatgrass abundance. Results of this analysis could then be communicated to landowners and natural resource professionals to help guide cheatgrass control efforts. Efforts to minimize the spread of other invasive species, including black henbane, should continue. County Weed and Pest District invasive species control efforts should be supported and enhanced. Education and partnership opportunities for invasive species control exist with the energy industry.

Increase research on the sagebrush habitat ecology and the effects of habitat treatments.
Research should focus on determining the influence of management practices on multiple wildlife species and ecological functions. Investigations relative to the type of management practice (e.g., seeding, thinning, removal, and no treatment), the method of treatment (e.g., mechanical, herbicide, fire, or a combination of these), and associated grazing strategies (e.g., prior, during, and post treatment) are needed. The size of treatment, species composition, and site condition should be among the parameters investigated. Until more information is available, prescribed fire should not be used where sagebrush cover is a limiting factor for sage-grouse, where the understory lacks perennial forbs and grasses, or where invasive species or high amounts of less palatable shrubs such as rabbitbrush, horsebrush, or broom snakeweed are present (Miller and Eddleman 2001).

A variety of entities have been successful in mediating conflicting perceptions about sagebrush management into integrated habitat plans. These include the University of Wyoming Cooperative Extension Service, local conservation districts, and local Coordinated Resource Management teams. Efforts should be made to increase general public awareness about sagebrush conservation issues and the value of sagebrush habitats to wildlife.

Enhance planning and mitigation efforts to minimize the negative impacts of energy development on sagebrush habitats.
The development and implementation of energy-development plans, particularly for oil, gas, and wind, is crucial to the success of accommodating growth in these industries while minimizing negative impacts to sagebrush ecosystems, wildlife habitats, and wildlife species. Mitigation plans should stress avoiding biologically sensitive areas within project sites and directing off-site mitigation funds to nearby high-value wildlife locations. Energy development planning and mitigation efforts could be specifically benefited by:

- Continued research about the effects of energy development on sagebrush wildlife species and ecosystems, the Wyoming Chapter of the Nature Conservancy, Wyoming Natural Diversity Database, and Wyoming Game and Fish Department completed research evaluating the vulnerability of Wyoming terrestrial SGCN to oil, gas, and wind development. Vulnerability was investigated by evaluating each species' potential exposure and sensitivity to energy development. Exposure was evaluated through a GIS analysis that overlays distribution maps of SGCN with areas of known and projected energy development. Sensitivity was determined by examining habitat and behavioral attributes of SGCN as well as reviewing existing impact studies. Research results give an indication of which species and taxonomic groups are potentially vulnerable to development, as well as help direct future research to address information gaps. The project can be found at: http://www.nature.org/media/wyoming/wyoming-wildlife-vulnerability-assessment-June-2014.pdf.

- Review management actions proposed by state and federal agencies involving sagebrush ecosystems and associated wildlife habitats, and work closely with the Wyoming Governor's office, industry, private land owners, and agency staff during early stages of energy development project planning. The SWAP, SHP, and Sage-grouse Core Population Areas should be consulted during development and mitigation planning. Maintaining connectivity between core areas will be important for the long-term conservation of sage-grouse and other sagebrush associated species.
- Where appropriate, encourage the implementation of mitigation measures and/or best management practices detailed within the Wyoming Game and Fish Commission documents: *Recommendations for Development of Oil and Gas Resources within Crucial and Important Wildlife Habitats* (Wyoming Game and Fish Department 2010a) and *Recommendations for Wind Energy Development in Crucial and Important Wildlife Habitat* (Wyoming Game and Fish Department 2010b). Sage-grouse habitat protection recommendations for uranium and bentonite mining as well as other significant surface disturbing activities are addressed in the Sage-grouse Core Area Implementation Recommendations available on the WGFD website. Development of stipulations for Sage-grouse core population areas and noncore areas and the *BLM Instructional Memorandum on Sage-grouse* should be reviewed.

Develop long-term grazing and habitat management plans for sagebrush ecosystems within identified priority sage-grouse habitats and big game winter range. Long-term, interagency management plans should be developed in key wildlife areas including those identified within Wyoming's SWAP, WGFD SHP, and Sage-grouse Core Population Areas. The publication *Grazing Influence, Management and Objective Development in Wyoming's Greater Sage-grouse Habitat – With Emphasis on Nesting and Early Brood Rearing* (University of Wyoming 2009) provides an excellent overview and discussion relative to the influences of livestock grazing on sagebrush ecosystems and sage-grouse habitat. Wet meadows within sagebrush systems deserve particular attention. Livestock prefer these sites as the summer progresses and uplands become desiccated, which increases the tendency for over utilization. Many wildlife species use these sites during critical periods, such as pronghorn and mule deer fawning and sage-grouse late brood-rearing. However, meadows excluded from livestock grazing by fences may need to be periodically grazed to reduce dense grassy cover that may inhibit forb availability for wildlife.

While fences are effective for livestock management, they can also be barriers to wildlife movement and cause direct mortality. Fences should be designed to readily allow the passage of big game including pronghorn. Fencing design and instructions can be found in the WGFD Habitat Extension Service Bulletin No. 53 *Fencing Guidelines for Wildlife* (WGFD 2004). Fences also can be a source of mortality to sage-grouse from strikes by flying birds (Wyoming Game and Fish Department 2009a).

Strikes have been documented in winter sage-grouse foraging areas, near leks, and fences around riparian areas used by sage-grouse broods in the summer. Problem fences should be modified, removed, or fitted with marking devices so grouse can see the wires while in flight in low visibility situations.

Efforts should be made to maintain big game herd numbers at ecologically sustainable levels that account for the carrying capacities of the herd unit's summer and winter ranges.

Develop incentives for landowners and land operators to adopt actions identified in the SWAP.
Many ranching operations own and use sagebrush dominated systems for various activities including livestock grazing. Additional incentives need to be developed before management strategies focused on increasing wildlife habitat values in sagebrush systems can be widely adopted. Examples of successful incentives include grassbanks, management agreements encouraging prescribed livestock grazing, and conservation easements. NRCS Farm Bill programs, the NRCS 2010 Sage-grouse Initiative, the USFWS Candidate Conservation Agreement with Assurances, and Wyoming Local Sage-grouse Working Groups all provide opportunities for the establishment of cooperative habitat improvement projects. Additional funding sources include the WGFD Trust Fund Program and Sage-grouse Programs, Tom Thorne Sage-grouse Fund, and Wyoming Wildlife and Natural Resource Trust.

Manage off-road vehicle use in environmentally sensitive areas or during seasons where wildlife is particularly sensitive to disturbance.
More efforts should be made on public lands to identify areas that are appropriate and inappropriate for off-road vehicle use including using Carsonite markers. Locations may vary seasonally to minimize disturbance to wildlife during critical periods such as when animals are on winter range or during nesting or fawning seasons. Public education should include increasing awareness of the ecological role of maintaining unbroken biological soil crust and the value of all types of vegetation.

Conduct more research about the potential effects of climate change on sagebrush ecosystems.
Reduced establishment of new sagebrush plants resulting from changes in climate, while currently hypothetical, could have serious consequences for the future of sagebrush ecosystems and wildlife in Wyoming. Additional research and modeling are needed to better understand the influence of temperature and precipitation on the establishment of sagebrush plants and potential future changes to Wyoming's climate patterns. This information could be used to make predictions on how climate change may influence sagebrush system health and distribution and where in the state these changes are likely to occur. This information should be communicated to wildlife biologists, natural resource managers, and landowners throughout the state to assist in sagebrush ecosystem and wildlife conservation planning.

Sagebrush Shrublands Monitoring Activities

Continue monitoring population trends or changes in distribution of sagebrush SGCN and other obligates in order to infer changes in habitat quality or other threats.
Monitoring should be used to determine distribution and seasonal habitat use to refine priority habitat maps.

Monitor the size and landscape distribution of sagebrush shrublands through remote sensing.
Remote sensing is useful in tracking the size and distribution of this habitat type in Wyoming. Information gathered would be helpful in determining the cumulative impacts of activities and events such as energy development, rural subdivision, road construction, conifer encroachment, and the spread of invasive species. Monitoring should also be conducted

in relation to the possible effects of climate change.

Establish sites and protocols for long-term monitoring to evaluate the effects of habitat management activities on individual plants, vegetation communities, wildlife species, and ecological processes.

Inventory and monitor sagebrush systems and habitats in federal grazing allotments as part of annual inspections and during the 10-year allotment reviews.

Monitoring should include evaluation of livestock and wildlife browsing levels, invasive species, conifer encroachment, and plant understory composition.

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Wetlands

Photo courtesy of WGFD

Table of Contents

Information included in this section was adapted from the Wyoming Wetlands Conservation Strategy (WJVSC 2010). Those desiring additional information on Wyoming wetlands and wetland conservation not covered in this section should consult this document.

Habitat Description

Wetlands are habitats where the soil is annually saturated with water or covered by water at some time during the growing season of each year. For the purposes of this document, wetlands include wet meadows, potholes, playas, oxbows, beaver ponds, marshes, bogs, seeps, the vegetated shorelines of lakes and ponds, and other types of open water. Wetlands have been segregated from riparian areas (page III-8-1) which are designated as habitats associated with riverine systems. This differentiation has been made for SWAP planning and implementation purposes. Conservation and ecological issues for wetlands and riparian habitat types have considerable overlap. A list of the NatureServe Ecological Systems included in the wetlands habitat type can be found in Table 19. Much of Wyoming lacks the precipitation needed to support expansive wetland complexes such as those found in wetter regions of the country (Hubert 2004). Wyoming is the fifth driest state in the United States based on a statewide average rainfall of 16.8 inches (Wyoming State Geological Survey undated).

Wyoming wetlands can be divided into several morphological groups depending on their location and origin. The plains and intermountain basins are typified by low densities of shallow, playa-type wetlands that formed either in blowouts or, in some cases, as a result of tectonic activity. Kettle, cirque, and moraine type wetlands and lakes are present in higher elevations once covered by montane glaciers; however, the Pleistocene glacial sheets that left dense wetland complexes throughout the U.S. and Canadian prairie pothole region, did not reach Wyoming. Springs, bogs, and seeps are scattered throughout the state, but are most common in the montane areas.

Prior to settlement, natural wetlands covered about 3.2% of Wyoming (Dahl 1990) and were predominantly associated with riparian corridors and glaciated montane regions. By the mid-1980s, the total area of wetlands had been reduced to approximately 2% (Dahl 1990). Both the number and area of natural wetlands continue to decline, though this is offset to some extent by an increase in ponds and other human-created wetlands and water bodies.

Since the late 1800s, manmade wetlands have been created, both deliberately and coincidentally, as a result of human activities. Created wetlands vary in quality and can be associated with livestock impoundments; spring developments; windmill basins; irrigation seepage or runoff; sediment retention basins; reclaimed and abandoned mine impoundments; produced water from oil and gas operations; highway ditches and borrow pits; reservoir backwaters; mitigation sites; habitat areas on private, state, and federally-managed lands; and other miscellaneous activities (Tessmann 2004).

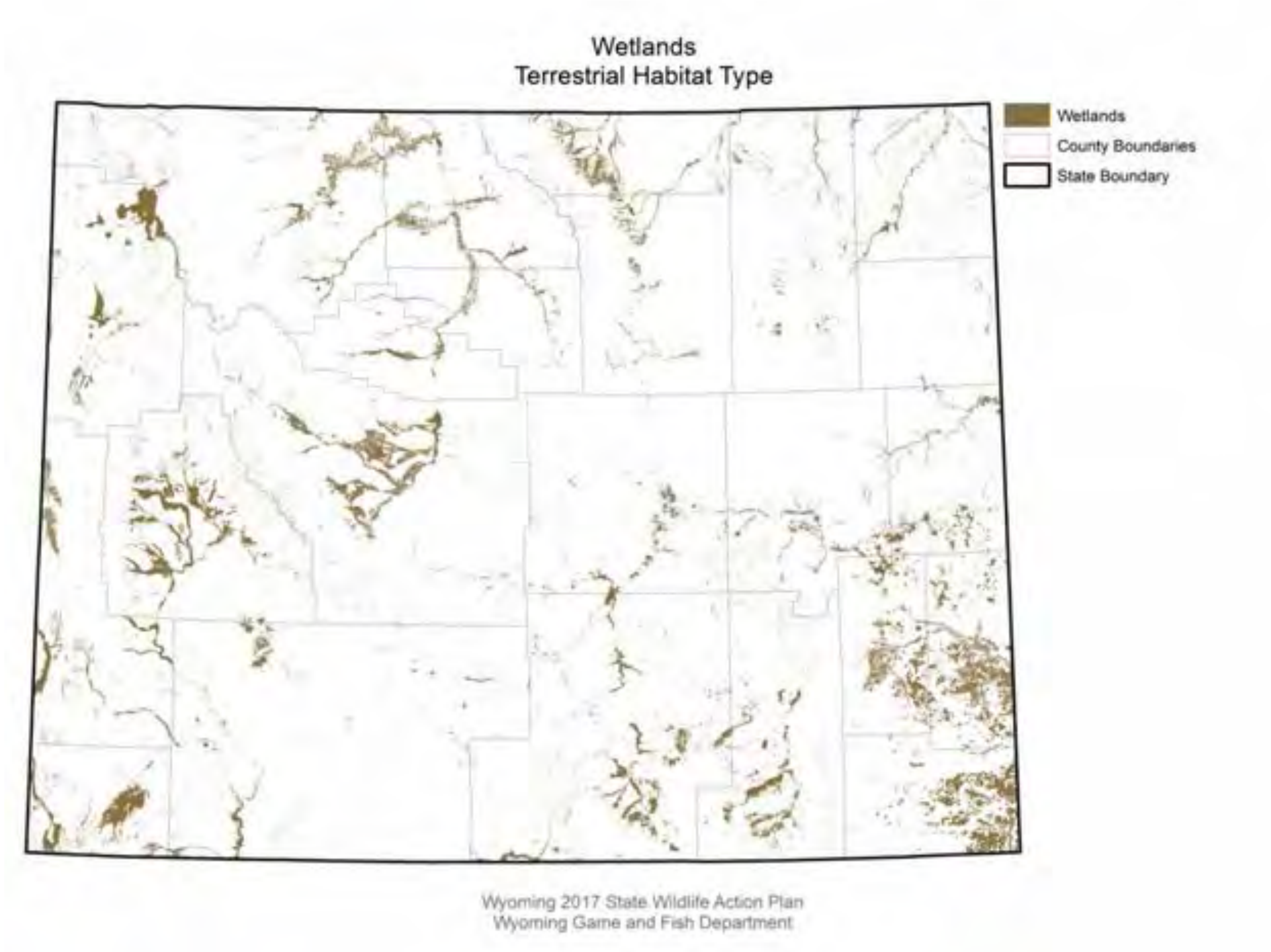


FIGURE 19. Wyoming Wetlands

TABLE 19. Wyoming Wetlands NatureServe Ecological Systems[1]

1. Open Water
2. Pasture/Hay
3. Inter-Mountain Basins Playa
4. Introduced Riparian and Wetland Vegetation
5. Great Plains Prairie Pothole
6. Rocky Mountain Alpine-Montane Wet Meadow
7. Western Great Plains Open Freshwater Depression Wetland
8. North American Arid West Emergent Marsh
9. Columbia Plateau Vernal Pool
10. Rocky Mountain Subalpine-Montane Fen
11. Western Great Plains Closed Depression Wetland
12. Western Great Plains Saline Depression Wetland
13. Inter-Mountain Basins Alkaline Closed Depression
14. Inter-Mountain Basins Interdunal Swale Wetland

[1] Descriptions of NatureServe Ecological Systems which make up this habitat type can be found at: NatureServe Explorer: an online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. http://www.natureserve.org/explorer.

TABLE 20. Wyoming Wetlands Species of Greatest Conservation Need

Mammals
Fringed Myotis
Hayden's Shrew
Little Brown Myotis
Long-eared Myotis
Long-legged Myotis
Moose
Northern Long-eared Myotis
Pallid Bat
Preble's Shrew
Pygmy Shrew
Spotted Bat
Townsend's Big-eared Bat
Water Vole

Birds
American Bittern
American White Pelican
Black-crowned Night-Heron
Black Tern
Caspian Tern
Cattle Egret
Clark's Grebe
Common Loon
Forster's Tern
Franklin's Gull
Snowy Egret
Trumpeter Swan
Virginia Rail
Western Grebe
White-faced Ibis

Reptiles
Red-sided Gartersnake
Valley Gartersnake
Plains Gartersnake
Smooth Greensnake
Western Painted Turtle

Amphibians
Columbia Spotted Frog
Great Basin Spadefoot
Great Plains Toad
Northern Leopard Frog
Plains Spadefoot
Western Tiger Salamander
Western Toad
Wood Frog
Wyoming Toad

Wetlands Wildlife

Wetlands are an extremely important wildlife habitat, disproportionately contributing to the diversity of Wyoming wildlife relative to the land base which they occupy. About 90% of wildlife species in Wyoming use wetlands and riparian habitats daily or seasonally during their life cycle, and about 70% of Wyoming bird species are wetland or riparian obligates (Nicholoff 2003). The high wildlife value of wetlands is derived largely from the presence of water which supports a large diversity of plants and animals, including invertebrates, which provide a forage base. Along altitudinal gradients, wetlands at mid and lower elevations tend to support greater diversity and density of wildlife because the growing season is longer, enabling those wetlands to be more productive. High elevation wetlands (over 8,000 ft) can be important for specific life stages of several species, but are not as productive.

Wetlands serve a valuable role in storing water. Marshes, fens, wet meadows, and similar cover types act as sponges that absorb and retain snowmelt and runoff, then slowly release it through the growing season. This increases the amount and reliability of downstream flows, especially in late summer, which in turn increases the quality of downstream riparian habitats. In addition, most wetlands improve the quality of water that is discharged. This is accomplished by removing sediments and some pollutants from water, thus acting as filtration systems for downstream communities, both human and ecological.

Clusters of wetlands in close proximity (wetland complexes), especially wetlands of differing size, chemistry, vegetation cover, and hydrology tend to sustain greater use by wildlife (WJVSC 2010). In addition, species richness and abundance tend to increase with wetland size (Mack and Flake 1980, Belanger and Couture 1988, Brown and Dinsmore 1986, McKinstry and Anderson 2002). Accordingly, diversity of size and water permanence are important attributes of wetland systems. Isolated wetlands in arid environments are also extremely valuable for wildlife. Wetlands in these areas often provide a crucial water source and enhanced cover and forage production, making them a hub of activity for terrestrial wildlife that inhabit the surrounding area.

Wetlands provide irreplaceable habitat for waterfowl. Notable waterfowl species in Wyoming include the mallard, pintail, American widgeon, gadwall, green-winged teal, blue-winged teal, cinnamon teal, redhead, ring-necked duck, goldeneye, snow goose, and Canada goose.

Migrating shore birds also depend on wetlands. Shorebirds are known to have the longest migrations of any animal species, migrating as far as from the Arctic to the tip of South America, with non-stop flights, exceeding a thousand miles per leg (Brown et al. 2001). Wetlands provide food rich environments for shorebirds to build up fuel reserves needed to complete these long flights. Shorebirds frequently seen in Wyoming wetlands include American avocet, black-necked stilt, Wilson's phalarope, greater and lesser yellowlegs, long-billed dowitcher, killdeer, common snipe, spotted sandpiper, solitary sandpiper, western sandpiper, semipalmated sandpiper, willet, long-billed curlew, and white-faced ibis.

Wetlands are also very important for bats. Physical characteristics that influence how bats use water resources include size of the water body, extent of open water, surrounding and emergent vegetation, turbulence of the water, proximity to roosts, and water quality. In general, water features increase in value to bats if they are large, calm, and uncluttered; are in close proximity to roosts; have a diverse and productive riparian zone; support a diverse insect community; and are free of pesticides and other contaminants. Bats drink while in flight, accordingly they require water sources that are large and uncluttered for them to approach and skim the surface. Although tall vegetation and other features surrounding small bodies of water may reduce accessibility for some bats, the presence of some vegetation around water is nevertheless an important component of bat habitat. The vegetation provides abundant insect prey and protection from predators, and improves foraging conditions by blocking wind.

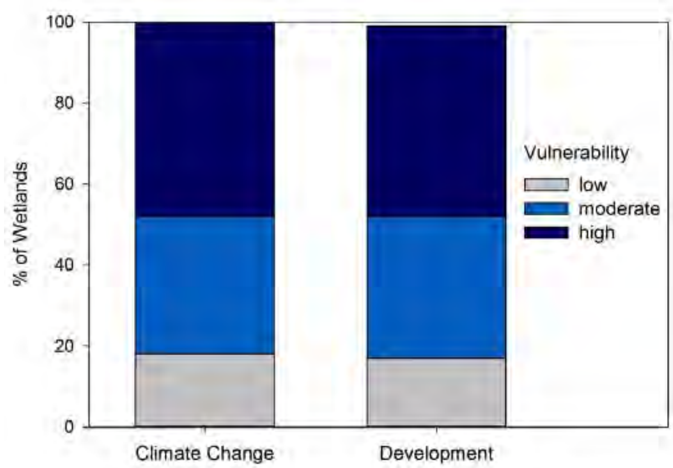
Alpine and sub-alpine wetlands and wet meadows are especially important for shrews and the water vole. These semi-aquatic species, rely heavily on leaves, roots, and stems of forbs, and invertebrates.

Wetlands are an important feature for amphibians. All of Wyoming's amphibian species are reliant on water to complete their life cycle. Eggs are laid aquatically, where they hatch into larvae (some are referred to as tadpoles). The larvae then undergo metamorphosis to become terrestrial adults. However, the western tiger salamander may remain aquatic as an adult while retaining larval characteristics (termed *paedomorphism*). Many wetlands provide ephemeral fishless pools that amphibians prefer for breeding. In addition to utilizing wetlands for breeding and larval development, many frogs, toads, and salamanders are tied to aquatic environments as adults. Many amphibians, primarily frogs and salamanders, require wet environments to prevent desiccation and to provide cover from predators. Western tiger salamanders may live their entire lives in an aquatic environment, exhibiting paedomorphism.

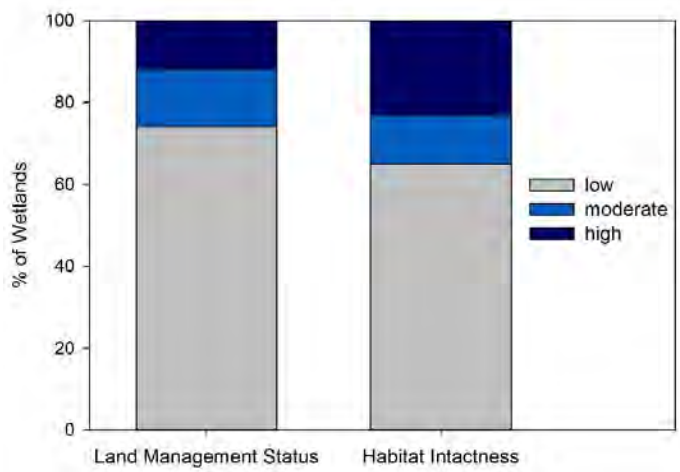
Many reptile species also prefer wetland habitats. Gartersnakes are particularly reliant on this habitat type. Gartersnakes are found in the subfamily Natricinae and closely related to the genus Nerodia (watersnakes). They are typically found in the moist environments found in wetlands and other riparian corridors. Gartersnakes feed on a variety of aquatic species including fish, invertebrates, and amphibians.

Wetland Habitat Threats

Figure 20. Wetlands Vulnerability Analysis



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high vulnerability to climate change or development, based on classification of scores ranging from 0 to 1 into the following categories: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for climate change or development vulnerability were based on the land area of the habitat type classified as having high vulnerability: low (<10%), moderate (10-33%), or high (>33%). Vulnerability was calculated as exposure minus resilience. Development vulnerability includes existing and projected residential, oil and gas, and wind energy development. Further details are provided in the Leading Challenges section of this report and in Pocewicz et al. (2014).



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high land management status or habitat intactness. For land management status, high corresponds to the percent of the habitat occurring in GAP status 1 or 2, moderate to the percent occurring in GAP status 2b or 3, and low to the percent occurring in GAP status 4. Rankings for land management status were based on the land area of the habitat type classified as having high status or legal protection: low (<10%), moderate (10-33%), or high (>33%). For habitat intactness, scores ranging from 0 to 1 were assigned to categories as follows: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for intactness were based on the land area of the habitat type classified as having high intactness: low (<25%), moderate (25-75%), or high (>75%).

For a more additional detail and more complete listing of threats facing Wyoming wetlands, please refer to *Wyoming Wetland Conservation Strategy* (WJVSC 2010) and *Wyoming Partners In Flight Bird Conservation Plan - Wetlands Section (*Nicholoff 2003). For consistency, habitat threats ranked *extreme* in the Wyoming Wetland Conservation Strategy were ranked *high* in the SWAP which does not use an *extreme* threat category.

Climate Change and Drought - High
Variable weather patterns and periodic drought cycles are common occurrences in the West and an important driver of wetland ecology. However, the frequency and duration of droughts have increased markedly since the 1980s, producing undesirable changes in wetland hydrology and the long-term loss of functional wetlands in some areas. Wetlands associated with irrigation may be insulated from drought if water continues to be available. Alternatively, wetlands dependent upon irrigation, particularly created wetlands with junior water rights, can remain dry for extended periods. In addition, natural wetlands can be severely impacted by long-term climatic changes leading to desertification and depleted stream flows (see Wyoming Leading Wildlife Challenges - Climate Change).

Rural Subdivisions – High
Houses, outbuildings, and lawns directly eliminate native wildlife habitat. Additional infrastructure such as roads, buildings, power lines, and fences, along with disturbances including traffic, human activity, and increased predator densities, can lessen the suitability of wetland habitats for sensitive wildlife. Loose pets, especially cats, are very problematic for wildlife near subdivisions. Pesticides, herbicides, and nutrients may enter aquatic environments, and their concentrations increase as a result of runoff from nearby lawns and landscaping use. Soil disturbance from construction and the year-round grazing of horses and other hobby livestock can facilitate the establishment of invasive plant species. Wildlife attempting to avoid human-related disturbances expend greater energy and displace to lower quality habitats, resulting in lower survival and reproductive capacity (See Wyoming Leading Conservation Challenges – Rural Subdivision and Development).

Conversion of agricultural operations to rural residential development can also lead to a loss of flood irrigated meadows which are important to many wildlife species. The establishment of water wells for domestic use can deplete groundwater and negatively impact springs and wetlands.

Invasive Plant Species - High
Invasive plants impair habitat functions of wetlands and riparian communities in many regions of the Wyoming. Tamarisk (also known as *saltcedar*) and Russian olive are causing the most significant impact on Wyoming's wetland habitats. Although tamarisk and Russian olive provide cover and forage benefiting some species of wildlife, they often dominate native vegetation, adversely affect wetland hydrology, and attract abnormally high densities of predators (see Wyoming Leading Wildlife Challenges – Invasive Species). Other invasive species also impact wetlands including leafy spurge, Dalmatian toadflax, whitetop, Canada thistles, black henbane, and spotted knapweeds.

Water Development Projects – High
The Wyoming Game and Fish Department's Stream/Lake Database includes 666 manmade reservoirs covering a surface area of slightly over 248,000 acres or 388 mi^2 (these figures do not include most livestock impoundments or waters on the Wind River Indian Reservation). At least 30 Wyoming reservoirs exceed 10,000 acre-ft in capacity, and 15 exceed 100,000 acre-ft. Although dams create large deepwater habitats, significant areas of wetlands and riparian habitats are often inundated. The potential for wetland margins to develop around shores of large reservoirs is limited by wave action and unstable water levels, which generally preclude the establishment of wetland vegetation. In addition, large reservoirs stabilize flows and cause several downstream impacts including loss of braided channels, eventual loss of oxbow wetlands, and channel constriction by riparian vegetation. Flood control also allows residential and commercial development to take place within floodplains. Finally, reservoirs trap silt loads, and the clear water that is discharged from dams causes additional channel downcutting and

erosion (see Wyoming Leading Wyoming Wildlife Challenges – Disruption of Historic Disturbance Regimes *and* Riparian Habitat Type).

Energy Development and Mining Practices - High
Gas, oil, coal, uranium, coal-bed methane, and wind development are taking place on a landscape scale throughout many regions of Wyoming (see Wyoming Leading Conservation Challenges – Energy Development). Bentonite, trona, and gypsum are also mined on a large scale. Impacts from energy development vary depending on the type of development, location, regulatory requirements, and mitigation efforts.

Vegetation clearing, road construction, noise, and increased human and equipment activity associated with energy development and mining are known to adversely impact several species of wildlife (see Transportation Infrastructure). Ponds and wetlands have been created on some gas fields by discharging oil- and gas-produced water onto the surface in specific locations. Such ponds are often beneficial to wildlife. However in inappropriate locations, they may enhance breeding conditions for mosquitoes and increase spread of West Nile virus, which is detrimental to sage-grouse and several other avian species. New water sources on big game winter ranges can also change animal distribution, potentially resulting in less forage available during winter. Wind turbines sited within or too close to lakes and wetlands can potentially cause waterfowl, waterbirds, and shorebirds to displace from or avoid areas of otherwise suitable habitat. Turbines and associated power lines also increase mortality due to collisions if they are located too near migration corridors, refuges, and feeding and resting sites (WJVSC 2010). Sand and gravel mining operations sited on floodplains have likely produced a net gain of wetlands and open water habitats in Wyoming because it was historically common to convert abandoned or reclaimed gravel quarries into ponds and small lakes with wetland margins. The net effect of this practice has been an increase in pond-type habitats and some loss of riverine, shrubland, and other types of habitats.

Incompatible Agricultural Practices - High
Agricultural operations have created wetlands in conjunction with irrigation projects, livestock watering ponds, and federal cost share programs for wetland restoration in several areas of Wyoming. However, in the absence of adequate financial incentives or alternative conservation options, some agricultural practices adversely affect wetlands. Sediment runoff from tilled fields, heavily grazed pastures, or poorly managed watersheds can decrease the lifespan of ponds and wetlands. Some agrichemical runoff, including fertilizers, pesticides, herbicides, and animal waste, also impairs water quality and is harmful to plant life, and wildlife. Livestock grazing within wetland basins can remove vegetation cover, and destroy nests of ground-nesting birds. It is important to manage the timing of grazing so nests are not trampled and paths through wetland vegetation are not created, which allows predators to access vulnerable nests, eggs, and young. Most agricultural impacts are minimized or avoided by following appropriate best management practices (Dressing et al. 2003).

Transportation Infrastructure - High
Road improvements can affect wetlands through vegetation removal, alteration of hydrology, and increased human activity including vehicle traffic. Hydrology is affected by drainage ditches, borrow pits, gravel quarries, culvert installation, and instances of construction of the original roadbed blocking surface drainage. Additional impacts associated with roads include disturbances caused by traffic, which can displace sensitive species from nearby wetlands. Roads also become barriers to less mobile wildlife such as salamanders and turtles, and heavy traffic increases mortality of all wildlife attracted to nearby wetlands.

Management and Maintenance of Existing Wetland Projects - High
It can be a challenge for agencies to obtain ongoing funding needed to maintain wetlands in a productive, properly functioning condition. This is particularly the case at created wetlands where water levels need to be manipulated, dikes maintained, vegetation treated, and the appropriate grazing and erosion control practices administered.

Alternation of Irrigation Delivery Systems - Moderate
Wetlands have become established in many locations by seepage along irrigation canals and lateral ditches, and runoff from irrigated fields. Improvement projects intended to reduce seepage losses, such as installing canal linings or pipes, can potentially eliminate some of these wetlands. On the other hand, more efficient water delivery can increase appropriated water supplies to some wetlands, and may also increase irrigation runoff into others. Ongoing conversions from flood irrigation to center pivot sprinkler systems is adversely impacting wetlands in several regions of Wyoming because this water conservation measure yields substantially less runoff or waste water into watersheds and wetland basins.

Current Wetlands Conservation Initiatives

Wetlands conservation is receiving a great deal of attention in Wyoming. Prominent organizations engaged in these efforts include Ducks Unlimited, US Fish and Wildlife Service's Partners for Fish and Wildlife Program, Intermountain West and Northern Great Plains Joint Ventures, Natural Resource Conservation Service, Conservation Districts, The Nature Conservancy, and regional land trusts.

Ducks Unlimited (DU) is a nonprofit organization focused on wetland and waterfowl conservation. To accomplish its goals, DU frequently works with private landowners to build, restore, and conserve wetlands through conservation easements, fee title acquisitions, management agreements, and technical assistance. Two of DU's efforts that benefit Wyoming are the Platte River Initiative and Rainwater Basin Initiative in DU's Southern Great Plains region and the High Country Wetlands Initiative in DU's Northern and Southern Rockies region.

The mission of the Intermountain West Joint Venture (IWJV) is to facilitate the long-term conservation of key avian habitat including planning, funding, and developing habitat projects that benefit all biological components of Intermountain ecosystems. The IWJV Management Board reviews and ranks various habitat protection, restoration and enhancement projects for funding through NAWCA and other programs. The IWJV Implementation Plan identifies priority bird species and lists statewide conservation goals for priority habitats such as total acreage protected, maintained, enhanced, or restored (Intermountain West Joint Venture 2005). The Northern Great Plains Joint Venture (NGPJV), a similar initiative, has been engaged primarily in planning efforts and is a cooperator in the development of a NE Wyoming regional component of the Wyoming Wetlands Conservation Strategy. The NGPJV administrative boundary includes seven counties in NE Wyoming: Campbell, Converse, Crook, Johnson, Niobrara, Sheridan, and Weston (Pool and Austin 2006).

The U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program promotes on-the-ground wetland restoration projects on private lands. Focal areas targeted for wetland projects include the Laramie Plains, Goshen Hole, Wind River Indian Reservation, Great Divide Basin, and the New Fork Pothole Region of the Upper Green River Basin.

The Dumbell Ranch Stream, Riparian and Wetland Bank was approved by the U.S. Army Corps of Engineers in 2014, in conjunction with an Interagency Review Team consisting of the U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, Bureau of Land Management, Natural Resources Conservation Service, Wyoming Department of Environmental Quality, Wyoming Game and Fish Department and Wyoming State Engineer's Office. The Bank can be used to mitigate unavoidable wetland and stream impacts within a defined geographical service area. Credits may be approved for use outside of the service area with at the discretion of the U.S. Army Corps of Engineers. The stated goal of the Bank is to restore, enhance and maintain palustrine emergent wetlands, riparian areas and aquatic resources within the 740.59 acre bank boundary.

The Natural Resources Conservation Service (NRCS) offers three Programs, authorized through the 2014 Farm Bill that can be used to address wetland conservation needs on the land. The Environmental Quality Incentives Program (EQIP) provides financial and technical assistance to agricultural producers in order to address natural resource concerns and deliver environmental benefits. The Conservation Stewardship Program (CSP), helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resources concerns. The Agricultural Conservation Easement Program (ACEP) provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits. The Agricultural Land Easements (ALE) component protects working agricultural lands. Under the Wetlands Reserve Easements (WRE) component, NRCS helps to restore, protect and enhance enrolled wetlands.

The Wyoming Game and Fish Department (WGFD) has worked on a number of small projects to provide nesting and summer habitat for a population of trumpeter swans established in the Upper Green River basin through a captive breeding program.

Local Conservation Districts in Wyoming have been involved in numerous projects to improve wetlands habitat through land management and restoration techniques on private lands. Conservation easements held by Wyoming land trusts, including the Jackson Hole Land Trust, Sheridan Community Land Trust, and Wyoming Stock Growers Agricultural Land Trust, also help to protect wetlands from potentially detrimental land uses and development.

The Wyoming Wetlands Conservation Strategy (WWCS) was developed through a collaboration between several agencies and organizations represented on the Wyoming Joint Ventures Steering Committee (WJVSC) in 2010 (WJVSC 2010). The WWCS presents a thorough review and analysis of important wetland and riparian habitats, major threats, conservation goals and strategies, regulatory framework, partnership opportunities, and links to resources that can assist efforts to conserve and enhance wetlands and riparian habitats in Wyoming.

Conservation focus areas identified in the WWCS were based upon results of two studies. The first was a semi-qualitative assessment completed by the WGFD and U.S. Fish and Wildlife Service (USFWS) for inclusion in the 1995 Statewide Comprehensive Outdoor Recreation Plan (WGFD 1995). The 1995 study identified 49 wetland complexes including 8 priority complexes throughout Wyoming. A more recent geospatial analysis by The Nature Conservancy (TNC) has identified 222 wetland complexes (Copeland et al. 2010). The Copeland et al. study also produced several sets of condition indices that can be applied in a variety of ways to prioritize wetlands.

For purposes of the WWCS, 28 priority complexes were identified based on highest species diversity scores (Copeland et al. 2010), and the WJVSC selected three additional complexes based on unique ecological considerations (Appendix A, Table 21). From the 31 priority wetland complexes, the WJVSC identified 9 primary focus areas (wetland complexes) in which partners will be encouraged to plan and implement projects over the next 10-year horizon (shown as green-shaded rows in Appendix A, Table 21, and as dark blue shaded complexes in Figure 11). The criteria for selecting 6 focus areas included a normalized Shannon diversity score of at least 93 (on a scale of 100), combined with a *high* project opportunity rating. The 3 complexes with unique ecological values were added to these. All 8 priority complexes identified in the 1995 study are included in the 9 focus areas identified by the WJVSC.

A thorough review of the regulatory and statutory framework influencing wetland conservation, mitigation, and restoration in Wyoming is provided in the WWCS (WJVSC 2010).

Figure 21. Thirty-one priority wetland complexes including nine primary focus areas (dark blue) identified by the Wyoming Joint Ventures Steering Committee. The nine primary focus areas are: Bear River, Goshen Hole, Laramie Plains, Little Snake R./Muddy Cr., NE Wyoming (Little Missouri R./Belle Fourche R./Beaver Cr.), Red Desert/Great Divide Basin, Snake River Valley (Jackson), Upper Green River, and Wind River Basin. Based on data provided by Copeland et al. (2010).

Recommended Wetlands Conservation Actions

A more comprehensive description of wetland conservation recommendations can be found in the WWCS (WJVSC 2010).

Secure additional human resources to plan and implement wetland conservation projects.
The WJVSC has identified the limited availability of agency specialists and other human resources as the leading constraint to making full use of available wetlands conservation programs and funding sources in Wyoming. Wetlands conservation projects can be complex and time consuming and frequently call for persistent attention to ensure all requirements are met. Specific knowledge is needed to identify and develop project proposals, assemble grant applications, complete certified engineering designs, conduct land surveys, secure permits and clearances including water rights, and administer projects. Currently, a lack of dedicated personnel with specific expertise in these areas is a significant limitation to the level of wetlands conservation work in Wyoming, despite available funding.

The WWCS (WJVSC 2010) has recommended creation of statewide or regional wetlands coordinator positions to connect conservation organizations with partners and available funding sources and to help develop project proposals in order to increase the amount of wetland conservation work done in Wyoming. Funding to support such positions could be assembled from several sources, and the positions could be designed to advance the work of multiple wetland conservation groups operating within the state. The current state hiring freeze may limit the ability to house these positions within the WGFD.

Enhance use of existing wetland conservation and funding programs.
Wetland conservation programs and funding sources available in Wyoming are not being used to their full potential.

Because future state allocations are partially based on previous years' program use, this could negatively impact the amount of funding made available to Wyoming for this program in the future. Capitalizing on existing wetland conservation programs may become increasingly important in an era of budget reductions where the establishment of new funding sources may be limited.

Methods to enhance the use of existing funding sources include increasing coordination and partnerships to leverage dollars in order to meet matching fund requirements for WWNRT, Joint Ventures, and other grant programs. The establishment of watershed/basin scale projects can also improve the ability to access large funding sources such as NAWCA. Organizing projects on a larger watershed or wetlands complex scale can help create lists of eligible shovel-ready projects which are often necessary to take full advantage of funding sources that operate on annual granting cycles. Additionally, increasing dialogue with the Wyoming State Engineers Office, Board of Control, and the NRCS could help identify opportunities to streamline permitting processes and better align permitting with grant funding cycles.

The capability to fully utilize existing wetlands programs is often dependent on availability of personnel to deliver projects. Efforts to fully fund the Wyoming Wildlife and Natural Resource Trust Fund at $200 million should continue in order to meet the state match requirement for most federal conservation programs.

In addition to pursuing voluntary conservation agreements, wetlands protection efforts should include monitoring compliance with state and federal wetlands protection laws; notifying appropriate regulatory authorities of potential violations; and working collaboratively with landowners, industry, and agencies to recommend avoidance or effective mitigation for projects that may potentially impact wetlands.

Rely on the WWCS statewide prioritized list of high wildlife value wetlands to focus conservation efforts.
The 31 priority wetland complexes and 9 focus areas that have been identified in the WWCS (WJVSC 2010) should be used to guide wetlands enhancement and conservation actions in Wyoming (Appendix A, Table 21). However, projects for which there is high interest, partnership potential, and funding availability should not be excluded even if they are not located within one of the priority or focus areas. The WJVSC recently

produced a report highlighting the nine focus areas and strategies for conservation in each area. This report could help catalyze wetlands projects in the nine focus areas, and help make the case for grant funding.

Distribute a statewide list of potential wetlands projects and restoration sites to agencies, industry, and nongovernmental organizations involved with wetlands conservation and mitigation.

Appendix B of the WWCS (WJVSC 2010) contains a statewide list of potential wetlands and riparian conservation and restoration projects and project concepts. The list will be made available to government agencies, industry, and conservation organizations administering wetlands programs. As well, efforts will be made to increase awareness and training for entities required to mitigate wetlands as part of the construction permitting process. The WWCS contains links to several credible sources in the wetlands design arts and other resources that can assist with planning and implementing wetlands projects throughout the state. Advancing wetland creation and enhancement through the Wyoming Wetlands Act [W.S. §§ 35-11-308 through 35-11-311] mitigation banks will also be investigated (WJVSC 2010).

Increase availability and dependability of water supplies.

Water supplies can be a limiting factor for creating and maintaining wetlands in several areas of Wyoming. Excellent water quality at all nesting and foraging sites is critical. Water level management is also vital to ensure that emergent vegetation used for nesting and cover has adequate water for growth, and that nests are neither flooded nor left high and dry, both of which contribute to nest failure. Recurring drought and increasing agricultural, industrial, and residential demands for water will likely be a part of Wyoming's future. New options should be explored to provide adequate water for wetlands creation and enhancement projects. Possibilities include investigating new and existing funding sources to enhance water delivery, developing groundwater wells to augment surface water supplies into constructed wetlands, and leasing or acquiring property on which water rights can be managed to enhance wildlife habitats. Other options to obtain water should be explored with the Wyoming State Engineers Office. Additionally, numerous opportunities exist throughout Wyoming to establish small palustrine wetlands by reintroducing beaver into suitable vacant habitat.

Continue to support wetland-based recreational opportunities.

Access to wetlands outdoor recreation and educational opportunities is important to maintain public support for wetlands conservation. Federal Duck Stamps, required for migratory waterfowl hunting, have generated more than $800 million which has been used to help purchase or lease over 5.7 million acres of waterfowl habitat in the U.S. (USFWS website). Nonprofit organizations founded by outdoor recreationists have contributed even more to wetlands conservation. For example, Ducks Unlimited has directly conserved 13 million acres of wetlands in North America (DU website). In addition to hunting, wetlands sustain other outdoor activities such as fishing, wildlife viewing, and nature photography. In 2006, close to 35 million people visited national wildlife refuges in the lower 48 states, generating almost $1.7 billion of sales in regional economies (Carver and Caudill 2007). About 82 % of these expenditures were generated by activities other than hunting and fishing. While encouraging this interest and support, special attention should be given to minimizing human disturbance, especially during the breeding season, because many species are extremely sensitive and, if disturbed, will abandon nests, eggs, or young.

Create Wyoming wetlands conservation website.

The WJVSC recommends developing and hosting a statewide website to increase awareness about wetlands in order to foster wetland conservation throughout Wyoming. The website would identify wetland habitat protection, mitigation, and enhancement opportunities in priority regions of the state. The overriding purpose is to facilitate cooperation and collaboration among wetlands conservation groups operating in Wyoming and to connect project proponents with available funding and other resources to accomplish additional projects. Projects lists will also present opportunities for companies, individuals, and agencies to fulfill mitigation obligations, as required under various federal laws and programs. Finally, the website would contain basic information about the ecological values of wetlands, laws and programs pertaining to wetland conservation in Wyoming, as well as mitigation guidelines and management practices. The website could also host a downloadable version of the aforementioned focus areas report.

Wetlands Monitoring Activities

Continue monitoring wetlands SGCN in order to detect population trends or changes in distribution that may reflect habitat problems. This information should be used to guide future monitoring and research, as well as habitat conservation needs.

Continue to monitor the distribution and condition of wetlands through remote sensing and ground surveys.
Remote sensing is a useful tool for tracking the size and distribution of wetlands and changes in their hydrologic condition. Such information would be useful in determining the cumulative impacts through time of activities and events such as drought, energy development, rural subdivision, agricultural conversions, and wetlands creation projects. Special attention should be given to monitoring these parameters within the 31 priority wetland complexes and 9 primary focus areas identified by WJVSC (2010) (Figure 11). This technique will require the further development of monitoring protocols. In addition, periodic ground surveys will be needed to monitor the physical, chemical, and biological condition of wetlands throughout Wyoming, and to identify those that exist in an impaired condition.

Track wetlands conservation, mitigation, and restoration projects on the 31 priority wetland complexes and 9 primary focus areas identified by WJVSC (2010) to assess their success and guide future actions.
Monitoring records should include acreages under various conservation strategies, conservation mechanism (easement, fee title acquisition, management agreement, wetland creation or enhancement project, etc.,), issues addressed (development restrictions, grazing plan, water or watershed management, habitat creation, etc.,) and partners involved. The use of state, federal, and private funds and in-kind match should also be tracked.

In cooperation with research entities and the Wyoming State Climatologist, monitor the effects of climate change including extended drought or wet cycles.

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Appendix A

The Nature Conservancy Wetlands Assessment Study

The Wyoming Wetlands Conservation Strategy (WJVSC 2010) identifies focus areas for wetlands conservation based upon two wetland complex prioritization efforts. The first assessment was completed by the WGFD and U.S. Fish and Wildlife Service (USFWS) for inclusion in the 1995 Statewide Comprehensive Outdoor Recreation Plan (SCORP). The SCORP prioritization relied upon qualitative ranking criteria adapted from National Wetlands Priority Conservation Plan (NWPCP). Priority rankings were based on the following NWPCP criteria and weights: wetland functions and values (33%), historic trends of wetland losses (33%), and relative threat of future loss or degradation (33%).

The Nature Conservancy (Copeland et al. 2010) led a study to define 222 wetland complexes through Wyoming and examine the landscape scale characteristics and conditions of each. Descriptors included wetland density (average number of wetlands per hectare within each complex perimeter), wetland condition or integrity (based on proximity of land uses or activities known to impair wetland functions, Figure 12), wildlife species richness (number of SGCN present), species diversity (Shannon index based on SGCN, Figure 13), number of rare species (based on state and internationally-recognized species), and future vulnerability (based on models projecting future residential and oil and gas development and climatic conditions, Figure 14). Identification of priority complexes was based on SGCN diversity. Primary focus areas included those priority complexes with a normalized diversity score of at least 93 and high project potential. Three additional complexes identified by the WJVSC were included in the list of nine focus areas based on unique ecological considerations and/or high project interest.

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Table 21. Wyoming Wetlands Conservation Strategy (WJVSC 2010) 31 priority wetland complexes and 9 focus areas. *

										Normalized Scores = [(raw score) ÷ (max score)] X 100				
	TNC ID No.	WGFD ID No.	Shannon Diversity Rank	WGFD Rank	Complex Name	Complex Area (mi^2)	Wetland Density (No/mi^2)	Wetland Area (acres)	No. SGCN	Shannon Diversity	Rare Species Presence	Integrity	Vulnerability	Project Opportunity
	1	49	11		Beartooth Plateau	255.9	10.7	3,433	27	86	83	81	22	Unk.
	6	41	3	6,7	Snake R.Valley – Jackson	239.6	8.0	8,554	32	96	67	70	44	High
	7	39	7	2	Salt River	155.2	10.8	10,064	27	91	67	70	36	Medium
	26	36	11		Henrys Fork	168.4	6.7	10,377	28	86	67	75	31	Low
**	64,66	28,29			Red Desert/Great Divide Basin **	59.9	8.0	2,997	8	59	0	85	34	Medium
	72,189 212	38	4	3	Bear River (3 segments)	587.6	8.0	40,060	32	94	67	71	24	High
**	75,77, 79, 214	27			Little Snake R./ Muddy Creek **	429.5	6.0	11,654	14	69	17	75	62	High
	80	11	9		Pathfinder – Sweetwater River	573.9	6.0	12,527	33	89	67	79	19	Medium
	104	1,2,3,6	4	4	Goshen Hole	491.0	5.7	7,149	32	94	50	56	29	High
	136	17	10		Old Woman Creek	2.0	2.5	5	21	88	33	72	0	Low
	165	21	7		Clear Creek – Powder River	92.2	0.8	109	30	91	33	66	56	Medium
	173	37	12		Sulphur Creek	26.3	16.7	1,012	25	85	67	63	13	Medium
	174	36	9		Wasatch Front	135.6	14.7	2,473	29	89	83	77	10	Unk.
**	175, 218-19	25			NE WY (L Missouri/ Belle F/Beaver Cr)**	877.9	5.0	5,371	23	83	33	76	42	High
	178	25	9		Inyan Kara	477.3	4.6	3,497	27	89	33	71	21	Medium
	179	25	10		Beaver Cr. – Upton	933.5	4.5	4,878	27	88	33	68	16	High

Table 21. (continued)

									Normalized Scores = [(raw score) ÷ (max score)] X 100				
TNC ID No.	WGFD ID No.	Shannon Diversity Rank	WGFD Rank	Complex Name	Complex Area (mi²)	Wetland Density (No/mi²)	Wetland Area (acres)	No. SGCN	Shannon Diversity	Rare Species Presence	Integrity	Vulnerability	Project Opportunity
180	4 & 5	6		Wheatland	236.6	5.6	4,819	30	92	50	52	8	Medium
181	N/A	9		Laramie Range	1,214.4	5.4	8,295	32	89	50	78	4	Low
182	8	3	8	Middle N. Platte R.	753.3	5.1	9,802	34	96	67	57	75	Low
184	44	1		Bighorn River/ Greybull River	1,859.4	5.7	29,825	41	100	100	53	90	Medium
185	N/A	10		West Wind R. Range	1,603.9	11.3	29,782	36	88	83	86	24	Low
193	Out	10		Skull Creek/Pat O'Hara Creek	80.2	5.4	147	30	88	67	64	37	Unk
207	Out	12		East Wind R. Range	709.7	8.1	9,783	35	85	67	93	6	Low
208	43	3		Wind River Basin	1,246.8	7.1	37,706	40	96	100	65	97	High
210	38	10		Smiths Fork/ Lower Bear River	317.7	5.7	4,860	32	88	67	82	10	High
211	34	2		Green River Basin	2,594.6	8.2	174,193	36	97	100	69	81	High
213	35	4		Blacks Fork/Little Muddy Creek	590.2	8.3	38,006	32	94	83	70	7	Unk.
216	Out	13		Snowy Range	1,021.1	10.1	22,461	30	81	67	73	13	Low
217	15	5	5	Laramie Plains	1,401.9	6.4	83,094	32	93	67	70	34	High
221	22	8		Tongue R. – Sheridan	564.6	4.8	3,625	29	90	33	54	81	High
222	26	6		Upper N. Platte R.	655.6	7.0	27,969	32	92	50	70	8	High

* Data from Copeland et al. (2010) and WGFD (1995, 2008). Areas highlighted in green are priority wetland complexes identified by the Wyoming Joint Ventures Steering Committee (WJVSC). Except as noted below, these areas have TNC diversity ranks in the top 5 *and* high project potential.

** Additional wetland complexes were included at the discretion of the WJVSC because they have unique ecological values that are not reflected by their TNC diversity scores *and* exceptionally high potential for conservation projects.

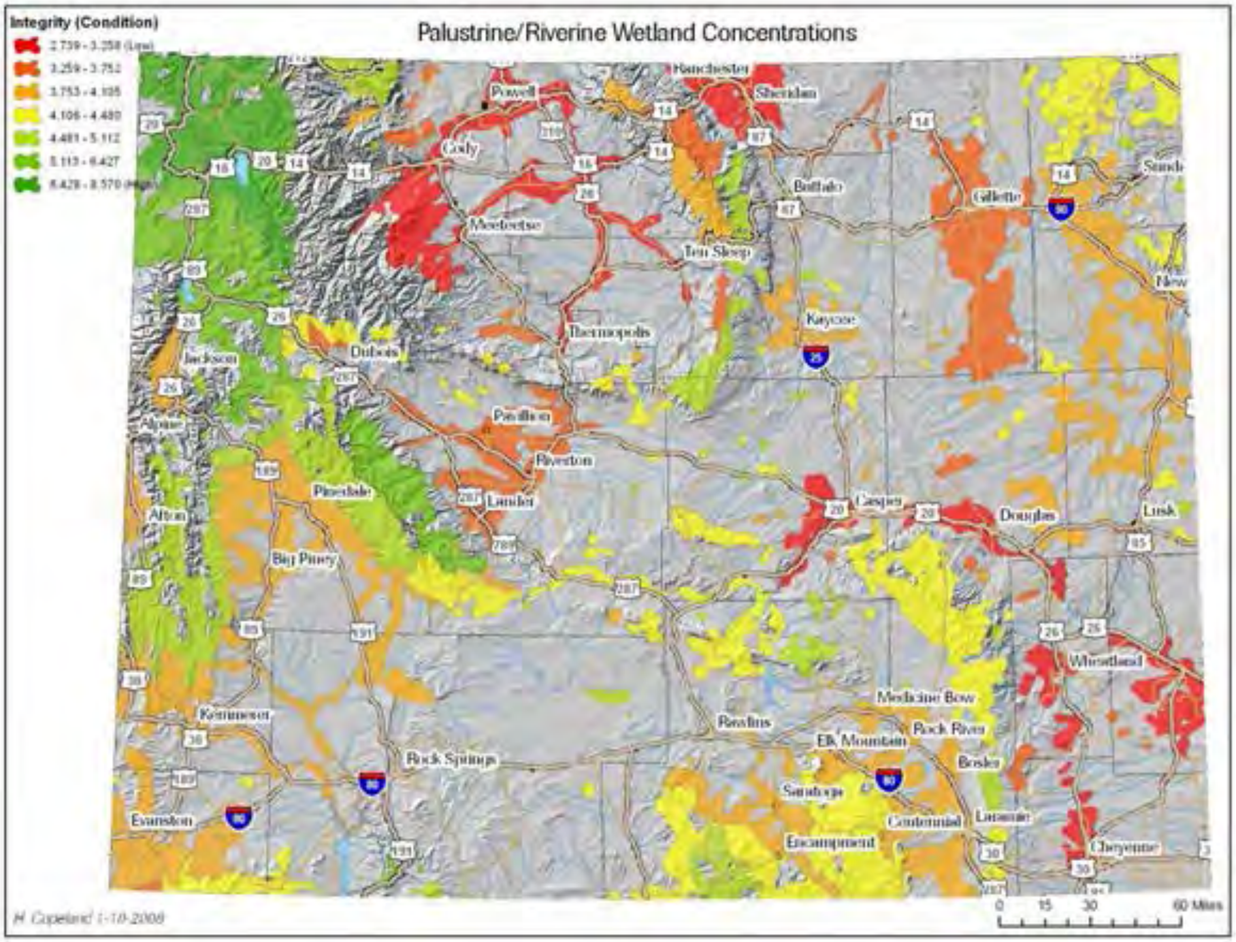

Figure 22. Integrity scores of Wyoming wetland complexes (Copeland et al. 2010).

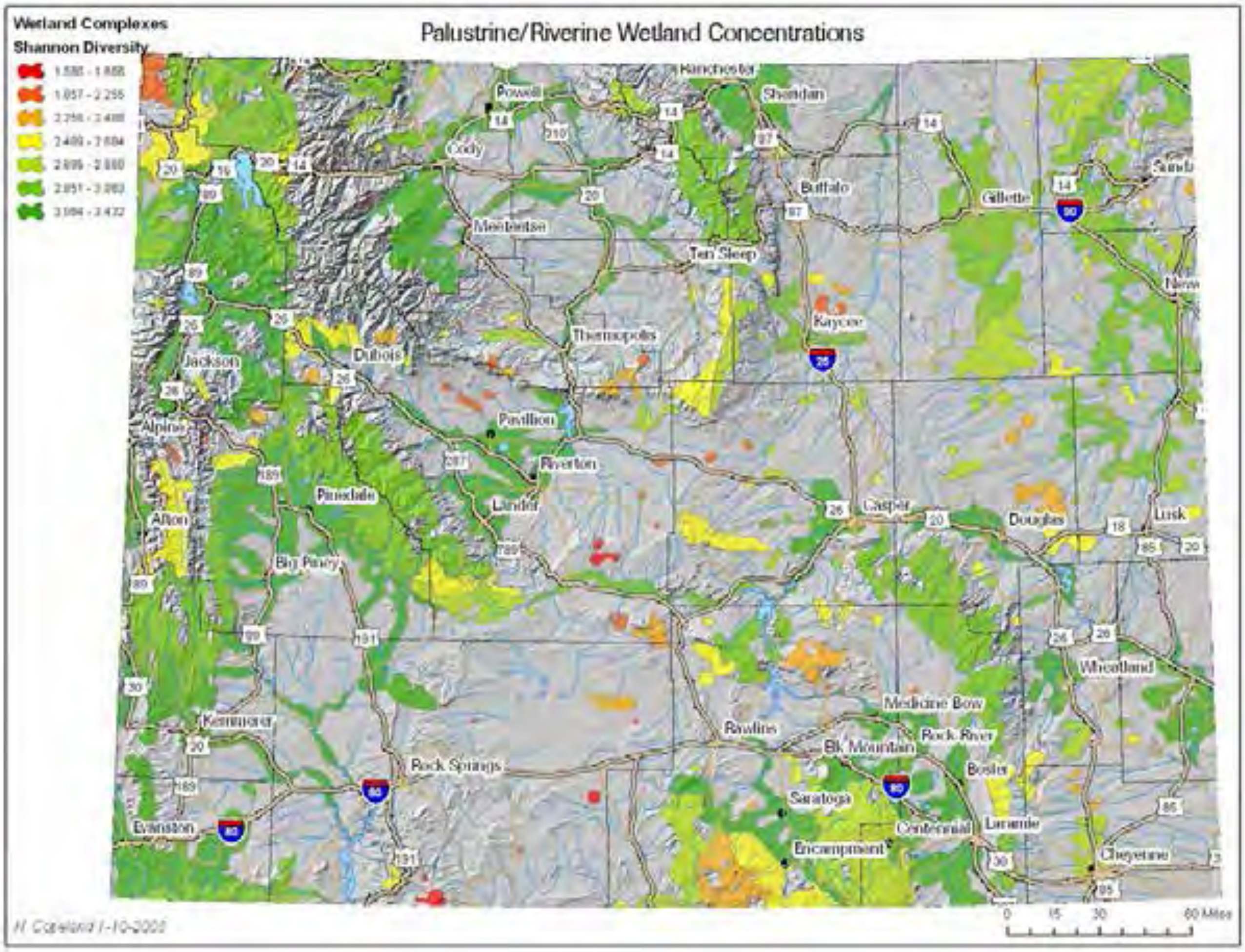

Figure 23. Species diversity (Shannon Diversity Index) of Wyoming wetland complexes based on wetland-associated SGCN (Copeland et al. 2010).

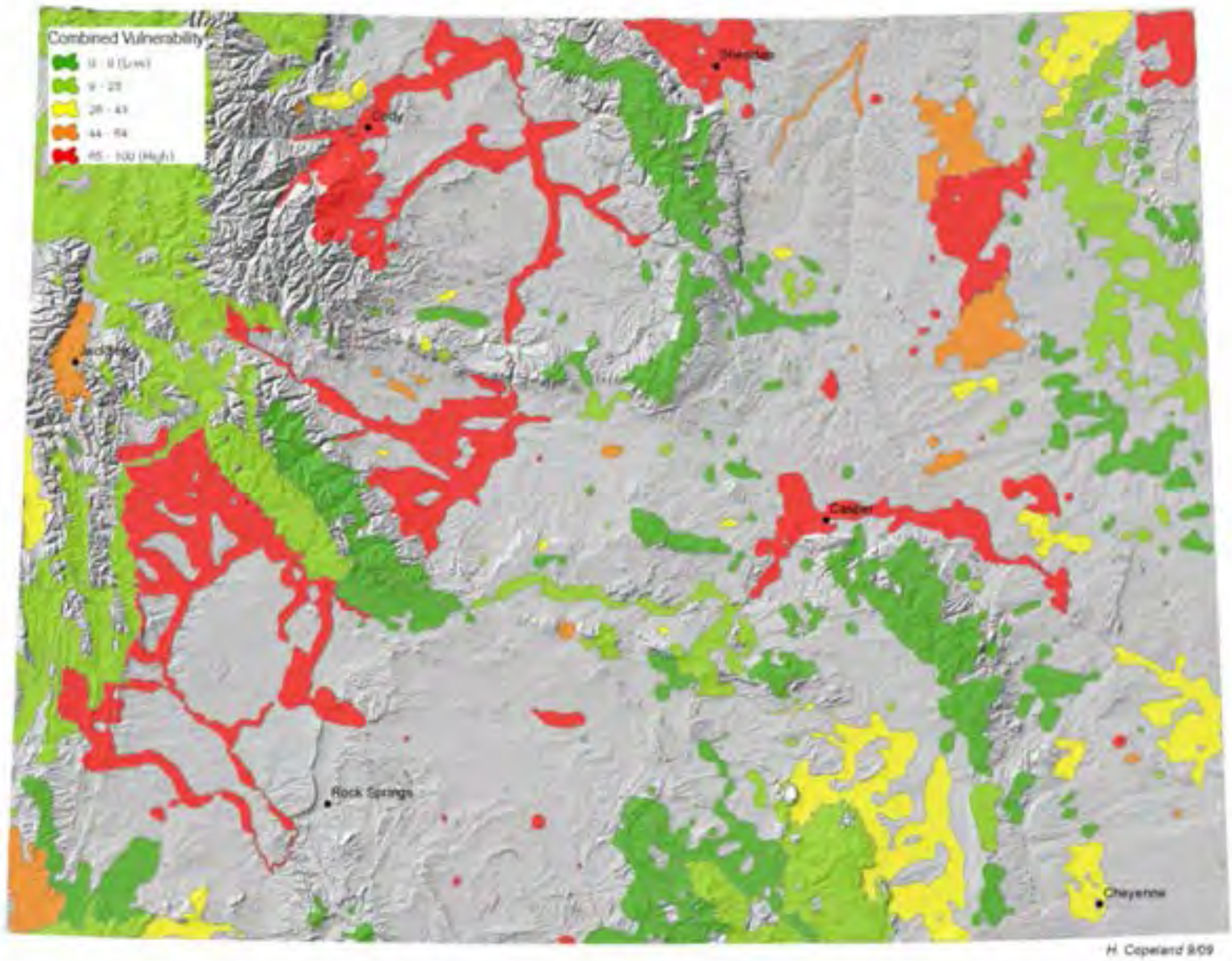

Figure 24. Vulnerability of Wyoming wetland complexes to ongoing and future development (Copeland et al. 2010).

Xeric and Lower Montane Forest

Photo courtesy of WGFD

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Habitat Description

Xeric and lower montane forests exist in a variety of areas in the western United States and Wyoming ranging from lower elevations to high elevations (Arno 1980, Bock et al. 1993, Green and Conner 1989, Idaho Partners In Flight 2000, Knight 1994, NatureServe 2009). NatureServe (2009) lists eight ecological systems in Wyoming within this habitat type (Table 22). Within the three ponderosa pine systems they list over 50 associations, and within the five limber pine/juniper systems they list over 40 associations in the western United States. Historically, before about 1890, frequent fires often confined these conifer woodlands to rocky sites or the leeward sides of slopes. Typically, this fire pattern created open savannahs and patchy, park-like woodlands. Present conditions have changed the appearance and distribution of these ecosystems across the landscape. Mature forest landscapes are more fragmented and denser with younger trees dominating stands. At many sites, tree densities and fuel loads would support high intensity crown fires rather than the low intensity understory fires typically associated with these sites. In some areas stands are expanding into adjacent grassland and shrublands. Common uses of these forests include wildlife habitat, livestock grazing, commercial timber harvesting and firewood gathering, recreation, residential development, and mineral development. The lower elevation and openness of this habitat type often leads to more intensive human activity.

Juniper

Junipers are conifers with leaves of overlapping scales and seed-bearing cones that resemble small berries. Juniper sometimes forms pure stands, but is often mixed with other gymnosperms (Elias 1980). It commonly grows on bluffs, ridges, cliffs, and dry, rocky hillsides, and it does best on slightly alkaline/calcium-based soils (Elias, 1980). Only 2.2% of the land area in Wyoming supports juniper woodlands. Juniper can be found from 4,000 to 10,000 feet in elevation, but it generally occurs below 6,000 feet (Nicholoff 2003). In these areas, annual precipitation averages 8 to 20 inches (West et al. 1975), and typically comes in the form of snow, spring rain, and infrequent summer thunderstorms.

Rocky Mountain and Utah juniper are widespread, ranging from British Columbia to Arizona and New Mexico, and from Nevada and Washington east to the Dakotas and Nebraska. They are the most common juniper species in Wyoming. Utah juniper is found along escarpments in western Wyoming and in arid basins throughout the state. Rocky Mountain juniper is found in eastern Wyoming along ravines that receive greater summer precipitation and is often found in association with ponderosa pine, mountain-mahogany, or limber pine.

Today, in Wyoming, tree densities in juniper communities vary from open savannahs to closed canopies. Prior to European settlement, juniper woodlands ranged from savannah-like conditions to more closed canopy stands on rocky ridges and rocky low sagebrush flats. Fire return intervals and severities were mixed in juniper communities and were very site specific. Low intensity fires may have occurred every few decades, while high intensity crown fires occurred less frequently, often in terms of centuries (Baker and Shinneman 2004). This mix of fire severity created a mosaic of different tree densities and associated grass and shrub species.

Since 1860, the distribution of juniper woodlands has increased 125–625% across the West (Miller et al. 2008), although juniper expansion has not been as dramatic in most areas of Wyoming as it has been in other areas of the West (Nicholoff 2003). Juniper expansion has most frequently occurred northward, as well as downward in elevation into grasslands and shrublands with deeper soils, more fine fuels, and previously higher fire frequencies (Gillihan 2006). The cause of this expansion is debated. Some researchers contend that expansion is part of a natural cycle in response to changes in climate, citing documented evidence that juniper has been on this landscape since 10,000 years before present (BP) (Jackson, et al. 2005). Since this period, the range of juniper has probably varied in response to the documented climatic variations such as the Medieval Climate Anomaly and the Little Ice Age. In addition to climate fluctuations, it is widely agreed that in some areas the recent expansion of juniper has been aided by a combination of fire suppression and overgrazing.

Unlike in the southwestern United States, mature piñon (or pinyon) pine is uncommon in juniper woodlands in Wyoming. Exceptions can be found in southwestern Wyoming near Flaming Gorge Reservoir and in the foothills of the Uinta Mountains. Shrub species associated with juniper woodlands include big sagebrush, black sagebrush, true and curl-leaf mountain-mahogany, rabbitbrush, antelope bitterbrush, yucca, and skunkbush sumac (Knight 1994).

Juniper expansion can alter the local plant communities by reducing the abundance of grasses, forbs, and shrubs through competition for water, light, and nutrients, as well as by producing plant-growth inhibiting chemicals. Dense stands of juniper can also change the hydrology of a site by increasing erosion. The reduction of the herbaceous understory increases water runoff and decreases water infiltration. This reduction in understory plants creates an extended period of self-perpetuating conditions favorable for juniper expansion by reducing the amount of fuel available for fire. Thinning juniper and increasing shrubs and herbaceous cover may create a more historic fire return interval by improving fuel availability.

Juniper wood is resistant to decay, is durable and clean-burning, and it is often harvested for fence posts, poles, firewood, and furniture making. In Wyoming, approximately 572,000 acres (231,000 ha) of juniper habitat are in public ownership; the remaining 282,000 acres (114,000 ha) are privately owned (Thompson et al. 2005).

Limber Pine

Limber pine comprises about 4% of Wyoming forested lands (Wyoming State Forestry Division 2009). Limber pine is a generalist and pioneer species, and it is cold- and drought-tolerant, allowing it to grow under a wide variety of environmental and physiological circumstances (Schoettle 2004). It grows across the widest elevational range of any conifer in the Rocky Mountains, ranging from approximately 5,250 feet to almost 11,000 feet (Schoettle and Rochelle 2000). At low elevations it often occurs with ponderosa pine, juniper, and Douglas fir, and at treeline it is frequently located in association with whitebark pine. Limber pine has been documented as having moved both upslope and downslope throughout the Holocene (approximately 11,500 years BP to present day), driven by factors such as drought, changing climate, and management techniques (Means 2010).

In some circumstances, changing fire regimes combined with low competitiveness with other species, poor regeneration due to blister rust, and spreading infestations of mountain pine beetle are altering distribution and lowering survival for limber pine. Where many of these woodlands serve as climax communities, limber pine can reach ages of up to 1,500 to 2,000 years (Tomback 2009). It often has irregular or multi-stem growth formation on harsh exposed sites and may even have Krummholz formation at higher elevations, rarely reaching over 50 feet in height. Typically limber pine has been restricted to rocky soils and ridges because the seedlings do not compete well with other species (Knight 1994). Choke cherry, ground juniper, king spike fescue, mountain big sagebrush, Oregon-grape, and western snowberry are commonly found with limber pine (Knight 1994). Although limber pine has received little attention, it fills a similar ecological role to whitebark and piñon pine. As a pioneer species, it regenerates well after fire or canopy-opening disturbances. It acts as a nurse tree, facilitating the establishment of later successional species at both low and high elevations (Baumeister and Callaway 2006, Rebertus et al. 1991, and Tomback 2009).

Ponderosa Pine

Ponderosa pine can grow to over 130 feet tall and occurs on a wide variety of soils, usually in open areas because this species is intolerant of shade. Trees can grow in pure stands, especially at lower elevations where they are subject to frequent forest fires. Ponderosa pine and limber pine are commonly found in Wyoming foothills and on escarpments in warmer areas with higher summer precipitation. Areas with notable concentrations of ponderosa pine include the Black Hills, at lower elevations in the Bighorn Mountains, on the east slope of the Laramie Mountain range, and in a few localities around the Medicine Bow, Split Rock, and Seminoe Mountains (Knight 1994). Associated tree species in the Black Hills include the southernmost outliers of white spruce and paper birch in the U.S. and in the more northern parts of the Black Hills there is a significant component of bur oak and green ash. Aspen is also present but typically not in pure stands. Other tree species associated with ponderosa pine in other parts of the state include Douglas fir, limber pine, lodgepole pine, and Rocky Mountain juniper. Other woody and herbaceous plant species frequently found with ponderosa pine include skunkbush sumac, sideoats grama, and little bluestem (Knight 1994).

Ponderosa pine is a fire adapted tree. Adaptations to survive surface fires include open crowns; self-pruning branches; thick, insulative, relatively inflammable bark; thick bud scales; tight needle bunches that enclose and protect meristems, then open into a loose arrangement that does not favor combustion; high foliar moisture; and a deep rooting habit (Howard 2003). Where fires are common, ponderosa pine often exists in savannah-like landscapes. Mean Fire Historic Interval (MFI) varies between ponderosa pine sites. Prior to the 1900s, ponderosa pine was perpetuated by surface fires that recurred every 5 to 30 years. (Howard 2003). Unlike in the southwestern U.S., ponderosa pine in Wyoming has a historical record of a mixed severity fire regime with crown fire being a component (Hunter et al. 2007) as well as low severity surface fires. Pine leaves can be toxic to cattle, and trees reduce the rate of herbaceous forage production in the understory (Knight 1994).

Ponderosa pine is an important tree species for the forest industry in Wyoming. Sixty-six percent of the saw log harvest was composed of ponderosa pine in 2000 (Wyoming State Forestry Division 2009). Equally significantly, 73% of those materials came from privately owned forests (Wyoming Division of Forestry 2009). In particular, private lands in the northeast corner of the State are producing 78% of the harvest volume (The Conservation Fund 2009).

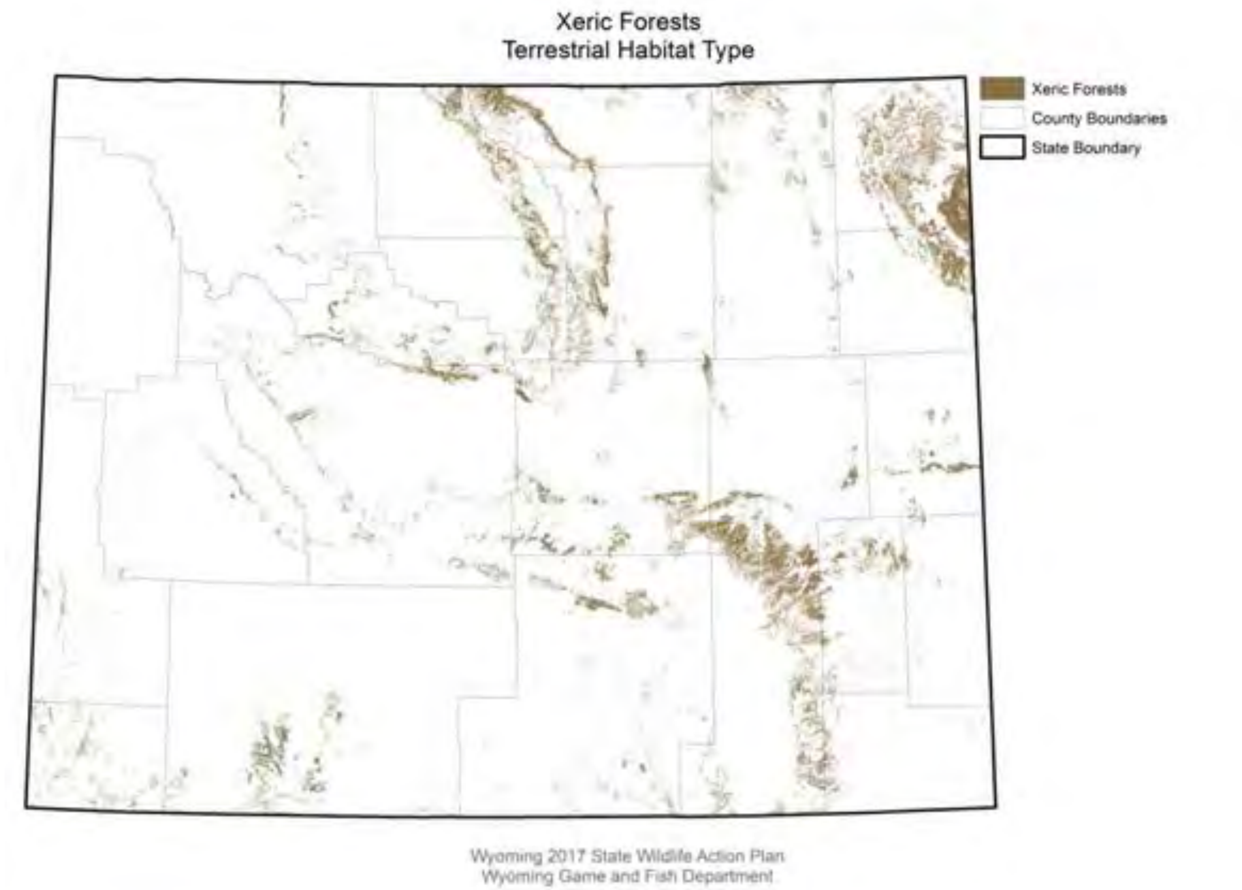


FIGURE 25. Wyoming Xeric and Lower Montane Forests

TABLE 22. Wyoming Xeric and Lower Montane Forests NatureServe Ecological Systems[1]

1. Colorado Plateau Pinyon-Juniper Woodland
2. Northern Rocky Mountain Foothill Conifer Wooded Steppe
3. Northern Rocky Mountain Ponderosa Pine Woodland and Savanna
4. Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna
5. Rocky Mountain Foothill Limber Pine-Juniper Woodland
6. Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland
7. Southern Rocky Mountain Ponderosa Pine Woodland
8. Northern Rocky Mountain Subalpine Woodland and Parkland

[1] Descriptions of NatureServe Ecological Systems which make up this habitat type can be found at: NatureServe Explorer: an online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, VA. http://www.natureserve.org/explorer.

TABLE 23. Wyoming Xeric and Lower Montane Forests Species of Greatest Conservation Need

Mammals
Albert's Squirrel
Canyon Mouse
Cliff Chipmunk
Eastern Spotted Skunk
Fringed Myotis
Long-eared Myotis
Long-legged Myotis
Little Brown Myotis
Northern Long-eared Myotis
Pallid Bat
Piñon Mouse
Ringtail
Silky Pocket Mouse
Spotted Bat
Townsend's Big-eared Bat
Western Small-footed Myotis
Yellow-pine Chipmunk
Yuma Myotis

Birds
American Kestrel
Ash-throated Flycatcher
Bewick's Wren
Black-throated Gray Warbler
Blue-gray Gnatchatcher
Bushtit
Canyon Wren
Clark's Nutcracker
Ferruginous Hawk
Gray Vireo
Juniper Titmouse
Lewis's Woodpecker
Loggerhead Shrike
Merlin
Pygmy Nuthatch
Red-headed Woodpecker
Scott's Oriole
Virginia's Warbler
Western Scrub-Jay

Reptiles
Black Hills Red-bellied Snake
Desert Striped Whipsnake
Northern Tree Lizard
Pale Milksnake
Plateau Fence Lizard
Smooth Greensnake

Xeric and Lower Montane Forests Wildlife

Juniper woodlands often have a higher abundance and diversity of birds than other habitats including big sagebrush, ponderosa pine, and lodgepole pine (Nicholoff 2003). In fact, piñon-juniper woodlands support one of the highest proportions of obligates or semi-obligate bird species (Paulin et al. 1999). Over 100 species of birds have been documented in the juniper woodlands of southwestern Wyoming and approximately 40 species nest there routinely (Nicholoff 2003). Higher bird concentrations in juniper stands are related to their structural diversity which provides numerous sites for perching, singing, and nesting. Most of the juniper obligates favor mature trees (older than 100 years) along with a shrub understory for nesting and foraging. Older trees with dead or dying limbs provide nesting sites for cavity nesters. Species richness is highest in early and mid-succession juniper communities because these provide both food and cover from the junipers as well as from their associated shrubs and grasses. Wildlife food from junipers comes in the form of plentiful berries and diverse insects. Species richness of all wildlife declines once juniper canopies close because there is less variety and quantity of food.

Many species of wildlife also use junipers for thermal cover. The shape of juniper trees is effective at blocking wind and trapping ground heat in winter and providing shade in the summer. Juniper is an important wintering habitat for mule deer and elk, and mule deer, in particular, also browse on juniper.

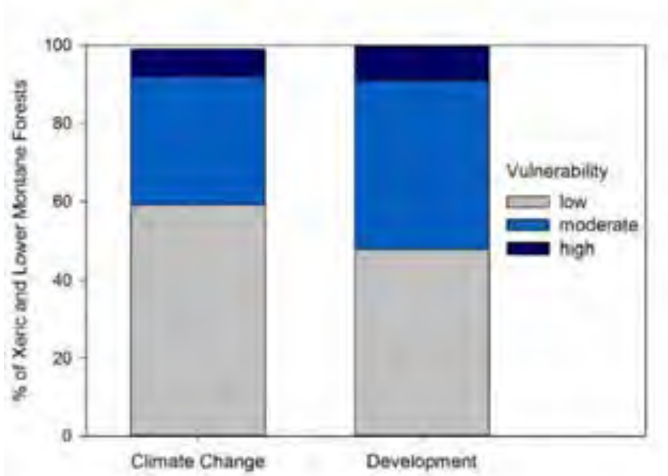
Sparse juniper and lower elevation limber pine habitats are often utilized by many reptile species. One notable example is the northern sagebrush lizard. Trees are often used as basking sites and thermal refugia. Yellow-bellied racers may also be found in this habitat at lower elevations.

Many ponderosa pine communities occur on south-facing slopes at elevations that lie between big game summer and wintering grounds. Due to these topographic features, ponderosa pine communities can provide quality early-green forage for mule deer. If fall moisture occurs, these slopes also provide green re-growth. Many of these communities support crucial winter range for mule deer and elk. Ponderosa pine forests also provide habitat for white-tailed deer, black bear, wild turkey, blue and ruffed grouse, migratory songbirds, black-backed and American three-toed woodpeckers, olive-sided flycatcher, mountain bluebird, flying squirrels, and red squirrels, as well as various other rodent and squirrel species (Tomback 2009). Abert's squirrel is a ponderosa pine obligate species whose range just barely extends into Wyoming in the southern part of the Snowy Range. Ponderosa pine is an important tree species for cavity-nesting birds such as mountain bluebirds, American kestrel, chickadees, wrens, and a variety of woodpeckers. In Wyoming, ponderosa pine savannas contain over 60% of Wyoming's known merlin nesting sites and a significant but not quantified portion of nesting Lewis's woodpeckers. Clark's nutcracker is an important distributor of limber pine seeds across the landscape.

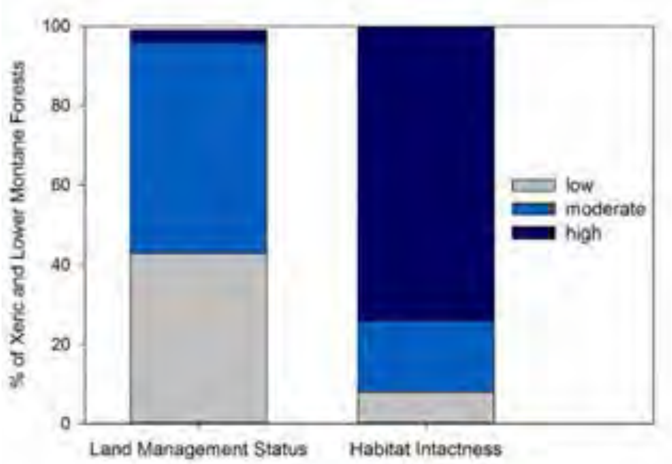
In southern Sweetwater County, rock outcrops in proximity to juniper habitats are particularly valuable to several SGCN mammals. The distribution of the cliff chipmunk, canyon mouse, and piñon mouse is restricted to this portion of the state. Important habitat components include high diversity of invertebrates, as well as vegetative seeds and berries. Also, the steep cliffs and canyons that are common in juniper woodlands provide many opportunities for rock and crevice-roosting bats. The structural diversity, shrub understory, and other vegetation in most juniper woodlands provide high insect diversity and important foraging, roosting, and hibernating habitat for several species of bats (Hester and Grenier 2005).

Xeric and Lower Montane Forests Habitat Threats

Figure 26. Xeric and Lower Montane Forests Vulnerability Analysis



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high vulnerability to climate change or development, based on classification of scores ranging from 0 to 1 into the following categories: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for climate change or development vulnerability were based on the land area of the habitat type classified as having high vulnerability: low (<10%), moderate (10-33%), or high (>33%). Vulnerability was calculated as exposure minus resilience. Development vulnerability includes existing and projected residential, oil and gas, and wind energy development. Further details are provided in the Leading Challenges section of this report and in Pocewicz et al. (2014).



The colored bars show the proportion of the habitat type that was identified as having low, moderate, or high land management status or habitat intactness. For land management status, high corresponds to the percent of the habitat occurring in GAP status 1 or 2, moderate to the percent occurring in GAP status 2b or 3, and low to the percent occurring in GAP status 4. Rankings for land management status were based on the land area of the habitat type classified as having high status or legal protection: low (<10%), moderate (10-33%), or high (>33%). For habitat intactness, scores ranging from 0 to 1 were assigned to categories as follows: low (<0.34), moderate (0.34-0.66), and high (>0.66). Rankings for intactness were based on the land area of the habitat type classified as having high intactness: low (<25%), moderate (25-75%), or high (>75%).

Fire suppression - High
Prior to European settlement, fire was a frequent occurrence in ponderosa, limber pine, and juniper forests and produced savanna-like landscapes. Fire suppression has resulted in range expansions, increased tree densities, buildup of dead downed material, and reduced understory plant species diversity in these woodlands. Increased densities in ponderosa pine stands have led to hotter crown fires occurring more frequently and over larger acreage when compared to historic fire patterns. In the Laramie Range, this has resulted in many ponderosa pine forests changing to grasslands during the last 10–15 years. The loss of old growth has resulted in few snags (see Wyoming Leading Wildlife Conservation Challenges – Disruption of Historic Disturbance Regimes).

Diseases and insects – High
Bark beetles (*Ips* spp and *Dendroctonus* ssp), are serious pests to ponderosa pine, piñon pine, and limber pine with regular infestations occurring over centuries. There have been significant outbreaks of mountain pine beetle (MPB) in the Black Hills every 11–20 years. MPB tends to most seriously impact second-growth stands that have been undisturbed for many years. However, beetle epidemics combined with environmental conditions, such as prolonged drought, has resulted in increased pine mortality in many regions (Howard 2003). The spread of MPB has been aided by the general warming climate, by the persistent drought of the early 2000s, as well as by management practices which have excluded fire and reduced tree thinning and harvest.

White pine blister rust (WPBR), an exotic disease, is currently infecting all age classes of limber pine at all elevations (Means 2010). This disease, in conjunction with MPB, will likely reduce the future abundance of this species throughout its range in Wyoming. Greenhouse trials have shown limber pine has infection levels as high as 98–100 % and mortality rates of 75% (Hoff and McDonald 1993). The low resistance of limber pine to WPBR reduces the number of potentially resistant trees. When limber pine stands are lost due to WPBR infections, the limber pine becomes functionally extinct in the local area for hundreds of years until rust-resistant types emerge (Kendall 1997).

Dwarf mistletoe (*Arceuthobium* spp.) is a serious disease for limber pine (Koski et al. 2009) and ponderosa pine, with ponderosa pine infection rates up to 33% in some areas (Howard 2003). Dwarf mistletoe alters tree form, suppresses growth, and reduces volume and the overall wood quality of its host (Epp and Tardif 2004).

Invasive species – High to Moderate
Cheatgrass and other annual grasses such as Japanese brome are invading juniper, limber pine, and ponderosa pine forests. Invasions often originate from disturbed sites at lower elevations. These fire-adapted, nonnative species have the potential to increase the frequency of fire and reduce native grasses and forbs, which supply wildlife forage and support insect diversity (see Wyoming Leading Wildlife Conservation Challenges – Invasive Species).

Varied perceptions on the location and extent of removal and thinning treatments - Moderate
While their ranges have varied over the centuries, juniper and limber pine are believed to have expanded their range in Wyoming within historic times (Jackson et al. 2005). Due to the vast amount of open spaces found in Wyoming, many private landowners and public value the presence of trees, and consequently are reluctant to support management efforts in xeric and montane forest lands that call for removal of trees. Because their establishment can result in decreased plant diversity and productivity, including reductions in forage for livestock and big game, removal and thinning programs are common. If not adequately considered, the value of this habitat type to obligate species can be unknowingly eliminated or reduced through the inclusion of prescribed treatment projects or the exclusion of fire suppression plans.

Drought and climate change - Moderate
In the Black Hills, some climate change modeling (Rehfeldt 2006) shows that climate

has supported ponderosa pine transitioning into a new extramural climate that has not previously existed. If this continues to occur, spruce/paper birch habitat will become a decreasing component of the ecosystem, and ponderosa pine seedling establishment may become more sporadic. Observed lack of seedling and sapling establishment, in at least one stand in the Bighorn Basin, indicates stress from climatic change; however, some climate change models show a potential for ponderosa pine to expand in this and other areas (Joyce et al. 2001), which will be contingent upon temperature extremes, precipitation conditions, soil suitability, and a host of other factors.

Limber pine position on the lower treeline and foothills in semi-arid climate systems is predicted to be particularly vulnerable to climate change (Means 2010). Vegetation redistribution is likely to be most rapid and obvious at semi-arid ecotones (Allen and Breshears 1998). A multifactor combination of climate stress, dwarf mistletoe, WPBR, and bark beetles have created complex situations in limber pine forests, which has caused high population mortality in many areas (Schoettle 2004, Millar et al. 2007). A major drought event from 1985 to 1995 caused a widespread mortality wave, whereas a subsequent drought event from 1999 to 2004 did not affect as many populations, with healthy regeneration occurring in some areas (Miller et al. 2007). However, high potential still exists for an extensive, rapid drought-induced die-off at a sub-continental scale (Breshears et al. 2005, Coop and Schoettle 2009), particularly when trees have the physiological stress of fighting off pathogens, which can divert energy resources from other plant functions or make the plant more sensitive to environmental stresses (Schoettle 2004). Some research predicts that vegetation redistribution resulting from climate change is more likely to be driven by mass mortality as opposed to the establishment of new populations (Allen and Breshears 1998). Some preliminary research indicates that limber pine may be shifting its range downslope in response to changing climatic conditions (Means 2010). It is unknown how juniper species will be affected by climate change, but Rehfeldt (2006) predicted a significant decrease in Utah juniper in Wyoming by the year 2090. Finally, some studies have shown the infilling of sub-alpine coniferous forests at treeline and into alpine landscapes as a result of changing climate conditions (Joyce et al. 2007). (See Wyoming Leading Wildlife Conservation Challenges – Climate Change).

Habitat fragmentation – Moderate

Rural subdivision and development can reduce, degrade, and fragment foothill shrublands habitats (see Wyoming Leading Wildlife Conservation Challenges – Rural Subdivision and Development). Houses, outbuildings, and lawns directly replace native wildlife habitat. Soil disturbance from construction, year-round grazing of horses and other hobby livestock, and the use of nonnative plants as ornamentals can facilitate the establishment of invasive species (Maestas et al. 2002).

Wildlife commonly abandons or alters use of habitats with greater human and pet activity. Increased energy expenditures in avoiding people or greater use of lower quality habitat can decrease animal health and reproductive capacity. Greater road densities and traffic volume can increase wildlife–vehicle collisions. Predation on wildlife can intensify with greater numbers of domestic dogs and cats, as well as increases in generalist predatory species such as ravens and human-commensal species such as raccoons (U.S. Department of Agriculture 2007).

Fragmentation of land ownership can adversely affect natural resource management in ponderosa pine forests. As large blocks of private land are subdivided, habitat management may become more difficult. There is economy of scale in forest management, and management of small parcels can become economically unfeasible (Wyoming State Division of Forestry 2009). Easements for the use of roads across multiple landowners for habitat improvement projects can be expensive and difficult to obtain. Greater human safety and property loss concerns increase the need for fire suppression.

Off-road recreational vehicle use – Moderate
Vehicle use off established roads can enhance the spread of invasive species—especially spotted knapweed and cheatgrass—damage native vegetation, and destroy nests. Soil disturbance can increase erosion and impact water quality. Wildlife often avoids areas of increased noise and disturbance from outdoor recreational vehicles. These impacts can also lead to conflicts with hunting, wildlife viewing, and other forms of nature-based recreation.

Xeric and Lower Montane Forests Conservation Initiatives

The Wyoming Game and Fish Department, Bureau of Land Management (BLM), various conservation districts, and The Nature Conservancy have been involved in multiple conifer removal/thinning projects throughout the state of Wyoming. The size and type of treatments typically vary depending upon the density of the stand, location in relation to other stands, existing understory vegetation, and threat of invasive species, primarily cheatgrass. Treating early and mid-successional stands is cheaper than treating dense, closed stands and often does not require post-treatment seeding. Removing juniper may lead to an invasion of weeds if the understory is missing or in poor condition.

A regional effort has brought together the US Forest Service, BLM, National Park Service, Colorado State University, and the Rocky Mountain Research Station to identify and grow WPBR-resistant limber pine through seed collection and breeding. It is expected that this project will initially take five or six years to develop seedlings for planting.

The Black Hills National Forest, the State of Wyoming, various conservation districts, and BLM, along with private landowners, have undertaken aggressive forest health treatments to reduce ponderosa pine stand densities in order to lessen the impact of mountain pine beetle and crown fires. There have also been a number of efforts to reduce ponderosa pine tree densities on the west slope of the Big Horns, primarily on BLM lands. A National Science Foundation grant has been awarded to conduct workshops regarding climate change influence on ponderosa pine expansion in the Bighorn Basin. Other ponderosa pine management projects have been completed in the Ferris, Laramie, and other mountain ranges in the south central part of the state; however, most of this work has been localized.

Wyoming State Forestry Division (2010) has highlighted the need to maintain whitebark and limber pine stands in the Wyoming Statewide Forest Resource Strategy. The BLM in Wyoming has listed both whitebark and limber pine on their sensitive species list (Bureau of Land Management 2010a).

Recommended Xeric and Lower Montane Forests Conservation Actions

Identify juniper habitat within the state that should be managed for the long-term conservation of juniper obligate species.
Breeding populations for four avian and three mammalian SGCN (ash-throated flycatcher, bushtit, juniper titmouse, western scrub-jay, canyon mouse, cliff chipmunk, and piñon mouse) are limited to juniper habitats in a relatively small area in southwestern Wyoming. Resource managers should be informed of the location and value of these habitats so that they are not unknowingly included in prescribed treatment projects or automatically excluded from fire suppression plans without adequate consideration. In these areas, the Wyoming Bird Conservation Plan, Version 2.0. (Nicholoff 2003) should be consulted for appropriate management actions.

Outside of identified juniper obligate conservation areas, habitat management goals should be designed to maintain site ecological function with consideration to the historic climax plant community. The USGS Pinyon and Juniper Field Guide, Circular 1335 (Tausch et al. 2009) contains a good overview of site considerations and habitat treatment options.

Increase coordination among state and federal agencies, private landowners, and conservation groups for developing and implementing habitat management plans. Mixed landownership and associated differences in mandates and management goals increase the need for inter-agency coordination in developing management strategies for xeric and lower montane forests. Coordination should extend to federal and state agencies in Colorado and Utah for juniper due to the peripheral nature of much of this habitat in Wyoming.

Manage ponderosa pine forests to mimic natural disturbance regimes to promote a diverse, fire-adapted forest mosaic. Manage forest stands to improve vigor, age and species diversity; reduce fuel loads and wildfire intensity; and reduce competition between species to avoid future stand conditions that would again lead to landscape-level beetle mortality. Fire should be used where appropriate. In areas with low fuel load and tree density, fire could be used immediately. In other areas, there may need to be fuels reductions and/or thinning prior to fire. Better results can be obtained in these areas from mechanical treatments that allow managers to determine residual stand complexity and density, species and age selection, and retain valued stand components such as snags. In these locations fire is better used as a maintenance tool following other treatments.

Develop methods to advance timber management practices that benefit wildlife on private lands. Ponderosa pine forests comprise a large proportion of forest products despite being a small portion of Wyoming's commercially productive forest lands. These lands also provide critical habitat for many wildlife species. The adoption of wildlife-sensitive timber management practices should be encouraged through:

- Promoting the development and implementation of stewardship plans with participation in cost share programs.
- Increasing the amount and accessibility of information and education to private landowners on the best management practices including reaching out to absentee landowners, developing assessment tools for landowners, training landowners on basic data collection techniques and basic forest management, and using local media to reach out to landowners.
- Encouraging implementation of Forest Inventory and Analysis (FIA) in Wyoming to capture information about private forest lands. (See above.)
- Providing financial incentives for management through the use of cost-share programs.
- Developing and implementing certification programs for landowners including American Tree Farm System and Stewardship Forest Wyoming (Wyoming State Forestry Division 2010).

Work to mitigate the effects of land fragmentation.

- Encourage landowners to work together, rather than as individual entities, when developing subdivision-level habitat and timber management plans as part of subdivision development.
- Provide incentives to conserve working forest lands including conservation easements. The Forest Legacy Program can be a source of funding for these easements.
- Keep private forestry practices financially viable by developing and maintain a forest products industry infrastructure to provide consistent markets for forest products (Wyoming State Forestry Division 2010).

Habitat management and treatments should be followed by long-term monitoring where appropriate.
Tree removal and thinning can result in unintended consequences such as increases in invasive species. If an increase in weeds or erosion will likely occur after a burn, using mechanical removal may be the best option. To minimize the establishment of invasive species following fires, sterilized soils from intensely burned areas, including brush pile locations, should be inoculated by adding soil from unburned patches, and native seed mixes should be planted. The creation of maps that include data on treatment sites should be a component of post-treatment monitoring protocols. Special attention should be directed toward mechanical removal for problems such as heavy equipment damage to other plants and unseen changes in soil water retention. On large-scale treatment areas there is also a need to monitor the results to the ecological system. Depending on the size of the treatment, funding availability, land manager goals, and regulations, monitoring may range from merely photo points to multiple established transects both within and adjacent to the treatments.

Work with State Forestry to identify forest health conditions of low-elevation (below 8,500 feet) limber pine woodlands within priority wildlife areas to facilitation statewide management strategies.

BLM has issued management strategies for whitebark and limber pine. Both are managed to preserve healthy stands, improve stands in decline due to beetles, and attempt to restore stands severely affected by insects, disease, or natural disturbances.

Work with State Forestry to develop silvicultural prescriptions that can be used to maintain limber pine woodlands on the landscape within priority wildlife habitat areas.
Thin limber pine stands to appropriate stocking levels to improve individual tree and stand vigor and to reduce interspecies competition in order to provide some stand resistance to mountain pine beetle attacks. Where feasible, plant WPBR-resistant limber pine seedlings to increase stand resistance to the disease.

Consult wildlife habitat priority areas and best management practices to improve energy development planning and mitigation design.
Energy development mitigation plans should stress avoiding biologically sensitive areas within project sites and directing off-site mitigation funds to nearby high-value wildlife locations. The WGFD's Strategic Habitat Plan Crucial areas and Wyoming Sage-grouse Core Areas can help guide these efforts. The implementation of mitigation measures and/or best management practices detailed within the Wyoming Game and Fish Commission's *Recommendations for Development of Oil and Gas Resources within Important Wildlife Habitats* (Wyoming Game and Fish Department 2010) and *Recommendations for Wind Energy Development in Crucial and Important Wildlife Habitat* (Wyoming Game and Fish Department 2010) should be encouraged. Mitigation plans should consider the need to reduce fragmentation of important habitats by using practices such as acquiring conservation easements and implementing associated stewardship plans in areas of high biological value.

Xeric and Lower Montane Forests Monitoring Activities

Continue monitoring xeric and lower montane forests SGCN in order to detect population trends or changes in distribution that may reflect habitat problems. This information should be used to guide future monitoring and research.

Monitor the landscape distribution and habitat intactness of xeric and lower montane forests through remote sensing.
Remote sensing is useful in tracking the size, distribution, and fragmentation level of this habitat in Wyoming. Information gathered would be helpful in determining the cumulative

impacts of activities and events such as energy development, rural subdivision, wildfire, and presence of invasive species. This technique may require the further development of monitoring protocols and identification of sample sites.

Whenever possible, establish vegetation monitoring transects to determine the vegetation and community responses to habitat treatments. Transects should include photo points, with special notes on invasive plant species.

Monitor the establishment and spread of invasive plant species in cooperation with Weed and Pest Districts and other federal and state agencies.

In cooperation with research entities, monitor the effects of climate change including extended periods of drought or pluvial cycles. Special attention should be given to the effects of climate on outbreaks of insects and disease.

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Bear River Basin

Bear River

Table of Contents

Watershed Description

Six major watersheds were identified for conservation planning purposes under this State Wildlife Action Plan (SWAP) using hydrographic boundaries and fisheries assemblage and management considerations.

The Bear River basin corresponds with the Bear River hydrologic unit (HUC 1601). It includes two 6-digit HUCs: Upper Bear and Weber (Figure 1). Three 8-digit HUCs and twelve 10-digit HUCs occur partly or wholly within this area. These watersheds span about 1,500 square miles in southwestern Wyoming's Lincoln and Uinta counties. Land ownership is predominantly public, but substantial private land (38%) occurs. The public land is managed primarily by the Bureau of Land Management (40%) and U.S. Forest Service (12%).

The 7,500–sq mi Bear River basin includes portions of northeast Utah, southeast Idaho, and southwest Wyoming. In Wyoming, the basin is simply the Bear River and its tributaries. There are approximately 1,800 miles of streams on the USGS National Hydrography Dataset in the Bear River basin in Wyoming. Major drainages in the basin include the Bear River (originates in Utah), Smiths Fork and Thomas Fork.

Additional information about the basin's drainages, geography, geology, land forms, climate, dams, reservoirs and diversions, hydrology, habitat types, land use and classifications are detailed in the 2010 SWAP.

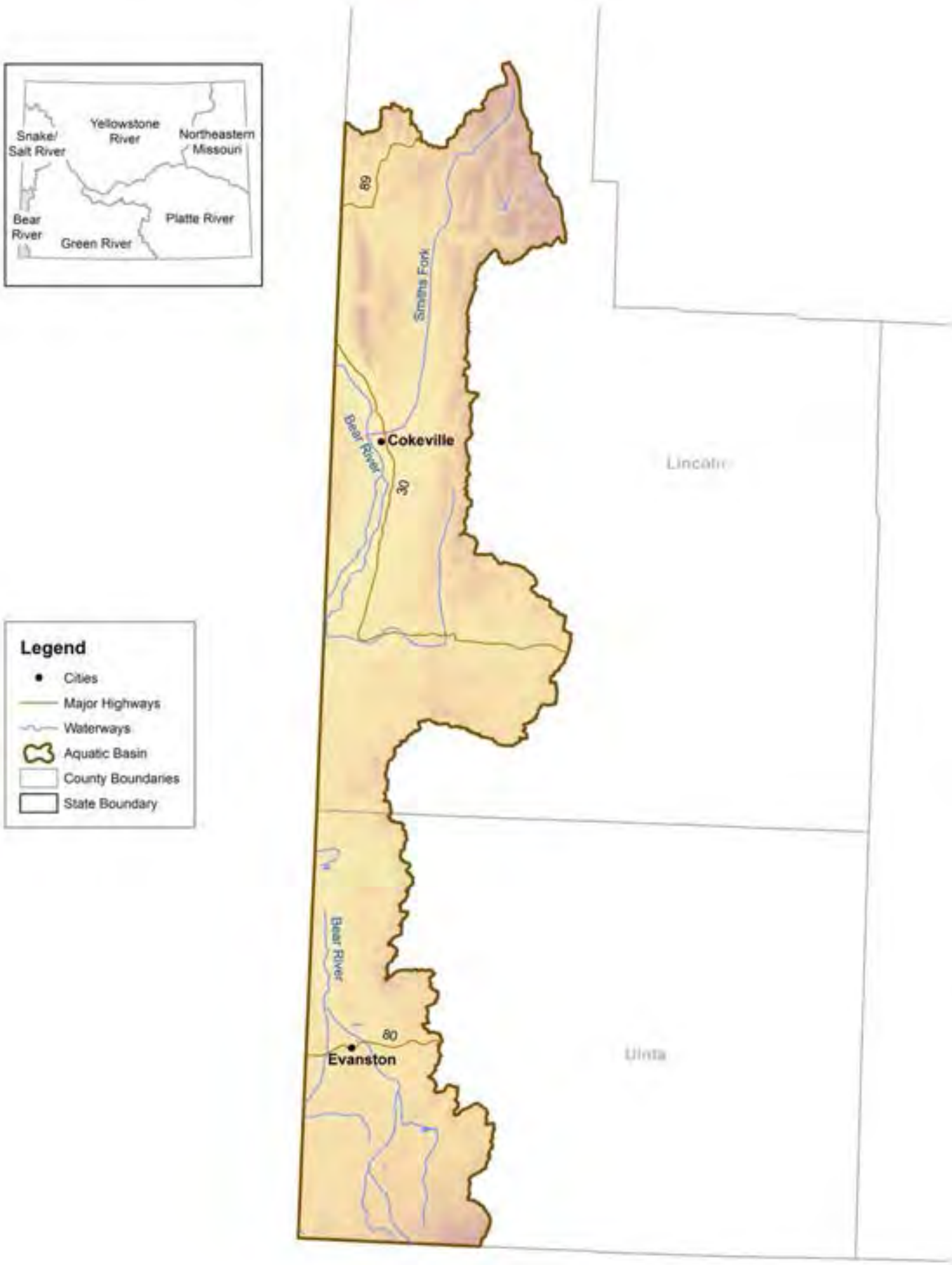

Figure 1. Bear River Basin.

Aquatic Wildlife

Fish

A detailed history of fish collections and surveys in this basin, which began in the mid 20th century is chronicled in the 2010 SWAP. These surveys and collections are the basis for describing the native fish community.

Twenty-two fish species, including two subspecies of cutthroat trout and twelve native species, are now found in the Bear River basin (Table 1). The nonnative fish community consists of nine game species, the most common of which are introduced salmonids.

There are three SGCN fish in the basin. The Bonneville Cutthroat Trout occupies much of the available coldwater habitat in the headwaters of the basin. The basin constitutes the core of the native range of Northern Leatherside Chub in Wyoming. The species has a notoriously patchy distribution. In the Bear River basin Northern Leatherside Chub are known from the Smiths Fork drainage near Cokeville, the Rock Creek drainage near Fossil Butte National Monument, and upper Bear River tributary streams south of Evanston (Schultz and Cavalli 2012). The Bluehead Sucker is also found in the basin but distribution and abundance is poorly understood.

No native species are known to have been extirpated from the Bear River basin, but introduced Brook, Brown, and Rainbow Trout are common. Introduced Snake River Cutthroat Trout, Largemouth Bass, Smallmouth Bass, Green Sunfish, and Yellow Perch are rare. Walleye and Smallmouth Bass were illegally introduced into Sulphur Creek Reservoir where they are successfully reproducing. Similarly, Yellow Perch were illegally introduced and have reproduced in Woodruff Reservoir. Green Sunfish are extremely rare in the basin. A single Green Sunfish was discovered in the UP Ice Pond in 2011. Largemouth Bass were previously stocked in a small number of waters in the basin, however there are no known populations remaining. Common Carp are abundant in the mainstem Bear River.

Table 1. Fishes present in the Bear River Basin. Species of Greatest Conservation Need (SGCN) are followed by an asterisk (*).

Native game	Native nongame	Nonnative game	Nonnative nongame
Bonneville Cutthroat Trout* Mountain Whitefish	Bluehead Sucker* Longnose Dace Mottled Sculpin Mountain Sucker Northern Leatherside Chub* Paiute Sculpin Redside Shiner Speckled Dace Utah Chub Utah Sucker	Brook Trout Brown Trout Green Sunfish Largemouth Bass Rainbow Trout Smallmouth Bass Snake River Cutthroat Trout Walleye Yellow Perch	Common Carp

Aquatic Reptiles

No turtles are native to the Bear River Basin watershed, and none have been introduced.

Freshwater Mollusks and Crayfishes

Wyoming is still in the discovery phase in terms of its freshwater bivalve mollusks and gastropods. Although fingernail and pill clams and aquatic gastropods are often encountered during invertebrate sampling, few published accounts of mollusk collections exist (Beetle 1989, Henderson 1924, Hoke 1979, Hovingh 2004). Many native mussels, clams, and gastropods are considered SGCN due to a lack of information regarding status.

Two bivalve mussel species have been documented in the Bear River Basin (Mathias 2014). In Wyoming, the range of the California Floater is restricted to the Bear River drainage. The more common and widespread Western Pearlshell is found in the Bear and Snake River drainages.

Most of what is known about species presence and distributions of gastropods in the basin are summarized in Beetle (1989). All gastropods in the basin are SGCN due to lack of adequate population and distribution information. Baseline survey data are needed for all gastropods in the Bear River watershed.

The only crayfish species known to be native to the Bear River basin in Wyoming is the Pilose Crayfish. This was the only species found during a 1985-–1987 crayfish survey (Hubert 1988). Virile Crayfish a nonnative species, was also found in the Bear River drainage during the 2007-2009 survey and appeared to have to some degree displaced Pilose Crayfish (Hubert 2010).

Table 2. Species of Greatest Conservation Need present in the Bear River Basin

Fish
Bluehead Sucker
Bonneville Cutthroat Trout
Northern Leatherside Chub

Crustaceans
Pilose Crayfish

Mollusks
California Floater Mussel
Western Pearlshell Mussel

Identification of Conservation Areas

The 7,500 sq mi Bear River basin includes portions of northeast Utah, southeast Idaho, and southwest Wyoming. Approximately 20% of the basin lies in Wyoming. While a relatively small portion of the basin lies in Wyoming, the Wyoming portion has some of the best remaining native fish populations. Because of this a large portion of the basin is considered conservation area for aquatic SGCN (Figure 2).

Conservation areas include major Bear River tributaries Twin Creek, Smiths Fork, and Thomas Fork that are critical to the conservation of Northern Leatherside Chub, Bonneville Cutthroat Trout or both. The headwater tributaries of Mill, LaChapelle, and Sulphur creeks draining the north slope of the Uinta Mountains are critical for Northern Leatherside Chub. Additionally the Bear River and tributaries above Evanston harbor important Bonneville Cutthroat Trout populations.

Figure 2. Aquatic Wildlife Conservation Areas in the Bear River Basin

Threats

Ungulate grazing and browsing – High

On a landscape scale, domestic livestock and big game grazing is the primary factor currently and historically influencing habitats in the Bear River basin. Stream habitat conditions are below potential because of eroded stream banks and high sediment levels contributed by degraded plant communities. Herbicide spraying in the 1960s and long-term heavy grazing have severely impacted the woody component of riparian communities (e.g. willow, cottonwood, and dogwood) communities. Subsequently, stream bank stability deteriorated and has negatively affected hydrological process and function. Proper stocking levels and grazing regimes can be effective habitat management tools and are compatible with stream channel, riparian, and upland area maintenance and improvement. However, improper grazing management can significantly reduce or eliminate vegetation and associated wildlife that depends on that forage, widen stream channels, vertically incise and entrench stream channels, cause soil erosion, increase water sediment loads, raise water temperature, encourage the spread of invasive plant species, destabilize and alter bank configuration, and lower surrounding water tables (Chaney et al. 1991, Nicholoff 2003). Overbrowsing by wildlife, particularly elk and moose, can also have similar negative effects on riparian shrubs. As with livestock grazing, impacts tend to be site specific, where herd numbers exceed forage availability, or where animals congregate to escape hunting and other forms of predation, or as a result of other causes.

Water development/altered flow regimes – High

Natural flow regimes in stream segments around the state have been altered by human activities including irrigation diversions and water developments for more reliable water supply, hydropower, fisheries and recreation, and flood control. These altered flow regimes are also a consequence of broad-scale changes in land use and management associated with agriculture, grazing, timber harvest, and housing development (see Wyoming Leading Wildlife Conservation Challenges – Disruption of Historic Disturbance Regimes). The majority of the Bear River basin is publically owned. Because it is such an arid region the limited amount of irrigated cropland can significantly affect aquatic wildlife. In addition, the direct effects of dewatering the irrigation diversions impede movement, and some fish are lost to entrainment into the irrigation ditches. Lateral and longitudinal hydrologic connectivity and physical access by fish populations to all habitats necessary to complete their life history is limited throughout the drainage. In-channel obstructions and dewatering have reduced some populations of native fishes.

Human infrastructure such as roads also alter flow with inappropriately sized and positioned culverts. This situation can compromise the integrity of some road crossings, stability of each stream themselves and create fish passage barriers and threaten road crossings.

Suburban development and small acreage ranchette subdivisions on some floodplain locations in the watershed are a contributing threat to stream and riparian health. The previously mentioned issues of livestock grazing, irrigation water use, roads, and road crossings are concentrated and often intensified on smaller acreages in subdivisions.

The need for additional water for human use will intensify in the immediate future, and that trend will be especially evident in the western U.S. This trend has multi-faceted consequences for fish and wildlife and the habitats upon which they depend. In Wyoming, trans-basin water diversions are not uncommon and are likely to be further proposed and pursued. Warmer conditions with more erratic precipitation— which some predict for Wyoming's future climate—may heighten the need for additional water storage for municipal and agricultural purposes. The likely trend will be water development projects closer to the delivery point and conveyance via pipelines instead of stream channels. Additional emphasis may be placed on lining irrigation ditches and other practices to more efficiently use water for consumptive purposes. The net effect of such water management practices in many situations will be to alter the timing, magnitude and duration of natural hydrographs as well as intra- and inter-annual variability in Wyoming's streams and associated riparian corridors (see Wyoming Leading Wildlife Conservation Challenges – Climate Change, and the Riparian habitat chapter). In other settings water conservation strategies may enhance stream flow in some segments of some streams.

One study of additional water storage has been conducted recently in this basin. The Sublette Creek Reservoir Mau / Covey Canal Rehabilitation Project proposes additional water development options in the Smiths Fork drainage (Wyoming Water Development Commission 2015). This project has completed Level 11 studies and is temporarily on hold pending consideration by the local project sponsor. It's future is questionable given its low Benefit/Cost ratio. Based on its most recent configuration the project could affect upstream migration of native fish and would likely reduce stream flow and trout habitat below the Covey/Mau irrigation diversion.

Drought and climate change – Moderate

Climate change may increase air and surface water temperatures, alter the magnitude and seasonality of precipitation and runoff, and shift the reproductive phenology and distribution of plants and animals (Seavy et al. 2009) (see Wyoming Leading Wildlife Conservation Challenges – Climate Change).

Changes in precipitation patterns under various climate change scenarios are predicted to produce peak flows earlier in the yearly cycle and to lower base flows (Barnett et al. 2004, Gray and Anderson 2009). Drought lowers water tables, leading to reduced plant growth and reproduction. Riparian vegetation declines lead to lower bank stability, higher siltation and altered stream habitat quality and quantity. Lower water levels increase water temperatures and reduce the living space available to fish and other aquatic wildlife. Changes to precipitation in native upland and riparian vegetation communities favor invasive plant species establishment such as cheatgrass, halogeton, reed grass, tamarisk, and Russian olive likely will deteriorate overall watershed stability and function. All these conditions can be detrimental to the health and reproductive success of all aquatic wildlife species.

Invasive species – Moderate
There are no listed aquatic invasive species (AIS) present in the basin. However, several introduced game fishes are problematic in the basin. Nonnative trout present a threat to Bonneville Cutthroat Trout through hybridization and competition. Other piscivorous nonnative fishes present a threat to native fishes in the basin. While nonnative game fish may need to be controlled for conservation and restoration of natives in some areas, these same fish support popular fisheries that provide important recreational and economic benefits (WGFD 2010).

Human Development and Infrastructure – Moderate
Inappropriately sized and positioned culverts on tributary stream road crossings impede fish passage and are incapable of passing higher stream discharges and sediment loads. Culverts too small for the discharge regime often nozzle high flow velocities and erode plunge pools on the downstream end of crossings, perching culverts at an elevation higher than the downstream stream bed elevation thereby creating passage barriers for some if not all fish species. Undersized culverts are unable to pass all sediment loads which are deposited and aggrade stream beds upstream of crossings to further exasperate problems. This situation can compromise the integrity of some road crossings and stability of each stream themselves. Unstable streams with active head cut incisions migrating upstream towards road crossings with culverts also create fish passage barriers and threaten road crossings.

Suburban development and small acreage ranchette subdivisions on some floodplain locations in the watershed are a contributing threat to stream and riparian health. The previously mentioned issues of livestock grazing, irrigation water use, roads, and road crossings are concentrated and often intensified on smaller acreages in subdivisions. More effort is exerted attempting to control migration of river channels and stream bank erosion in flood plain subdivisions to protect infrastructure and property. Rip-wrap and levees use to protect property often create more stream instability issues than what they solve.

Conservation Initiatives

Department plans and policies
The WGFD's Fish Division has developed basin management plans to guide management across the state. These plans provide background and history of aquatic wildlife management as well as management direction. These plans reference the SWAP and the Strategic Habitat Plan (SHP), attempting to incorporate management direction relevant to each basin.

Habitat management efforts are guided by the SHP that is regularly revised and approved by the Wyoming Game and Fish Commission. The SHP includes five goals: 1) Conserve and manage wildlife habitats that are crucial for maintaining terrestrial and aquatic wildlife populations for the present and future, 2) Enhance, improve, and manage priority wildlife habitats that have been degraded, 3) Increase wildlife-based recreation through habitat enhancements that maintain or increase productivity of wildlife, 4) Increase public awareness of wildlife habitat issues and the critical connection between healthy habitat and abundant wildlife populations, and 5) Promote collaborative habitat management efforts with the general public, conservation partners, private landowners, and land management agencies. Efforts are focused in priority areas in each of the management regions and include crucial areas essential for conservation of important species and communities and enhancement areas, which represent places where work should be conducted to manage or improve wildlife habitat.

In addition to these guiding documents, the WGFD has a number of tools, policies and protocols to protect and enhance native aquatic wildlife. Additional details on environmental commenting, aquatic wildlife stocking and transplant, and disease prevention can be found in the 2010 SWAP.

Interagency plans and agreements
The states of Utah, Nevada, Wyoming, and Idaho, and the U.S. Forest Service, Bureau of Land Management, National Park Service, U.S. Fish and Wildlife Service, Confederated Tribes of the Goshute Reservation, and Utah Reclamation Mitigation and Conservation Commission are signatories to a range-wide conservation agreement and strategy for Bonneville Cutthroat Trout (Lentsch et al. 2000). As part of the agreement an interstate working group meets annually and produces periodic range-wide status assessments (May and Albeke 2005).

The states of Idaho, Nevada, Utah, and Wyoming, along with the U.S. Forest Service, Bureau of Land Management, Bureau of Reclamation, National Park Service, Fish and Wildlife Service, Trout Unlimited, and The Nature Conservancy, signed a Conservation Agreement to jointly conserve, protect, and restore Northern Leatherside Chub populations within their historic range (NLSC Conservation Team 2009). A range-wide conservation team meets annually to further conservation efforts. As part of the agreement the team is charged with producing status assessments for the species at five year intervals.

The states of Arizona, Colorado, Nevada, New Mexico, Utah and Wyoming and U.S. Fish and Wildlife Service, Bureau of Land Management, National Park Service, U.S. Bureau of Reclamation, Jicarilla Apache Nation, Southern Ute Indian Tribal Council, and U.S. Forest Service are signatories to a range-wide conservation agreement and strategy for Roundtail Chub, Bluehead Sucker and Flannelmouth Sucker (Three Species Conservation Team 2006). As part of the agreement an interstate working group meets annually to discuss conservation needs and produces regular status assessments.

The National Fish Habitat Action Plan (NFHAP) was developed by a coalition of fisheries professionals, state and federal agencies, tribes, foundations, conservation and angling groups, businesses and industries, all determined to reverse the declines of America's fish habitats. The WGFD is involved with three NFHAP partnerships, Great Plains Fish Habitat Partnership, the Western Native Trout Initiative, and the Desert Fishes Habitat Partnership. The last two partnerships cover the Bear River Basin. Additional information on Fish Habitat Partnerships can be found in the 2010 SWAP.

The USFWS recently established the Bear River Watershed Conservation Area. Under this program Land and Water Conservation Funds will be used to fund Conservation Easements in the Bear River watershed in Utah, Idaho, and Wyoming.

Ongoing and completed conservation actions
Numerous projects have been completed to benefit SGCN in the Bear River basin since the implementation of the 2010 SWAP (previous accomplishments are documented in the 2010 SWAP). Multiple sources of funding have been used to implement projects. Projects have been completed by Department personnel and through contracting and granting with research partners. Accomplishments are listed under

headings taken from the Recommended Conservation Actions in the 2010 SWAP. While accomplishments are not duplicated under more than one action they commonly address multiple actions. Although this list is not comprehensive of all actions, most of the significant initiatives are summarized below.

Secure and enhance populations and habitats in SGCN priority areas
WGFD biologists conducted a statewide survey of Mountain Whitefish (SGCN in 2010 SWAP) from 2009 to 2013. A primary achievement of the study was the development of a sampling approach for assessing populations (Edwards 2014). The study demonstrated most populations are robust leading to the determination that a non SGCN status rank (NSS5) is appropriate.

Monitor the status and distribution of native aquatic wildlife assemblages with emphasis on Bonneville Cutthroat Trout, Bluehead Sucker, and Northern Leatherside Chub
The WGFD conducted a study of the distribution and habitat use of Northern Leatherside Chub throughout their expected range in Wyoming (Schultz and Cavalli 2012).

The WGFD assisted Trout Unlimited with an Adopt-A-Trout project to study seasonal movement and habitat use of Bonneville Cutthroat Trout and Bluehead Suckers in the Bear River. The project identified spawning migration corridors, fish passage barriers and entrainment issues. Results from the project have project construction of a fish ladder to provide passage over an identified barrier. (WGFD 2012, 2013, 2014).

Assess the genetic purity of Bonneville Cutthroat Trout, Bluehead Sucker, and Northern Leatherside Chub populations Identify and reduce threats to native fish populations from nonnative species
The WGFD funded a study at the University of Wyoming to determine genetic purity and patterns of hybridization amongst Wyoming suckers (Mandeville et al. 2015). The study included Bluehead Suckers from the Bear River drainage.

The WGFD contracted genetic analyses of suspected Bonneville Cutthroat Trout from Lake Alice, and the Bear River. Both were determined to harbor only pure Bonneville Cutthroat Trout.

The WGFD contributed towards a project investigating genetic variation of Northern Leatherside Chub across their native range (Blakney et al. 2014). Results revealed contemporary isolation with evidence of historical connection amongst most populations.

Increase educational efforts about the ecological, economic, and social values of aquatic SGCN
The WGFD created, produced and disseminated a poster detailing the State's native fishes and stickers and magnets of some native nongame fishes, including Northern Leatherside Chub and Bluehead Sucker.

The WGFD assisted Trout Unlimited with an Adopt-A-Trout project to study seasonal movement and habitat use of Bonneville Cutthroat Trout and Bluehead Suckers in the Bear River drainage. A key component of the Adopt-A-Trout program is to bring real world science into the classroom (WGFD 2012, 2013, 2014).

Continue building voucher collections for all aquatic wildlife
WGFD completed freshwater mussel distribution surveys in the Bear River drainage (Mathias 2014). Live Western Pearlshell and California floater were documented in the drainage. All vouchers specimens are submitted to the Museum of Southwestern Biology, Albuquerque NM.

Complete the comprehensive survey for freshwater mussels
WGFD completed freshwater mussel distribution surveys in the Bear River drainage (Mathias 2014).

Continue aquatic habitat work in the basin
WGFD completed water temperature monitoring for Muddy, Little Muddy, Mill, Coal, Raymond and Huff creeks (2013 – 2014).

WGFD completed livestock exclosure maintenance in several streams.

WGFD hired a consultant to complete habitat and water quality data collection for the Smiths Fork and Sublette Creek.

The WGFD and USFWS removed three fish migration barriers to connect portions of Yellow Creek to benefit Bonneville Cutthroat Trout and Northern Leatherside Chub.

Twenty-four of the 30 known water diversion structures in the Central Bear River watershed (including Smiths Fork) were assessed for fish passage.

Fish passage was improved at the old city of Evanston water diversion structure to benefit Bonneville Cutthroat Trout and other native species.

TU and WGFD completed numerous projects on Rock Creek to improve fish passage for Bonneville Cutthroat Trout and other native species.

TU and WGFD installed a new diversion and fish screen on Twin Creek to improve passage and reduce entrainment of Bonneville Cutthroat Trout and other native species.

Explore water management approaches that enhance fish habitat
No reported projects.

Follow up on recommendations from the graduate research project on gastropods
No reported projects.

Recommended Conservation Actions

Secure, enhance, or establish SGCN populations
No actions identified.

Inventory, assess, or examine life history requirements of SGCN
Survey to determine distribution and status of Bluehead Sucker and Leatherside Chub in the mainstem Bear River. If feasible, conduct movement studies to determine seasonal migration patterns of Bluehead Sucker in the drainage.

Survey to fill gaps in knowledge about native mussel distribution as described in Mathias (2014).

Conduct baseline gastropods surveys in the basin and identify needed actions to maintain or restore populations.

Provide passage and reduce entrainment at barriers impacting SGCN
Reconnect sections of Yellow Creek to improve habitat for Northern Leatherside Chub and Bonneville Cutthroat Trout.

Assess diversions and other manmade structures to determine passability by fish and other aquatic organisms in the Bear River basin.

Work with partners to address fish passage barriers in the Bear River drainage upstream of Woodruff Reservoir.

Incorporate fish passage in designs and plans for new irrigation infrastructure.

Improve aquatic habitat for SGCN
Work with landowners, TU, USFWS, and other partners on Giraffe Creek to enhance habitats through passive restoration, secure conservation easement(s) and public access, and develop a long-term restoration and management plan.

Work with the USFS to replace culvert on USFS road 10382, and reduce sediment from salt mine and impacts from sheep trailing on Salt Creek.

Repairs existing habitat structures on Salt Creek.

Work with BLM and WY Department of Agriculture to develop willow recovery projects in the basin.

Conduct stream habitat improvements to enhance habitat for Bonneville Cutthroat Trout and other native species in Giraffe and Coal Creeks.

Complete Salt Flats stream restoration work on the Thomas Fork River to improve habitat for Bonneville Cutthroat Trout and other native species.

Work with partners to enhance habitat in Yellow Creek. Focus on addressing limiting habitat conditions for Northern Leatherside Chubs through increasing summer and fall low flows and improving riparian function.

Work with partners to enhance habitat in Mill Creek. Focus on opportunities to consolidate irrigation diversions, improve infrastructure to reduce conveyance loss, and improve irrigation efficiency to maintain flow during June and July.

Work with partners to enhance habitat in the Bear River drainage upstream of Woodruff Reservoir. Focus on opportunities to consolidate irrigation diversions and improve infrastructure to reduce conveyance loss and maintain more flow in channel.

Increase educational efforts about the ecological, economic, and social values of aquatic SGCN
No actions identified.

Continue building voucher collections for aquatic wildlife
Continue to fill voids in voucher inventory for fish per WGFD protocol (Zafft and Bear 2009).

Build gastropod voucher collection and find permanent repository.

Monitoring

Establish standardized monitoring protocols and locations for SGCN
Establish a standardized sampling program at multiple sites in the Bear River drainage to monitor presence of Northern Leatherside Chub.

Determine if there are any useful locations for monitoring Bluehead Sucker in the mainstem Bear River.

Periodically conduct population estimates at standard locations for Bonneville Cutthroat Trout.

Monitor seasonal flow regimes and temperature in areas containing important native SGCN populations and lacking active USGS or other recording stations.

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Green River Basin

New Fork River

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Watershed Description

Six major watersheds were identified for conservation planning purposes under this State Wildlife Action Plan (SWAP) using hydrographic boundaries and fisheries assemblage and management considerations. The watersheds each include one to four sub-regions (4-digit hydrologic unit code [HUC] watersheds). This approach allows the nesting of multiple spatial and temporal scales for planning and prioritizing conservation actions.

The Green River basin corresponds with the Upper Colorado hydrologic unit in Wyoming (Figure 3; 2-digit HUC 14). Major drainages corresponding to 8-digit HUCs include Upper Green, New Fork, Upper Green-Slate, Big Sandy, Bitter, Upper Green-Flaming Gorge, Blacks Fork, Muddy, Vermillion, Great Divide Closed Basin, Little Snake, and Muddy (in Little Snake drainage). The Great Divide Basin is a closed basin and is included. These watersheds span about 21,000 square miles in southwestern Wyoming's Carbon, Lincoln, Sublette, Sweetwater, and Uinta counties. Very small portions of Fremont and Teton counties occur in the basin as well. Land ownership is predominantly public (72%). Much of the 28% of privately-held lands occur in the "checkerboard" band of ownership along the Union Pacific railroad. Green River basin public land is managed primarily by the Bureau of Land Management (56% of all surface acres) and U.S. Forest Service (10% of all surface acres).

There are approximately 23,000 miles of streams on the USGS National Hydrography Dataset in the Green River basin. Major river drainages include the Little Snake (Tributary to the Yampa River in Colorado), Henrys Fork, Blacks Fork, Hams Fork, Big Sandy, East Fork, New Fork, LaBarge, Cottonwood and Horse.

Additional information about the basins drainages, geography, geology, land forms, climate, dams, reservoirs and diversions, hydrology, habitat types, land use and water classifications are detailed in the 2010 SWAP.

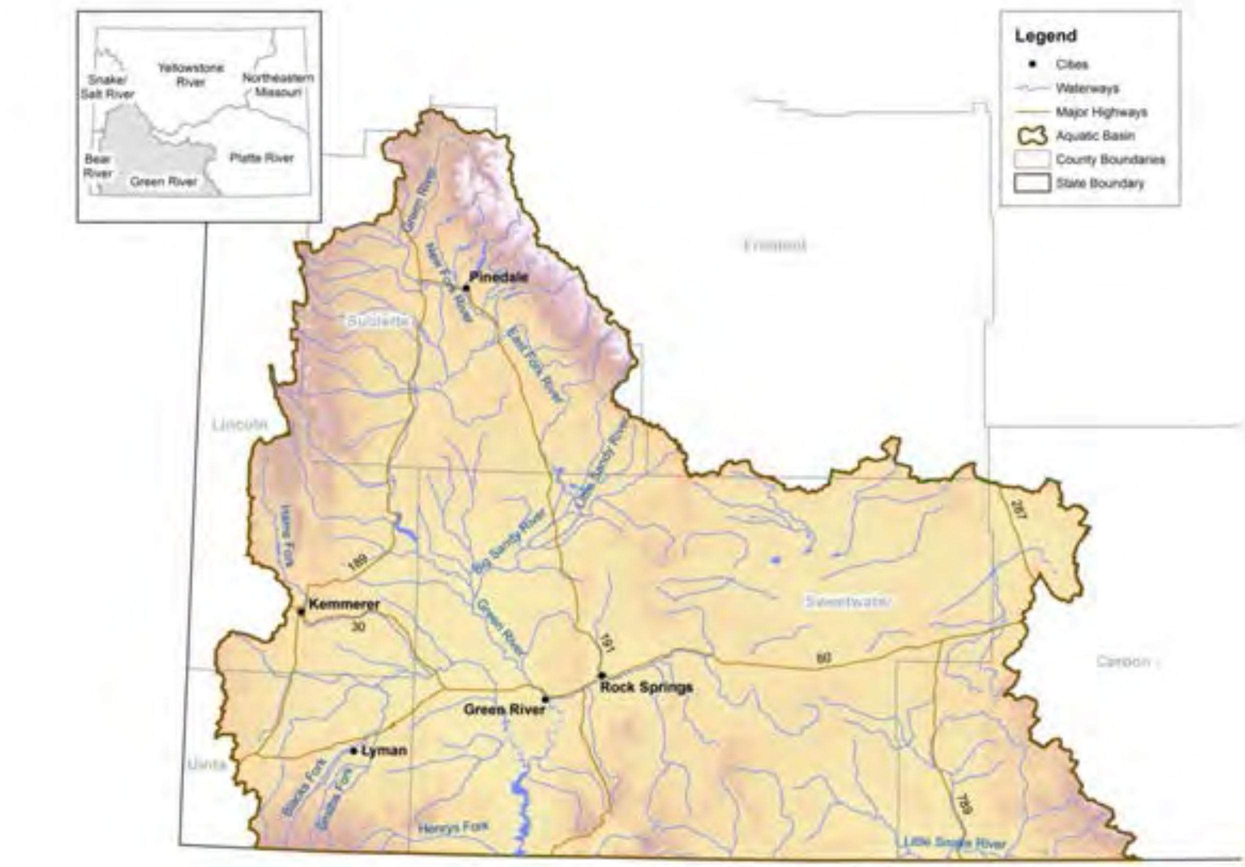

Figure 3. Green River Basin

Aquatic Wildlife

Fish

A detailed history of fish collections and surveys in this basin are chronicled in the 2010 SWAP. These surveys and collections are the basis for describing the native fish community. The 2010 SWAP also includes a summary of fish introductions to the basin. Most introductions were conducted by the WGFD but others were illegal or inadvertent.

The native fish community of the Green River basin in Wyoming is arguably the most imperiled in the state. Twelve species and subspecies were historically found in the basin, three of which have been extirpated. The basin is also home to four of Wyoming's five NSS1 fishes, the Bluehead Sucker, Flannelmouth Sucker, Roundtail Chub, and the federally endangered Kendall Warm Springs Dace (Table 3). The native community also included at least three of the four federally endangered species of the Colorado River basin, the Colorado Pikeminnow, Razorback Sucker, and Bonytail, all of which have been extirpated from the state.

The Green River basin has two native game fish and 11 native nongame fish (four are extirpated from the state; Table 3). A total of 12 game fish and 14 nongame fish have been introduced into the basin (Table 3). One game fish species and four nongame fish species are currently considered SGCN (Table 4).

Table 3. Fishes present in the Green River Basin. * denotes Species of Greatest Conservation Need (SGCN). ^{X} denotes extirpated from Wyoming. ^{E} denotes federally endangered species. ^{U} denotes fishes that may have been present in Wyoming, but historic presence has not been confirmed.

Native game	Native nongame	Nonnative game	Nonnative nongame
Colorado River Cutthroat Trout*	Bluehead Sucker*	Bonneville Cutthroat Trout	Burbot
Mountain Whitefish	Bonytail^{XE}	Brook Trout	Common Carp
	Colorado Pikeminnnow^{XE}	Brown Trout	Creek Chub
	Flannelmouth Sucker*	Channel Catfish	Fathead Minnow
	Humpback Chub^{EU}	Golden Trout	Iowa Darter
	Kendall Warm Springs Dace*^{E}	Grayling	Lake Chub
	Mottled Sculpin	Kokanee Salmon	Longnose Dace
	Mountain sucker	Lake Trout	Longnose Sucker
	Razorback Sucker^{XE}	Rainbow Trout	Northern Leatherside Chub
	Roundtail Chub*	Smallmouth Bass	Redside Shiner
	Speckled Dace	Snake River Cutthroat Trout	Sand Shiner
		Yellowstone Cutthroat Trout	Utah Chub
			Utah Sucker
			White Sucker

Aquatic Reptiles

No turtles are native to the Green River basin. Eastern Snapping Turtles have been found on occasion but none are known to have survived to reproduce.

Freshwater Mollusks and Crayfishes

Wyoming is still in the discovery phase in terms of its freshwater bivalve mollusks and gastropods. Although aquatic mollusks are often encountered during invertebrate sampling, few published accounts exist (Beetle 1989, Henderson 1924, Hoke 1979, Hovingh 2004). The WGFD retains SGCN status for some native bivalve mollusks and many gastropods due to lacking information.

No mussels are believed to be native to the basin but recent surveys found live Western Pearlshell mussels in the drainage (WGFD 2016).

Most of what is known about species presence and distributions of gastropods in the basin are summarized in Beetle (1989). All gastropods in the basin are SGCN due to lack of adequate population and distribution information.

No crayfish species are known to be native to the Green River basin in Wyoming. However, both Calico Crayfish and Virile Crayfish have been introduced (Hubert 1988, Hubert 2010). The Calico Crayfish is known from Fontenelle Reservoir and the Big Sandy River. The distribution of Virile Crayfish is much more widespread.

Table 4. Species of Greatest Conservation Need present in the Green River Basin

Fish

Bluehead Sucker
Colorado River Cutthroat Trout
Flannelmouth Sucker
Kendal Warm Springs Dace
Roundtail Chub

Identification of Conservation Areas

Conservation areas were identified based on distribution and conservation need for the Three Species (Roundtail Chub, Flannelmouth

Sucker and Bluehead Sucker) and Colorado River Cutthroat Trout.

Priority subdrainages for the conservation of Wyoming's Three Species include: Muddy Creek (tributary to the Little Snake River), Big Sandy River, Little Sandy Creek, Upper Bitter Creek, the Henrys Fork and select Finger Lakes near Pinedale.

Priority conservation areas for the Colorado River Cutthroat Trout are numerous and widespread. Priority areas in the Little Snake River drainage include: North Fork, West Branch of the North Fork, and the upper Roaring Fork of the Little Snake River; Dirtyman Creek watershed and upper Deep, Mill, Hatch, and Hells Canyon creeks in the Savery Creek watershed; Haggarty Creek; and Littlefield Creek in the Muddy Creek watershed. Priority areas in the Blacks Fork River drainage include: Muddy Creek, upper Sage and Gilbert creeks; and all tributaries to the upper Hams Fork River. Conservation areas in the upper Green River include LaBarge, Horse, and Cottonwood creek watersheds, North Piney Lake and the Lake Creek watershed, Beaver Creek watershed (tributary to Green River), Beaver creeks, Trail Ridge Creek and Fish Creek in the South Piney watershed, Tepee, Rock, Klondike, Jim, and Gypsum creeks.

Priority drainages and habitats have not yet been defined for the conservation of freshwater mollusks.

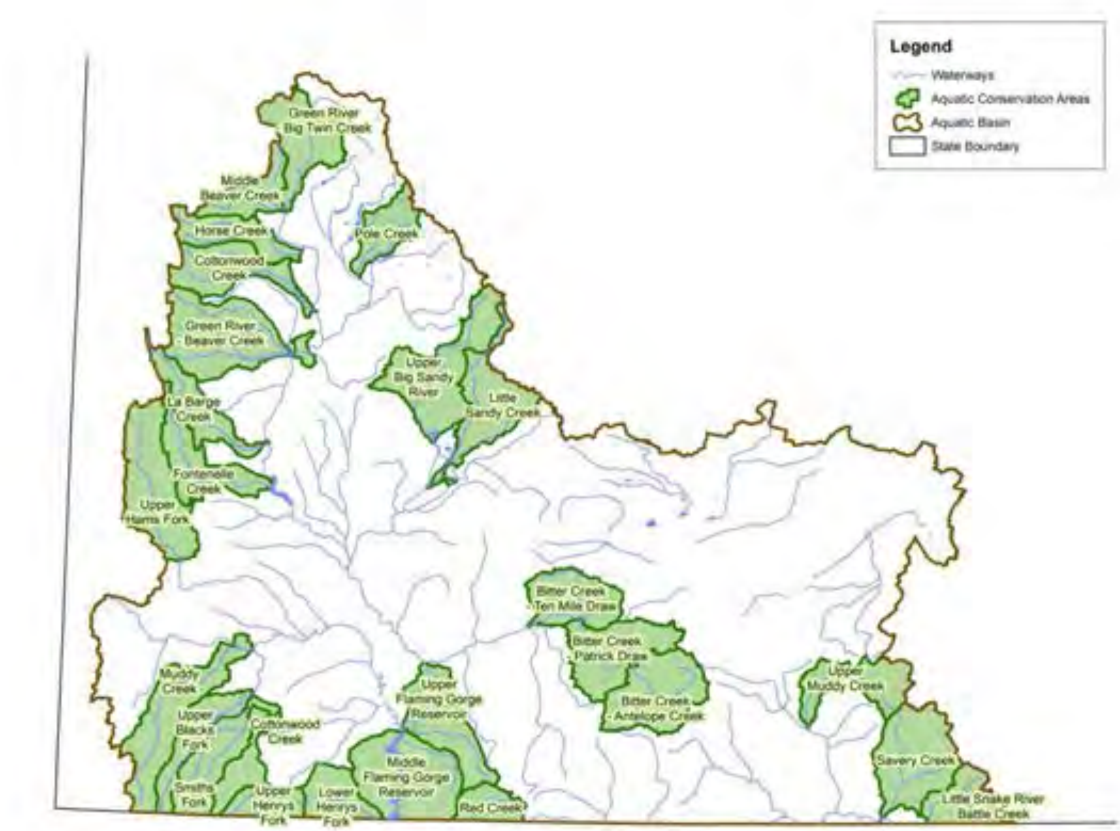

Figure 4. Aquatic Wildlife Conservation Areas in the Green River Basin.

Threats

Invasive species – High
Aquatic invasive species (AIS) present in the basin include curly pondweed. Additional descriptions and definitions of AIS can be found in the WGFD AIS management plan (WGFD 2010).

Curly pondweed was introduced into the United States in the mid 1800's and is now widespread. Curly pondweed reproduces by seed which can be easily transferred in mud or water. It is introduced into new areas through boating, fishing, and water hauling, and as an ornamental plant. New populations continue to be discovered in Wyoming. In the Green River Basin, it is found in New Fork Lake at the constriction between upper and lower New Fork lakes.

In addition to species designated as AIS, several introduced game fishes are problematic in the basin. Burbot, a voracious predator, are expanding in the basin and pose a significant threat to Flannelmouth and Bluehead Suckers in the Green and Big Sandy rivers and to the Three Species (Bluehead Sucker, Flannelmouth Sucker and Roundtail Chub) in the Blacks Fork and Hams Fork. White sucker in the drainage pose risk of competition and hybridization with native Flannelmouth and Bluehead suckers in the drainage. Additionally, competition and hybridization with nonnative trout poses a threat to important conservation populations of Colorado River Cutthroat Trout in the drainage. While nonnative game fish may need to be controlled for conservation and restoration of natives in some areas, these same fish support popular fisheries that provide important recreational and economic benefits (WGFD 2010).

Other invasive species, such as zebra and quagga mussels and silver carp, are present in neighboring states and potentially very harmful to the aquatic wildlife in the basin. Through outreach and education, watercraft inspections, and monitoring, the harmful impacts of these and other invasive species may be prevented. Watercraft are inspected at key locations entering the basin at Evanston and Kemmerer, and at major waters including Flaming Gorge Reservoir, Fontenelle Reservoir, and Fremont Lake. Twenty (20) waters in the basin are monitored annually to detect the presence of invasive species. These efforts to keep existing species in the basin from spreading to new waters, and other harmful species from entering the basin will continue.

Water development/altered flow regimes – High
Natural flow regimes in stream segments around the state have been altered by human activities including irrigation diversions and water developments for more reliable water supply, hydropower, recreation and flood control. These altered flow regimes are also a consequence of broad-scale changes in land use and management associated with agriculture, grazing, timber harvest, and housing development (see Wyoming Leading Wildlife Conservation Challenges – Disruption of Historic Disturbance Regimes). The majority of the Green River basin is publicly owned. Because it is such an arid region, the limited amount of irrigated cropland has a significant impact on aquatic wildlife in some areas. Besides the direct effects of depleting stream flow in some streams and enhancing stream flow where return flows are considerable in other places, irrigation diversions often impede movement, and in many situations significant numbers of fish are lost to entrainment into the irrigation ditches. Lateral and longitudinal hydrologic connectivity and physical access by fish populations to all habitats necessary to complete their life history is limited in portions of the drainage. In-channel obstructions and increased dewatering have reduced some populations of native fishes.

The need for additional water for human consumption will intensify in the immediate future, and that trend will be especially evident in the western U.S. Demand for additional water primarily in states that are downstream from Wyoming will increase even more than demand in Wyoming. This trend has multi-faceted consequences for fish and wildlife and the habitats upon which they depend, depending on how such demand influences water management. In Wyoming, trans-basin water diversions are not uncommon and are likely to be further proposed and pursued. Warmer conditions with more erratic precipitation— which some predict for Wyoming — may heighten the need for more creative water management including additional water storage for municipal, agricultural, and recreational purposes.

In recent years, entities from the lower Colorado River Basin have explored an incentive-based program to encourage Wyoming water users (mostly irrigators) to forgo late season irrigation as a way to produce more water in the system for those entities in the lower basin. If this practice continues, the net result could be to enhance late season flow in some stream segments which could improve habitat and species distribution for some species of fish and other aquatic organisms. Given the demand for water in the lower basin these kinds of water management practices could persist or increase.

The likely trend will be water development projects closer to the delivery point and conveyance via pipelines instead of stream channels. Additional emphasis will likely be placed on lining irrigation ditches and other practices to more efficiently use water for consumptive purposes. The net effect of all such water management practices will be to alter the timing, magnitude, and duration of natural hydrographs and reduce intra- and inter-annual variability in Wyoming's streams and associated riparian corridors (see Wyoming Leading Wildlife Conservation Challenges – Climate Change, and the Riparian habitat chapter). In many situations, changes in stream channel hydrologic patterns can alter habitat with the concurrent effect of altering the species or aquatic organisms that are found there.

Several water development projects have been proposed for the upper Green River Basin. Proposed sites are located on the Green River and Wyoming Range and Wind River tributaries (Green River Basin Plan 2010).

While water development can threaten native species, some introduced species, including those in popular sport fisheries, have thrived in the face of water development. The simplification of natural systems by human development tends to simplify habitat structure which can favor species with generalized and broad habitat requirements. For example, the Lake Trout fishery in Flaming Gorge Reservoir depends on the consistent deep water and forage production inherent in this man-made water body. Stable stream flow releases from dams, with relatively low peak flows and relatively high base flows, perpetuate productive sport fisheries like the Green River below Fontenelle Reservoir.

Drought and climate change – moderate
Climate change may increase air and surface water temperatures, alter the magnitude and seasonality of precipitation and runoff, and shift the reproductive phenology and distribution of plants and animals (Seavy et al. 2009) (see Wyoming Leading Wildlife Conservation Challenges – Climate Change).

Changes in precipitation patterns under various climate change scenarios are predicted to produce peak flows earlier in the yearly cycle and to lower base flows (Barnett et al. 2004). Drought lowers water tables, leading to reduced plant growth and reproduction. Riparian vegetation declines lead to lower bank stability, higher siltation and altered stream habitat quality and quantity. Lower water levels increase water temperatures and reduce the habitat available to fish and other aquatic wildlife. All these conditions can be detrimental to the health and reproductive success of all aquatic wildlife species.

Conservation Initiatives

Department plans and policies
The WGFD's Fish Division has developed basin management plans to guide management across the state. These plans provide background and history of aquatic wildlife management as well as management direction. These plans reference the SWAP and the Strategic Habitat Plan (SHP), attempting to incorporate management direction relevant to each basin.

Habitat management efforts are guided by the SHP that is regularly revised and approved by the Wyoming Game and Fish Commission. The SHP includes five goals: 1) Conserve and manage wildlife habitats that are crucial for maintaining terrestrial and aquatic wildlife populations for the present and future, 2) Enhance, improve, and manage priority wildlife habitats that have been degraded, 3) Increase wildlife-based recreation through habitat enhancements that maintain or increase productivity of wildlife, 4) Increase public awareness of wildlife habitat issues and the critical connection between healthy habitat and abundant wildlife populations, and 5) Promote collaborative habitat management efforts with the general public, conservation partners, private landowners, and land management agencies. Efforts are focused in priority areas in each of the management regions and include crucial areas essential for conservation of important species and communities and enhancement areas, which represent places where work should be done to maintain or improve wildlife habitat.

In addition to these guiding documents, the WGFD has a number of tools, policies and protocols to protect and enhance native aquatic wildlife. Additional details on these tools, policies and protocols including environmental commenting, aquatic wildlife stocking and transplant, and disease prevention can be found in the 2010 SWAP.

Interagency plans and agreements
The states of Colorado, Utah, and Wyoming along with the U.S. Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service, Ute Tribe and National Park Service, signed a Conservation Agreement to jointly conserve, protect, and restore Colorado River Cutthroat Trout within their historic range (CRCT Conservation Team 2006). As part of the agreement the interstate working group under the auspices of the Conservation Agreement completes range-wide status assessments (e.g. Hirsch et al. 2013).

The states of Arizona, Colorado, Nevada, New Mexico, Utah and Wyoming and U.S. Fish and Wildlife Service, Bureau of Land Management, National Park Service, U.S. Bureau of Reclamation, Jicarilla Apache Nation, Southern Ute Indian Tribal Council, and U.S. Forest Service are signatories to a range-wide conservation agreement and strategy for Roundtail Chub, Bluehead Sucker and Flannelmouth Sucker (UDWR 2009). As part of the agreement an interstate working group meets annually to discuss conservation needs and produces regular status assessments.

The National Fish Habitat Action Plan (NFHAP) was developed by a coalition of fisheries professionals, state and federal agencies, tribes, foundations, conservation and angling groups, businesses and industries, all determined to reverse the declines of America's fish habitats. The WGFD is involved with three NFHAP partnerships, Great Plains Fish Habitat Partnership, the Western Native Trout Initiative, and the Desert Fishes Habitat Partnership. The Western Native Trout Initiative and the Desert Fishes Habitat Partnership cover the Green River Basin. Additional information on Fish Habitat Partnerships can be found in the 2010 SWAP.

The Kendall Warm Springs Dace (KWD) is federally listed as an Endangered species. The U.S. Fish and Wildlife Service recovery plan for KWD is the primary guiding document for management of this species (USFWS 2015).

The Wyoming Landscape Conservation Initiative (WLCI) coalesced in the mid 2000s and is a long-term science-based effort to assess and enhance aquatic and terrestrial habitats at a landscape scale in Southwest Wyoming. To ensure Southwest Wyoming's wildlife and habitat remain viable in areas facing development pressure, the U.S. Bureau of Land Management, U.S. Fish and Wildlife Service, U.S. Geological Survey, USDA Forest Service, National Park Service, the U.S. Bureau of Reclamation, the Wyoming Department of Agriculture, the Wyoming Game and Fish Department, local conservation districts, and local counties are implementing the WLCI.

Ongoing and completed conservation actions

Numerous projects have been completed to benefit SGCN in the Green River basin since the implementation of the 2010 SWAP (previous accomplishments are documented in the 2010 SWAP). Multiple sources of funding have been used to implement projects. Projects have been completed by department personnel and through contracting and granting with research partners. Accomplishments are listed under headings taken from the Recommended Conservation Actions in the 2010 SWAP. While accomplishments are not duplicated under more than one action they commonly address multiple actions. Although this list is not comprehensive of all actions, most of the significant initiatives are summarized below.

Secure and enhance populations and habitats in SGCN priority areas

The WGFD completed a fish migration barrier on and chemically removed nonnative trout from Bare Creek. The stream will be re-stocked with genetically pure Colorado River Cutthroat Trout (WGFD 2016).

Determine the status and distribution of native aquatic wildlife assemblages with emphasis on Colorado River Cutthroat Trout, Bluehead Sucker, Flannelmouth Sucker, and Roundtail Chub

WGFD biologists conducted a statewide survey of Mountain Whitefish (SGCN in 2010 SWAP) from 2009 to 2013. A primary achievement of the study was the development of a sampling approach for assessing populations (Edwards 2014). The study demonstrated most populations are robust leading to the determination that a non SGCN status rank (NSS5) is appropriate.

WGFD biologists investigated the seasonal movements of Colorado River Cutthroat Trout in North and South Cottonwood Creeks. Results suggest variable movement and isolation of fragment populations (Rhea 2015).

The WGFD and Bridger-Teton National Forest aquatics biologists inventoried the distribution and abundance of Colorado River Cutthroat Trout in the upper Green River (Rhea and Gardiner 2012).

WGDF biologists assessed the habitat availability and use by Flannelmouth Sucker in Bitter Creek. Recommendations include barrier enhancement and channel modification (Senecal 2011).

The WGFD funded a research project at Colorado State University to aid in the design of fish migration barriers to prevent White Sucker and Burbot from entering conservation areas for Flannelmouth Sucker, Bluehead Sucker and Roundtail Chub (Gardunio 2014).

WGFD biologist monitored populations of Colorado River Cutthroat Trout, Flannelmouth Suckers, Bluehead Suckers and Roundtail Chub in the Muddy Creek drainage (WGFD 2011, 2012, 2015).

Assess the genetic purity of Colorado River Cutthroat Trout, Bluehead Sucker, Flannelmouth Sucker, and Roundtail Chub populations

The WGFD funded a study at the University of Wyoming to determine genetic purity and patterns of hybridization amongst Wyoming suckers (Mandeville et al. 2015). The study included numerous samples from Bluehead Sucker and Flannelmouth Sucker from the Green River basin.

Identify and reduce threats to native fish populations from nonnative species

The WGFD funded a research project at the University of Idaho to investigate the scale and scope of nonnative Burbot invasion in the

Green River and determine if population control may be feasible. Results suggest Burbot are widespread and abundant near reservoirs (Klein 2015).

In advance of work to restore Bluehead Sucker and Flannelmouth Sucker to the Big Sandy River, the WGFD conducted a study to determine effective lethal dosage of rotenone on Burbot (Compton 2013).

The WGFD led a mechanical removal of nonnative fish from tributaries of the Green River to protect and enhance populations of Roundtail Chub, Flannelmouth Sucker and Bluehead Sucker (Atwood and Keith 2012).

The WGFD chemically removed nonnative species (Longnose Sucker) from Meeks Lake in the Big Sandy drainage to eliminate competition and hybridization of native sucker species (WGFD 2013).

WGFD built fish migration barriers on Long Draw in the Little Sandy drainage and Sculpin Creek in the Big Sandy drainage to isolate the tributaries and facilitate chemical treatments which have eliminated significant source populations of nonnative species that are impacting native sucker species (WGFD 2013, 2016).

The WGFD chemically removed nonnative species from Sculpin Creek in the Big Sandy drainage and from Long Draw in the Little Sandy drainage to eliminate predation, competition and hybridization of native sucker species (WGFD 2013, 2016).

Trout Unlimited, in partnership with WGFD, completed the Eagle Creek fish migration barrier on McKinney Creek and the Bridger Pass fish barrier on Muddy Creek in the Muddy Creek drainage (WGFD 2016).

WGFD in partnership with BLM chemically removed nonnative species from McKinney Creek above the Eagle Creek fish barrier to eliminate predation, competition and hybridization of the three species (WGFD 2016). Bluehead Suckers and Roundtail Chub will be transplanted from downstream habitats into voided habitat.

WGFD began construction of a fish migration barrier on Big Sandy River to keep nonnative species from moving upstream into habitat used by native sucker species.

WGFD constructed the East Fork Rearing Station near the Boulder Rearing Station to hold native suckers and chubs during chemical treatments targeting non-native fishes. Studies were also conducted to determine the feasibility of salvaging and holding native suckers and chubs in captivity (WGFD 2013).

Implement existing plans and agreements to conserve SGCN
WGFD and cooperating entities continue to implement actions spelled out in Conservation Strategies for Colorado River Cutthroat Trout (CRCT Conservation Team 2006), and Roundtail Chub, Flannelmouth Sucker, and Bluehead Sucker (UDWR 2009).

Increase educational efforts about the ecological, economic, and social values of aquatic SGCN.
The WGFD created, produced and disseminated a poster detailing the state's native fishes.

WGFD created, produced and disseminated stickers and magnets featuring Flannelmouth Sucker, Bluehead Sucker, and Roundtail Chub.

Continue building voucher collections for all aquatic wildlife
WGFD biologists collected numerous fish voucher specimens since the last SWAP (2010). All vouchers specimens are submitted to the Museum of Southwestern Biology, Albuquerque NM.

Continue aquatic habitat work in the basin
WGFD biologists investigated Colorado River Cutthroat Trout passage and entrainment at Cheyenne Board of Public Utilities diversions in the Little Snake River drainage (Luginbill and Compton 2011). Results suggest the diversions

are barriers that impeded movement while entrainment is a low-level threat.

WGFD completed entrainment studies on several private land diversions in the Cottonwood drainage (WGFD 2016).

The WGFD partnered with USFS, TU, and USFWS to improve passage at two road crossings in upper LaBarge Creek to open up five miles of habitat to Colorado River Cutthroat.

The WGFD assessed 231 of 296 known points of diversions in the upper Green Basin (primarily along the East slope of the Wyoming Range) for fish passage needs and prioritization.

Fish passage was improved at four irrigation diversions in three different drainages; Horse Creek, Cottonwood Creek, and Piney Creek. A fish screen was installed in a large diversion of Pine Creek, tributary to the New Fork River, to eliminate entrainment.

Trout Unlimited in partnership with WGFD and Little Snake Conservation District modified numerous sheet piling structures to allow for fish passage in the Muddy Creek drainage (WGFD 2015, 2016).

Explore water management approaches that enhance fish habitat
A two year pilot program was initiated that paid water users to stop irrigation in early July and allow water to bypass their diversion with the goal to reach states in the lower Colorado River basin. Extra flow during late summer is very beneficial to habitat conditions at a critical time period for fish.

Follow up on recommendations from the graduate research project on gastropods
No reported projects.

Recommended Conservation Actions

Secure, enhance, or establish SGCN populations
Finish building fish migration barrier on the Big Sandy River, salvage native fish and chemically remove nonnative suckers, chubs and Burbot.

Restore Little Sandy Creek to a native fish assemblage including the three species. Build fish migration barriers and establish fish passage as necessary to facilitate restoration efforts.

Continue restoring Muddy Creek and its tributaries to a native fish assemblage including the three species and Colorado River Cutthroat Trout. Build fish migration barriers and establish fish passage as necessary to facilitate restoration efforts.

Transplant Roundtail Chub from lower Muddy Creek into Lowest Deep Gulch Reservoir. Increase the capacity of the East Fork Rearing Station (three species rearing facility) to hold and maintain additional fish.

Identify refuge lakes and implement transplants for Roundtail Chubs in lakes in the basin.

Restore Sage Creek, Currant Creek and Trout Creek to a native fish assemblage including Colorado River Cutthroat trout. Build fish migration barriers and establish fish passage as necessary to facilitate restoration efforts.

Reconnect East Muddy Creek, West Muddy Creek and Van Tassel Creek as metapopulation of native fish including Colorado River Cutthroat trout. Eliminate nonnative fish as necessary with chemical treatments. Protect the population with a fish migration barrier below the convergence of the three Muddy Creek tributaries.

Inventory, assess, or examine life history requirements of SGCN
Conduct baseline gastropods surveys in the basin and identify needed actions to maintain or restore populations.

Conduct sampling on non-wadeable streams in the Green River drainage which were undersampled in 2002-2006 surveys (Gelwicks et al. 2009) to better understand the status of Flannelmouth Sucker, Bluehead Sucker and Roundtail Chub in these waters.

Determine current status of Roundtail Chub populations in the Blacks Fork and Hams Fork drainages, especially after the recent invasion by non-native Burbot.

Conduct a study to better understand life history and movement patterns of Roundtail Chub in the Blacks Fork and Hams Fork drainages.

Provide passage and reduce entrainment at barriers impacting SGCN
Conduct entrainment study of seven irrigation diversions in the Cottonwood Creek drainage to determine need for screening.

Work with TU and landowner on South Cottonwood Creek to improve passage past two diversions and a road crossing.

Work with partners in the Henry's Fork drainage and its tributaries to improve fish passage and reduce or eliminate entrainment by irrigation diversions as necessary for Flannelmouth Suckers, Bluehead Suckers and Colorado River Cutthroat Trout.

Work with partners to improve fish passage in the Muddy Creek drainage for Colorado River Cutthroat Trout and the three species.

Work with partners to maintain existing fish migration barriers and to improve fish passage as needed in the Gilbert Creek drainage.

Work with project partners to improve passage at nine additional road crossings in upper LaBarge Creek to connect the entire watershed upstream of the fish migration barrier.

Assist water users with entrainment study on the Lee Ditch, a diversion on Pine Creek.

Assess remaining irrigation diversions and road crossings in the basin for fish passage and prioritization for fish friendly improvements.

Improve aquatic habitat for SGCN
Implement stream restoration designs on the New Fork River downstream of Pinedale to improve stream function and habitat conditions.

Implement stream restoration and habitat improvement projects on the Big Sandy River downstream of Buckskin Crossing to narrow and deepen the channel and expose hard surfaces for native suckers.

Implement stream riparian restoration projects in the Red Creek drainage to enhance habitat for native fish including Colorado River Cutthroat Trout.

Employ water management strategies that improve habitat for SGCN
Identify opportunities to work with private water right holders to manage water diversions and uses with the goal of restoring natural flow regimes. Where opportunities exist, develop cooperative strategies with landowners and other partners to implement strategies that are beneficial to aquatic resources.

Identify stream segments where habitat and available flow regimes indicate a need to file instream flow water rights for SGCN. As opportunities are identified, conduct needed studies and file for state-held instream flow water rights.

Continue building voucher collections for all aquatic wildlife
Continue to fill voids in voucher inventory for fish per WGFD protocol (Zafft and Bear, 2009).

Build gastropod voucher collection and find permanent repository.

Increase educational efforts about the ecological, economic, and social values of aquatic SGCN
No specific actions identified.

Monitoring

Routinely monitor SGCN populations
Conduct routine population assessments of Colorado River Cutthroat Trout at established monitoring sites.

Conduct routine population assessments of Roundtail Chub, Flannel Mouth Sucker and Bluehead Sucker at established monitoring sites.

Establish standardized monitoring protocols and locations for native SGCN
Develop a plan to monitor Flannelmouth Sucker, Bluehead Sucker and Roundtail Chub populations identified in Gelwicks et al. (2009).

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Northeastern Missouri River Basin

Cheyenne River

Table of Contents

Watershed Description

Six major watersheds were identified for conservation planning purposes under this State Wildlife Action Plan (SWAP) using hydrographic boundaries and fisheries assemblage and management considerations. The watersheds each include one to four sub-regions (4-digit hydrologic unit code [HUC] watersheds). This approach allows the nesting of multiple spatial and temporal scales for planning and prioritizing conservation actions.

The Northeastern Missouri River basin includes four 6-digit HUCs, all direct tributaries to the Missouri River (Figure 5). These include the Little Missouri, Belle Fourche, Cheyenne, and Niobrara River watersheds (Figure 5). Thirteen 8-digit HUCs and 52 10-digit HUCs occur in this area. These watersheds span an area of about 12,000 square miles in northeastern Wyoming's Crook, Weston, Campbell, Converse, Niobrara, and Goshen counties. Land ownership is 81% private. Public land is held primarily by the State of Wyoming (6%), Bureau of Land Management (5%), and U.S. Forest Service (4%).

With over 80% of the land in this basin in private ownership and many of the public-owned parcels inaccessible, land ownership presents a big challenge to effectively manage the aquatic species in this basin.

There are approximately 44,000 miles of streams on the USGS National Hydrography Dataset in the Northeastern Missouri River basin. However many of these streams are ephemeral. A closer approximation (although still high) of actual aquatic habitat may be the 8,000 named stream miles from the NHD GIS layer. Major drainages include the Little Missouri River, Belle Fourche River, Cheyenne River and the Niobrara River.

Additional information about the basins drainages, geography, geology, land forms, climate, dams, reservoirs and diversions, hydrology, habitat types, land use and classifications are detailed in the 2010 SWAP.

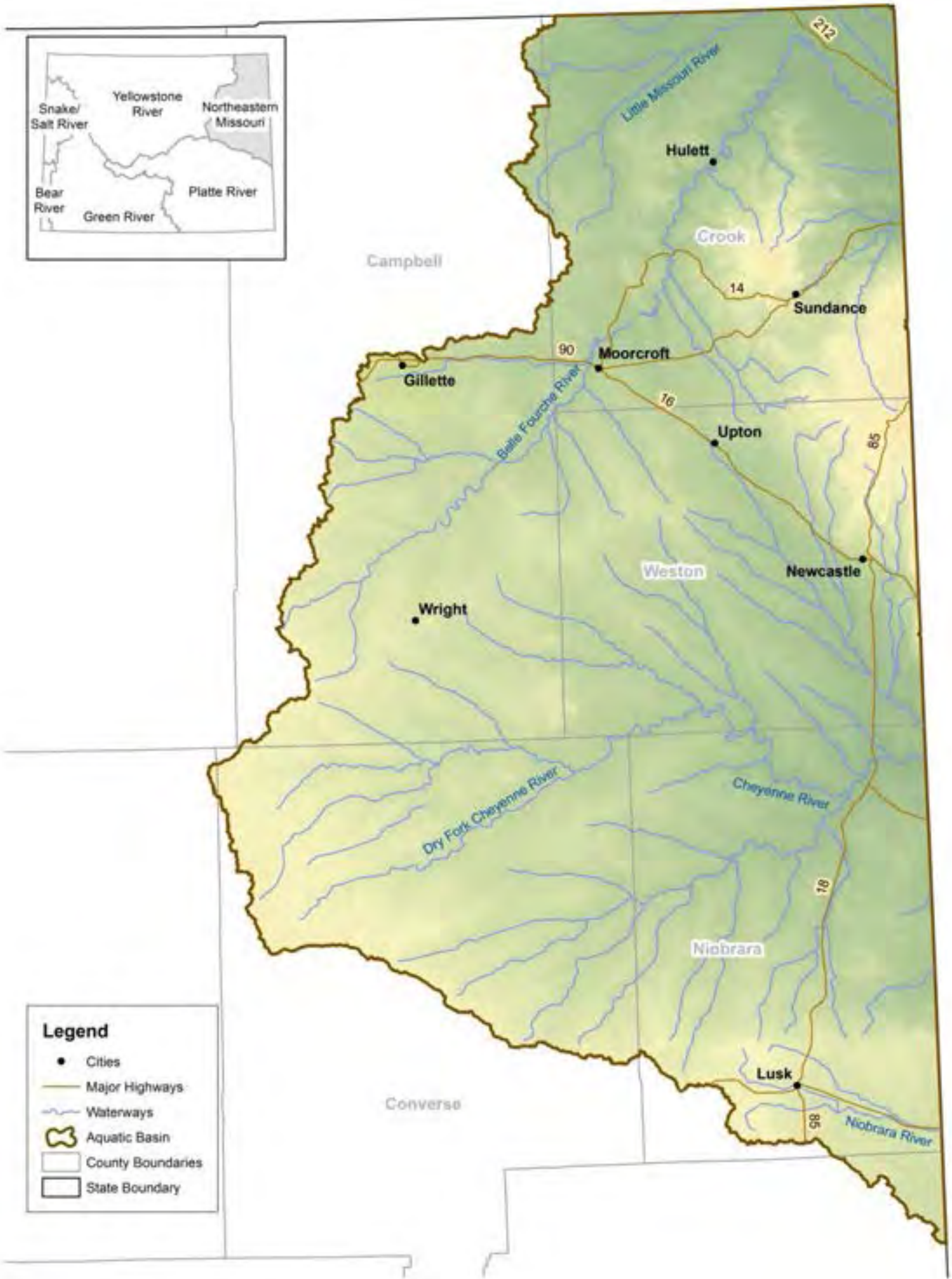

Figure 5. Northeastern Missouri River Basin.

Aquatic Wildlife

Fish

A detailed history of fish collections and surveys in this basin, which began in the mid 19th century is chronicled in the 2010 SWAP. These surveys and collections along with a detailed survey conducted in the 1990's (Patton et al. 1995, Patton 1997, Patton et al. 1998, Patton 2001) are the basis for describing the native fish community. The 2010 SWAP also includes a summary of fish introductions to the basin. Many introductions were conducted by the WGFD but others were illegal or inadvertent.

The Northeastern Missouri River basin is home to the most diverse fish community in the state. The known fish assemblage of the Northeastern Missouri River basin is shown in Table 5. The basin has three native game fish and 20 native nongame fish (Table 5). A total of 14 game fishes and nine nongame fishes have been introduced to the basin (Table 5). Nine nongame species native to the basin are currently considered SGCN.

Many of the fish SGCN in the basin (Brassy Minnow, Flathead Chub, Goldeye, Plains Minnow, and Western Silvery Minnow) belong to an assemblage associated with large turbid free flowing rivers. Others such as the Plains Topminnow and Finescale Dace are commonly associated with the small plains streams with large rainstorm induced flow fluctuations.

Table 5. Fishes present in the Northeastern Missouri River Basin. Species of Greatest Conservation Need (SGCN) are followed by an asterisk (*).

Native game	Native nongame	Nonnative game	Nonnative nongame
Black Bullhead	Brassy Minnow*	Black Crappie	Brook Stickleback
Channel Catfish	Creek Chub	Bluegill	Common Carp
Stonecat	Central Stoneroller	Brook Trout	Emerald Shiner
	Fathead Minnow	Brown Trout	Gizzard Shad
	Finescale Dace*	Freshwater Drum	Golden Shiner
	Flathead Chub*	Green Sunfish	Grass Carp
	Goldeye*	Largemouth Bass	Longnose Sucker
	Iowa Darter*	Northern Pike	Northern Plains Killifish
	Lake Chub	Rainbow Trout	Spottail Shiner
	Longnose Dace	Smallmouth Bass	
	Mountain Sucker	Snake River Cutthroat Trout	
	Pearl Dace*	Walleye	
	Plains Minnow*	White Crappie	
	Plains Topminnow*	Yellow Perch	
	Red Shiner		
	River Carpsucker		
	Sand Shiner		
	Shorthead Redhorse		
	Western Silvery Minnow*		
	White Sucker		

Aquatic Reptiles
Three turtles are found in the Northeastern Missouri River basin, all of which are native. The Western Painted and Western Spiny Softshell turtles are SCGN, but the Eastern Snapping turtle is not. The Western Spiny Softshell turtle is believed to have the widest distribution in the watershed of the three, however, few records exist for this species in the basin.

Freshwater Mollusks and Crayfishes
Wyoming is still in the discovery phase in terms of its freshwater bivalve mollusks and gastropods. Although aquatic mollusks are often encountered during invertebrate sampling, few published accounts exist (Beetle 1989, Henderson 1924, Hoke 1979, Hovingh 2004). The WGFD retains SGCN status for some native bivalve mollusks and many gastropods due to lacking information. However, the WGFD recently completed native mussel surveys statewide, including the Northeastern Missouri River Basin (Mathias 2016).

Three bivalve mussel species have been documented in the basin. Giant Floater have been documented in portions of the Little Missouri and Belle Fourche river drainages and White Heelsplitter and Giant Floater have been documented in the Belle Fourche drainage. Giant Floater remain SGCN with not enough information to provide a NSS rank. Both White Heelsplitter and Fatmucket are considered secure and not SGCN.

Most of what is known about species presence and distributions of gastropods in the basin are summarized in Beetle (1989). All gastropods in the basin are SGCN due to lack of adequate population and distribution information.

Little information is available on the distribution of Wyoming crayfishes. The Calico Crayfish is the only species of crayfish known to occur in the Northeastern Missouri River basin (Hubert 2010). The Calico Crayfish is native to the basin and an SGCN.

Table 6. Species of Greatest Conservation Need present in the Northeastern Missouri River Basin.

Fish

Brassy Minnow
Central Stoneroller
Finescale Dace
Flathead Chub
Goldeye
Iowa Darter
Pearl Dace
Plains Minnow
Plains Topminnow
Western Silvery Minnow

Reptiles
Western Painted Turtle
Western Spiny Softshell

Crustaceans
Calico Crayfish

Mollusks
Giant Floater Mussel

Identification of Conservation Areas

To address needs of SGCN in the Northeastern Missouri River basin, conservation priority areas were identified (Figure 6). Results from Stewart et al. (2015) guided prioritization, building upon previous inventories and assessments (e.g., Patton 1997, McGree et al. 2011).

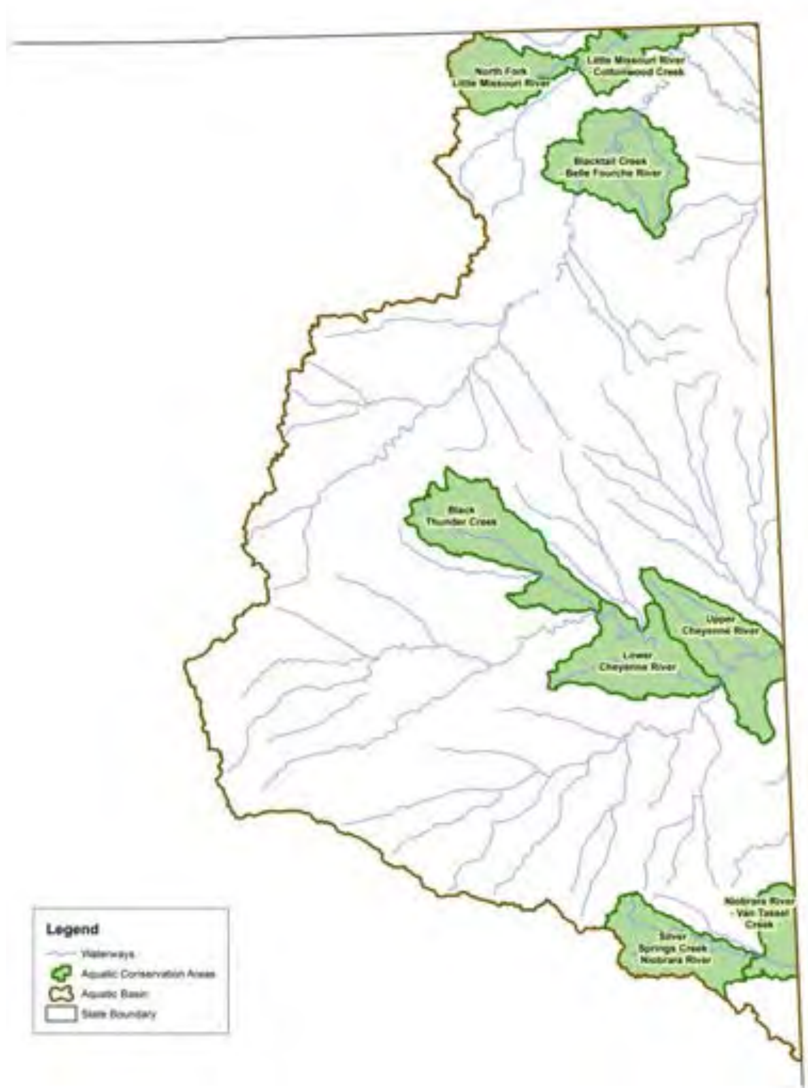

Figure 6. Aquatic Wildlife Conservation Areas in the Northeastern Missouri River Basin.

Priority areas include drainages where native fish diversity is highest in the basin and includes streams where the density of rare species (e.g., Finescale Dace and Pearl Dace) are high. Priority areas include most of the lower Little Missouri River drainage including the North Fork, the lower Cheyenne River including Lance Creek, the lower Niobrara River including Van Tassel Creek and the Belle Fourche below Keyhole Reservoir and including Redwater Creek (Figure 6).

Priority drainages and habitats have not yet been defined for the conservation of aquatic reptiles, freshwater mollusks, or crayfishes.

Threats

Water development/altered flow regimes – Moderate

Natural flow regimes in stream segments around the state have been altered by human activities including irrigation diversions and water developments for more reliable water supply, hydropower, and flood control. These altered flow regimes are also a consequence of broad-scale changes in land use and management associated with agriculture, grazing, timber harvest, and housing development (see Wyoming Leading Wildlife

Conservation Challenges – Disruption of Historic Disturbance Regimes). The majority of the Northeastern Missouri River basin is grasslands or sagebrush. There is some irrigated cropland and relatively few water storage reservoirs.

Groundwater use in prairie systems has been shown to negatively impact stream flow, increasing the extent and duration of dry or intermittent stream channels. Native prairie fishes evolved in a highly dynamic system and readily recolonize areas that periodically dry out. Key to the ability to recolonize is lateral and longitudinal hydrologic connectivity and physical access by fish populations to all habitats necessary to complete their life history. In-channel obstructions and increased drying have reduced some populations of native stream fishes.

The need for additional water for human use will intensify in the immediate future, and that trend will be especially evident in the western U.S. This trend has multi-faceted consequences for fish and wildlife and the habitats upon which they depend. In Wyoming, trans-basin water diversions are not uncommon and are likely to be further proposed and pursued. Energy diversification, including hydropower development, may increase as the nation's energy demands rise. Warmer conditions with more erratic precipitation— which some predict for Wyoming's future climate—may heighten the need for additional water development (water storage) for municipal and agricultural purposes.

The likely trend will be water development projects closer to the delivery point and conveyance via pipelines instead of stream channels. Additional emphasis will likely be placed on lining irrigation ditches and other practices to more efficiently use water for consumptive purposes. The net effect of all such water management practices will be to alter the timing, magnitude, and duration of natural hydrographs and reduce intra- and inter-annual variability in Wyoming's streams and associated riparian corridors (see Wyoming Leading Wildlife Conservation Challenges – Climate Change).

While water development can threaten native species, some introduced species, including those in popular sport fisheries, have thrived in the face of water development. The simplification of natural systems by human development tends to favor species with generalized and broad habitat requirements.

Drought and climate change – Moderate
Climate change may increase air and surface water temperatures, alter the magnitude and seasonality of precipitation and runoff, and shift the reproductive phenology and distribution of plants and animals (Seavy et al. 2009) (see Wyoming Leading Wildlife Conservation Challenges – Climate Change). Changes in precipitation patterns under various climate change scenarios are predicted to produce peak flows earlier in the yearly cycle and to lower base flows (Barnett et al. 2004).

Drought lowers water tables, leading to reduced plant growth and reproduction. Riparian vegetation declines lead to lower bank stability, higher siltation and altered stream habitat quality and quantity. Lower water levels increase water temperatures and reduce the habitat available to fish and other aquatic wildlife. All these conditions can be detrimental to the health and reproductive success of all aquatic wildlife species.

Invasive species – Moderate
Aquatic invasive species (AIS) present in the basin include curly pondweed and brook stickleback. Additional descriptions and definitions of AIS can be found in the WGFD AIS management plan (WGFD 2010).

Curly pondweed was introduced into the United States in the mid 1800's and is now widespread. Curly pondweed reproduces by seed which can be easily transferred in mud or water. It is introduced into new areas through boating, fishing, and water hauling, and as an ornamental plant. New populations continue to be discovered in Wyoming. In the Northeastern Missouri River Basin, it is found in Keyhole Reservoir.

The Brook Stickleback has been introduced to many states outside of its native range. Brook Stickleback are spread as a result of bait introductions or accidental introductions with aquaculture species. Juvenile fish and fish eggs may be difficult to see and can be moved in standing water in boats and bait buckets. Brook Stickleback are found in Turner Reservoir and Beaver Creek in the Cheyenne River drainage, and in Montana Creek in the Belle Fourche River drainage.

In addition to species designated as AIS, several introduced game fishes are problematic in the basin including Northern Pike, Yellow Perch and Black Crappie. While nonnative game fish may need to be controlled for conservation and restoration of natives in some areas, these same fish support popular fisheries that provide important recreational and economic benefits (WGFD 2010).

Other invasive species, such as zebra and quagga mussels and silver carp, are present in neighboring states and potentially very harmful to the aquatic wildlife in the basin. Through outreach and education, watercraft inspections, and monitoring, the harmful impacts of these and other invasive species may be prevented. Watercraft are inspected at key locations entering the basin at Beulah and at Keyhole Reservoir. Keyhole Reservoir is monitored annually to detect the presence of invasive species. These efforts to keep existing species in the basin from spreading to new waters, and other harmful species from entering the basin will continue. These efforts to keep existing species in the basin from spreading to new waters, and other harmful species from entering the basin will continue.

Conservation Initiatives

Department plans and policies

The WGFD's Fish Division has developed basin management plans to guide management across the state. These plans provide background and history of aquatic wildlife management as well as management direction. These plans reference the SWAP and the Strategic Habitat Plan (SHP), attempting to incorporate management direction relevant to each basin.

Habitat management efforts are guided by the SHP that is regularly revised and approved by the Wyoming Game and Fish Commission. The SHP includes five goals: 1) Conserve and manage wildlife habitats that are crucial for maintaining terrestrial and aquatic wildlife populations for the present and future, 2) Enhance, improve, and manage priority wildlife habitats that have been degraded, 3) Increase wildlife-based recreation through habitat enhancements that maintain or increase productivity of wildlife, 4) Increase public awareness of wildlife habitat issues and the critical connection between healthy habitat and abundant wildlife populations, and 5) Promote collaborative habitat management efforts with the general public, conservation partners, private landowners, and land management agencies. Efforts are focused in priority areas in each of the management regions and include crucial areas essential for conservation of important species and communities and enhancement areas, which represent places where work should be conducted to manage or improve wildlife habitat.

In addition to these guiding documents, the WGFD has a number of tools, policies and protocols to protect and enhance native aquatic wildlife. Additional details on these tools, policies and protocols including environmental commenting, aquatic wildlife stocking and transplant, and disease prevention can be found in the 2010 SWAP.

Interagency plans and agreements

The National Fish Habitat Action Plan (NFHAP) was developed by a coalition of fisheries professionals, state and federal agencies, tribes, foundations, conservation and angling groups, businesses and industries, all determined to reverse the declines of America's fish habitats. The WGFD is involved with three

NFHAP partnerships, Great Plains Fish Habitat Partnership, the Western Native Trout Initiative, and the Desert Fishes Habitat Partnership. The Great Plains Fish Habitat Partnership covers the Northeastern Missouri River Basin. The goal of the partnership is to work together to conserve (protect, restore, and enhance) aquatic resources of rivers and streams throughout the prairies of the central United States. Additional information on Fish Habitat Partnerships can be found in the 2010 SWAP.

Ongoing and completed conservation actions
Numerous projects have been completed to benefit SGCN in the Northeastern Missouri River basin since the implementation of the 2010 SWAP (previous accomplishments are documented in the 2010 SWAP). Multiple sources of funding have been used to implement projects. Projects have been completed by department personnel and through contracting and granting with research partners. Accomplishments are listed under headings taken from the Recommended Conservation Actions in the 2010 SWAP. While accomplishments are not duplicated under more than one action they commonly address multiple actions. Although this list is not comprehensive of all actions, most of the significant initiatives are summarized below.

Secure and enhance populations and habitats in SGCN priority areas
The WGFD conducted a project to inventory and assess amphibian and reptile populations and habitats in northeastern Wyoming (Snoberger and Walker 2016). Amongst other findings, Western Painted Turtle and Eastern Snapping Turtles were both documented but Western Spiny Softshell was not detected.

Protect native fish populations in the Niobrara drainage
WGFD biologists inventoried and assessed fish populations and habitats in northeastern Wyoming's prairie streams (Moan et al. 2010, McGree et al. 2011). Amongst other findings, numerous refinements were made to range distributions.

WGFD biologists carried out a project in 2014-2015 to determine the impacts of barriers and intermittency on native fish assemblages in the Niobrara River (Compton and Hogberg *In preparation*). Amongst other findings, non-native Northern Pike were documented in the lower Niobrara River in Wyoming for the first time.

Describe the distribution and intactness of aquatic habitats
No reported projects.

Protect relatively intact riparian systems and restore those in proximity to SGCN priority areas
The WGFD transplanted beaver to the Blacktail and Redwater Creek drainages. The objectives were to raise streamside water tables and moderate late season stream flows (WGFD 2011, 2012, 2015, 2016).

The WGFD implemented rehabilitation treatments in cooperation with the Black Hills National Forest to stabilize channel degradation at a three acre remnant beaver dam wetland complex that supports FSD in the headwaters on Middle Redwater Creek (WGFD 2016).

Explore water management approaches that enhance fish habitat
A project in Newcastle was completed that created a 1.6 acre publically accessible pond and enhanced downstream wetlands by using water from an unused water well.

Increase educational efforts about the ecological, economic, and social values of aquatic SGCN
The WGFD created, produced and disseminated a poster detailing the states native fishes.

Continue building voucher collections for all aquatic wildlife
WGFD biologists collected numerous fish voucher specimens since the last SWAP (2010). All fish voucher specimens are submitted to the Museum of Southwestern Biology, Albuquerque NM. All native mussel and crayfish voucher

specimens are submitted to the University of Colorado Museum of Natural History.

Complete the comprehensive survey for freshwater mussels
The WGFD conducted a SWG-funded project to assess the distribution and abundance of native mussels in northeast Wyoming. Inventory surveys were conducted in the Powder, Tongue, Belle Fourche and Cheyenne (Mathias 2016). Live White Heelsplitter, Fatmucket and Giant Floater were documented in the Tongue and Belle Fourche rivers (Mathias 2016).

Follow up on recommendations from the graduate research project on gastropods
No reported projects.

Increase connectivity where appropriate
The above mentioned project on Middle Redwater Creek helped reconnect a Finescale Dace population.

Remove nonnative species from the North Fork Little Missouri River
No reported projects.

Recommended Conservation Actions

Secure, enhance, or establish SGCN populations
Determine suitable locations and transplant Finescale Dace to increase distribution.

Inventory, assess, or examine life history requirements of SGCN
Investigate the distribution, impacts on SGCN and options for control of non-native Northern Pike in the lower Niobrara River. Conduct baseline gastropods surveys in the basin and identify needed actions to maintain or restore populations.

Survey to fill gaps in knowledge about native mussel distribution with a particular focus on Giant Floater.

Investigate the distribution and population structure of aquatic reptiles, especially Western Spiny Softshell.

Provide passage and reduce entrainment at barriers impacting SGCN
Enter information on physical measurements and locations of natural and manmade barriers in WGFD Fish Passage database.

Improve aquatic habitat for SGCN
Explore opportunities to increase suitable riparian habitats for beaver, and transplant beaver to suitable habitats.

Conduct habitat improvement projects to secure currently occupied Finescale Dace habitat in the Belle Fourche (e.g. Redwater Creek) drainage.

Employ water management strategies that improve habitat for SGCN
No actions identified.

Increase educational efforts about the ecological, economic, and social values of aquatic SGCN
No actions identified.

Continue building voucher collections for aquatic wildlife
Continue to fill voids in voucher inventory for fish per WGFD protocol (Zafft and Bear 2009).

Build gastropod voucher collection and find permanent repository.

Monitoring

Establish standardized monitoring protocols and locations for SGCN
Establish a standardized fish sampling program at multiple sites in the Little Missouri, Belle

Fourche, Cheyenne and Niobrara river drainages (McGree et al. 2010, Moan et al. 2010).

Monitor upstream distributions of introduced Northern Pike in the Niobrara River.

Monitor the existing population of Finescale Dace in the Redwater Creek drainage.

Monitor water quantity and temperature in areas containing important native SGCN populations.

Monitor the establishment and spread of invasive species.

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Platte River Basin

Little Medicine Bow River

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Watershed Description

Six major watersheds were identified for conservation planning purposes under this State Wildlife Action Plan (SWAP) using hydrographic boundaries and fisheries assemblage and management considerations. The watersheds each include one to four sub-regions (4-digit hydrologic unit code [HUC] watersheds). This approach allows the nesting of multiple spatial and temporal scales for planning and prioritizing conservation actions.

The Platte River Basin encompasses two 4-digit HUC watersheds: North Platte and South Platte (Figure 7). Major drainages in the North Platte River basin corresponding to 8-digit HUCs include the Upper North Platte, Pathfinder-Seminoe Reservoir, Medicine Bow, Little Medicine Bow, Sweetwater, Middle North Platte-Casper, Glendo Reservoir, Middle North Platte-Scotts Bluff, Upper Laramie, Lower Laramie, Horse, and a minor piece of Pumpkin basin. In the South Platte, major drainages with portions in Wyoming include Cache la Poudre, Lone Tree-Owl, Crow, Upper Lodgepole, Lower Lodgepole, and Sidney Draw. These watersheds span about one quarter of Wyoming, covering 24,200 square miles in southeastern and central Wyoming's Albany, Carbon, Converse, Fremont, Goshen, Laramie, Natrona, Niobrara and Platte counties. Land ownership is predominantly private (62%). Public land in this basin is managed primarily by the Bureau of Land Management (22%), U.S. Forest Service (9%), and the State of Wyoming (8%).

There are approximately 23,450 miles of streams on the USGS National Hydrography Dataset in the Platte River basin in Wyoming. Major river drainages in the basin include the North Platte, Encampment, Laramie, Sweetwater and Medicine Bow.

Additional information about the basins drainages, geography, geology, land forms, climate, dams, reservoirs and diversions, hydrology, habitat types, land use and classifications are detailed in the 2010 SWAP.

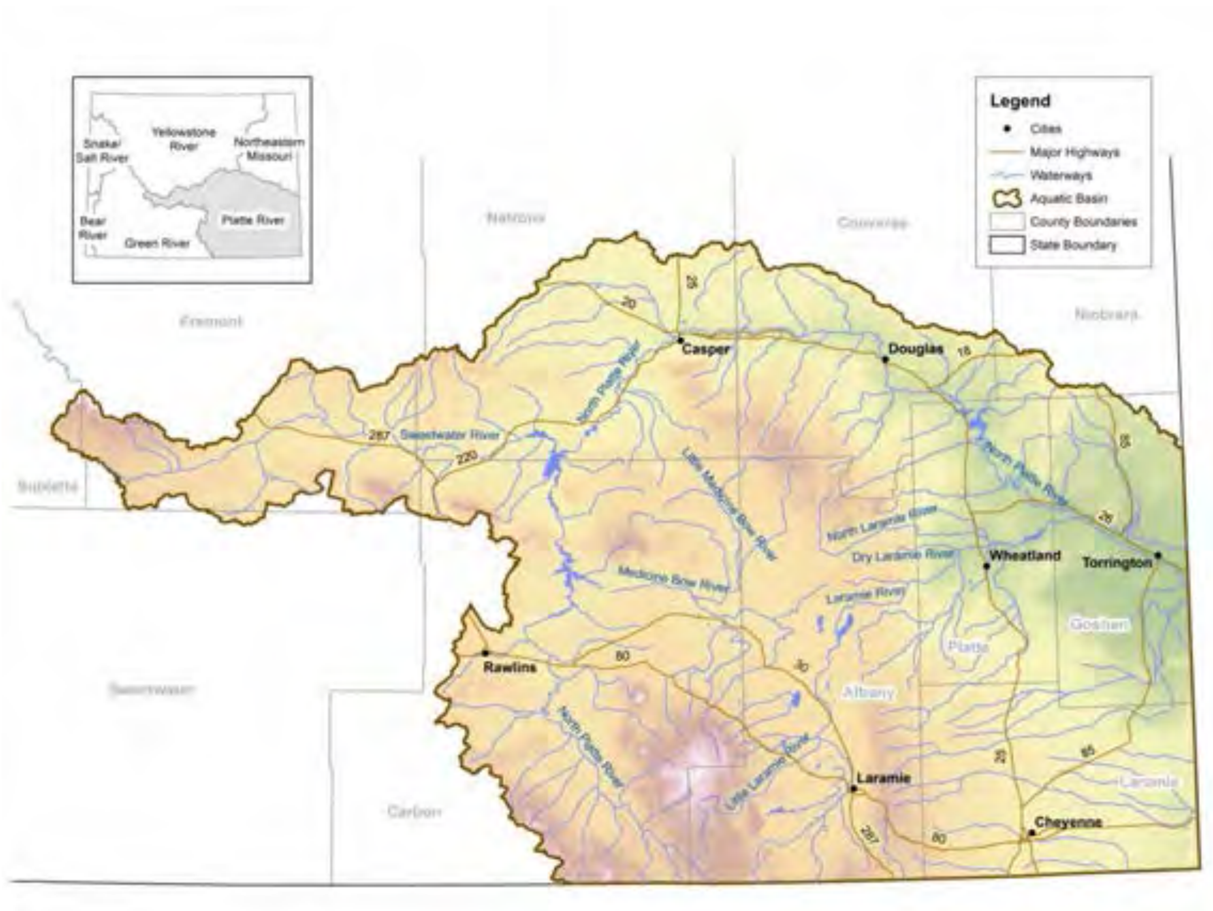

Figure 7. Platte River Basin.

Aquatic Wildlife

Fish

A detailed history of fish collections and surveys in this basin, which began in the mid 19th century is chronicled in the 2010 SWAP. These surveys and collections are the basis for describing the native fish community. The 2010 SWAP also includes a summary of fish introductions to the basin. Most introductions were conducted by the WGFD but others were illegal or inadvertent.

The Platte River Basin has six native game fish and 27 native nongame fish (Table 7). Six of these are believed to be extirpated from the basin (Table 7). A total of 21 game fishes and eight nongame fishes have been introduced to the basin (Table 7). Two game species and 13 nongame species are currently considered SGCN.

Table 7. Fishes present in the Platte River Basin. * denotes Species of Greatest Conservation Need (SGCN). ^{E} denotes extirpated from the basin.

Native game	Native nongame	Nonnative game	Nonnative nongame
Black Bullhead	Bigmouth Shiner*	Bonneville Cutthroat	Brook Stickleback
Channel Catfish	Brassy Minnow*	Black Crappie	Common Carp
Greenback Cutthroat Trout^{E}	Central Stoneroller	Bluegill	Emerald Shiner
Sauger*^{E}	Common Shiner*	Brook Trout	Gizzard Shad
Shovelnose Sturgeon*^{E}	Creek Chub	Brown Trout	Golden Shiner
Stonecat	Fathead Minnow	Colorado River Cutthroat	Goldfish
	Flathead Chub*	Freshwater Drum	Grass Carp
	Goldeye*^{E}	Golden Trout	Spottail Shiner
	Hornyhead Chub*	Grayling	
	Iowa Darter*	Green Sunfish	
	Johnny Darter	Kokanee Salmon	
	Lake Chub	Lake Trout	
	Longnose Dace	Largemouth Bass	
	Longnose Sucker	Pumpkinseed	
	Mountain Sucker	Rainbow Trout	
	Orangethroat Darter*	Smallmouth Bass	
	Northern Plains Killifish*	Snake River Cutthroat	
	Plains Minnow*^{E}	Walleye	
	Plains Topminnow*	White Crappie	
	Quillback	Yellow Perch	
	Red Shiner	Yellowstone Cutthroat	
	River Carpsucker		
	Sand Shiner		
	Shorthead Redhorse		
	Sturgeon Chub*^{E}		
	Suckermouth Minnow*		
	White Sucker		

Aquatic Reptiles
Four turtles are known to occur in the North Platte River basin, all of which are considered native species. The Western Painted Turtle, Western Spiny Softshell, and Ornate Box Turtle are SGCN, and the Eastern Snapping Turtle is not. The Western Painted Turtle and Eastern Snapping Turtle are the only species known from the South Platte River basin. The Western Spiny Softshell and Western Painted Turtles have been documented in the basin east of the Laramie Mountains.

The Ornate Box Turtle, a terrestrial turtle, is mentioned in this section with other turtles for convenience. Currently, the only record of this species in Wyoming is a museum specimen collected near Fort Laramie. The range of the Ornate Box Turtle may include the North Platte River basin near the Nebraska state line.

Freshwater Mollusks and Crayfishes
Wyoming is still in the discovery phase in terms of its freshwater bivalve mollusks and gastropods. Although aquatic mollusks are often encountered during invertebrate sampling, few published accounts exist (Beetle 1989,

Henderson 1924, Hoke 1979, Hovingh 2004). The WGFD retains SGCN status for some native bivalve mollusks and many gastropods due to lack of information. However, the WGFD recently completed native mussel surveys statewide, including the Platte River Basin (Mathias 2015).

Two bivalve mussel species are known from the Platte River basin, the Cylindrical Papershell, and Plain Pocketbook. Cylindrical Papershell are known from numerous locations in the basin. Shells of Plain Pocketbook have been documented from several locales in the North Platte drainage and a single live specimen was collected in 2008. Recent efforts to find additional Plain Pocketbook have been unsuccessful.

Most of what is known about species presence and distributions of gastropods in the basin are summarized in Beetle (1989) and Narr (2011). All gastropods in the basin are SGCN due to lack of adequate population and distribution information.

Little information is available on the distribution of Wyoming crayfishes. Four native species (Calico, Devil, Ringed and Virile Crayfish), have been documented in the Platte River basin (Hubert 1988, 2010). Ringed Crayfish are the only species known in the South Platte River basin (Crystal Reservoir). Devil Crayfish are only known from Horse Creek in the North Platte River basin. Calico Crayfish are believed to be the most widespread species in the Platte River basin but displacement by Ringed Crayfish may be occurring. Rusty Crayfish *O. rusticus* was illegally introduced in the basin (Wagonhound Creek). At this time it is unknown whether attempts at eradication have been successful. With the exception of the common Virile Crayfish, all native crayfishes are considered SGCN.

Table 8. Species of Greatest Conservation Need present in the Platte River Basin

Fish
Bigmouth Shiner
Brassy Minnow
Common Shiner
Flathead Chub
Hornyhead Chub
Iowa Darter
Orangethroat Darter
Northern Plains Killifish
Plains Topminnow
Suckermouth Minnow

Reptiles
Ornate Box Turtle
Western Painted Turtle
Western Spiny Softshell

Crustaceans
Calico Crayfish
Devil Crayfish
Ringed Crayfish

Mollusks
Cylindrical Papershell Mussel
Plain Pocketbook Mussel

Identification of Conservation Areas

To address needs SGCN in the Platte River basin, conservation priority areas were identified using a number of available tools (Figure 8). Results from Stewart et al. (2015) guided prioritization, building upon previous inventories and assessments (i.e., Bestgen 2013, Moan et al. 2011, Bear 2006).

Priority areas include drainages where native fish diversity is highest in the basin and includes streams where the density of rare species (e.g., Orangethroat Darter and Hornyhead Chub) are high. Priority waters include the lower mainstem portions of the North Platte and Laramie Rivers as well as Rawhide Creek, Labonte Creek, Lower Horse Creek and Lower Lodgepole Creek.

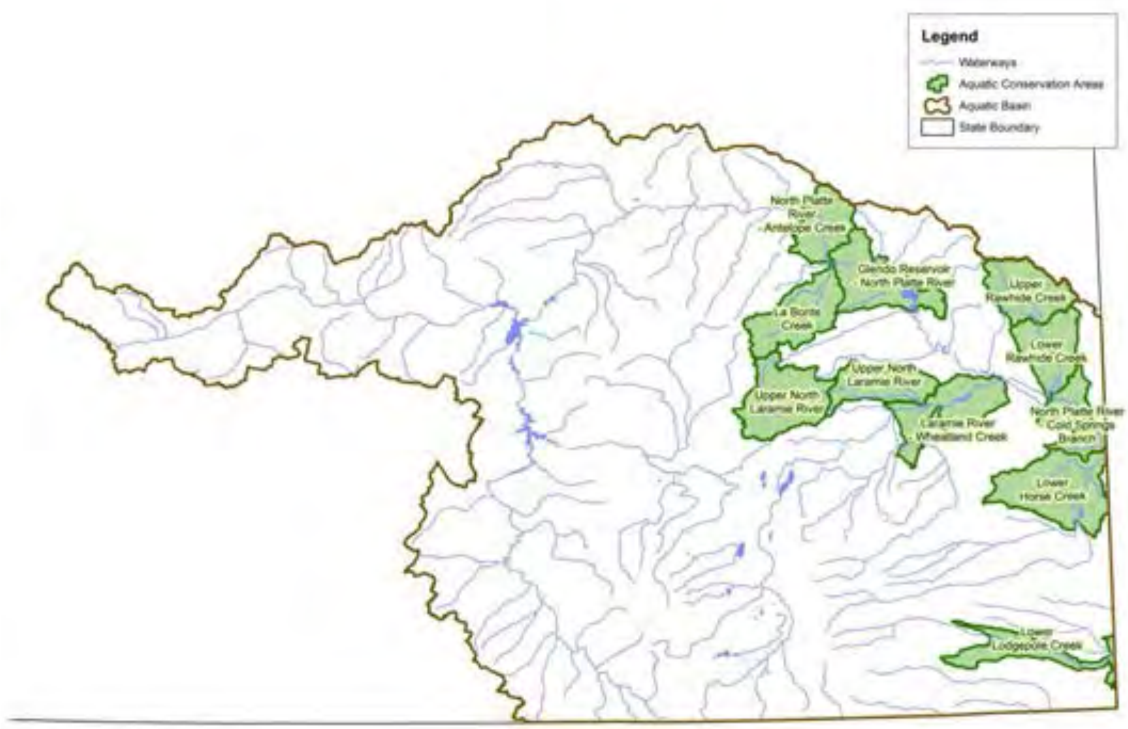

Figure 8. Aquatic Wildlife Conservation Areas in the Platte River Basin.

Priority drainages and habitats have not yet been defined for the conservation of aquatic reptiles, freshwater mollusks, or crayfishes.

Threats

Water development/altered flow regimes – Moderate

Natural flow regimes in stream segments around the state have been altered by human activities including irrigation diversions and water developments for more reliable water supply, hydropower, and flood control. These altered flow regimes are also a consequence of broad-scale changes in land use and management associated with agriculture, grazing, timber harvest, and housing development (see Wyoming Leading Wildlife Conservation Challenges – Disruption of Historic Disturbance Regimes). Lateral and longitudinal hydrologic connectivity and physical access by fish populations to all habitats necessary to complete their life history is limited throughout the drainage. In-channel obstructions and increased dewatering have reduced some populations of native stream fishes.

The need for additional water for human use will intensify in the immediate future, and that trend will be especially evident in the western U.S. This trend has multi-faceted consequences for fish and wildlife and the habitats upon which they depend. In Wyoming, trans-basin water diversions are not uncommon and are likely to be further proposed and pursued. Energy diversification, including hydropower development, may increase as the nation’s energy demands rise. Warmer conditions with more erratic precipitation— which some predict for Wyoming’s future climate—may heighten the need for additional water development (water storage) for municipal and agricultural purposes.

The likely trend will be water development projects closer to the delivery point and conveyance via pipelines instead of stream channels. Additional emphasis will likely be placed on lining irrigation ditches and other practices to more efficiently use water for consumptive purposes. The net effect of all such water management practices will be to alter the timing, magnitude, and duration of natural hydrographs and reduce intra- and inter-annual variability in Wyoming's streams and associated riparian corridors (see Wyoming Leading Wildlife Conservation Challenges – Climate Change, and the Riparian habitat chapter).

While water development can threaten native species, some introduced species, including popular sport fisheries, have thrived in the face of water development. The simplification of natural systems by human development tends to favor species with generalized and broad habitat requirements. For example, the walleye fisheries in the North Platte River reservoirs and Boysen Reservoir depend on the consistent deep water and forage production inherent in these man-made water bodies. Stable stream flow releases from dams, with relatively low peak flows and relatively high base flows, perpetuate productive sport fisheries. The famous "Miracle Mile" trout fishery below Kortes Dam and the "Grey Reef" fishery below Alcova Dam are examples.

Invasive species – High

Several aquatic invasive species (AIS) are present in the basin including curly pondweed, rusty crayfish, Asian clam, and brook stickleback. Additional descriptions and definitions of AIS can be found in the WGFD AIS management plan (WGFD 2010).

Curly pondweed was introduced into the United States in the mid 1800's and is now widespread. Curly pondweed reproduces by seed which can be easily transferred in mud or water. It is introduced into new areas through boating, fishing, and water hauling, and as an ornamental plant. New populations continue to be discovered in Wyoming. In the Platte River Basin, it is found in the North Platte River at the Miracle Mile section.

Rusty crayfish are native to the eastern United States and have been introduced into several western states, likely by baitfish introductions. Rusty crayfish out-compete native crayfish and established populations can destroy native plant abundance and diversity (WGFD 2010). Rusty crayfish are currently present in Wagonhound Creek, and tributary to the North Platte River near Douglas, where they were originally documented in 2006. Illegal stocking of the crayfish occurred in 2000, 2002, and 2006 in three ponds in the drainage as forage for sport fisheries. Two of the ponds were drained for repair in 2006, when it is believed crayfish migrated to nearby Wagonhound Creek (WGFD 2010). Chemical eradication of this population has been attempted several times. In 2006 and 2007, water levels in the ponds and creek were lowered and treated. Subsequent monitoring did not document any remaining rusty crayfish in the drainage following treatment. However, the species was again documented in 2012 and the area was subsequently treated. Post-treatment monitoring has not documented rusty crayfish in the lower portions of Wagonhound Creek near the confluence with the North Platte River, or in the mainstem North Platte River.

Asian clams were introduced to the United States intentionally as food or incidentally with the importation of Pacific oyster. They were discovered in 1938 in the Columbia River and are now widespread. Asian clams are spread through bait bucket introductions, accidental introductions with aquaculture species, illegal introductions for food, and through water currents. They can clog pipes at power generation and water supply facilities when shells wash downstream, causing millions of dollars in damage (WGFD 2010). Asian clam are found in the basin in the Laramie River upstream of the town of Laramie to tunnel road, and the North Platte River downstream of Guernsey Reservoir dam.

The brook stickleback has been introduced to many states outside of its native range. Brook stickleback are spread as a result of bait introductions or accidental introductions with aquaculture species. Juvenile fish and fish eggs may be difficult to see and can be moved in standing water in boats and bait buckets. Brook stickleback are widespread in the basin, commonly found in the Lone Tree-Owl, Cache La Poudre, Upper North Platte, Medicine Bow, Little Medicine Bow, Lower Laramie, Pathfinder-Seminoe Reservoir, Middle North Platte-Casper, and Glendo Resevoir drainages.

Other invasive species, such as zebra and quagga mussels and silver carp, are present in neighboring states and potentially very harmful to the aquatic wildlife in the basin. Through outreach and education, watercraft inspections, and monitoring, the harmful impacts of these and other invasive species may be prevented. Watercraft are inspected at key locations entering the basin at Cheyenne, Torrington, Laramie, and at major waters including Glendo, Grayrocks, Granite, Alcova, and Pathfinder reservoirs. Twenty-one (21) waters in the basin are monitored annually to detect the presence of invasive species. These efforts to keep existing species in the basin from spreading to new waters, and other harmful species from entering the basin will continue. These efforts to keep existing species in the basin from spreading to new waters, and other harmful species from entering the basin will continue.

Drought and climate change – Moderate
Climate change may increase air and surface water temperatures, alter the magnitude and seasonality of precipitation and run-off, and shift the reproductive phenology and distribution of plants and animals (Seavy et al. 2009) (see Wyoming Leading Wildlife Conservation Challenges – Climate Change).

Changes in precipitation patterns under various climate change scenarios are predicted to produce peak flows earlier in the yearly cycle and to lower base flows (Barnett et al. 2004). Drought lowers water tables, leading to reduced plant growth and reproduction. Riparian vegetation declines lead to lower bank stability, higher siltation and altered stream habitat quality and quantity. Lower water levels increase water temperatures and reduce the habitat available to fish and other aquatic wildlife. All these conditions can be detrimental to the health and reproductive success of all aquatic wildlife species.

Conservation Initiatives

Department plans and policies
The WGFD's Fish Division has developed basin management plans to guide management across the state. These plans provide background and history of aquatic wildlife management as well as management direction. These plans reference the SWAP and the Strategic Habitat Plan, attempting to incorporate management direction relevant to each basin.

Habitat management efforts are guided by the Strategic Habitat Plan (SHP) that is regularly revised and approved by the Wyoming Game and Fish Commission. The SHP includes five goals: 1) Conserve and manage wildlife habitats that are crucial for maintaining terrestrial and aquatic wildlife populations for the present and future, 2) Enhance, improve, and manage priority wildlife habitats that have been degraded, 3) Increase wildlife-based recreation through habitat enhancements that maintain or increase productivity of wildlife, 4) Increase public awareness of wildlife habitat issues and the critical connection between healthy habitat and abundant wildlife populations, and 5) Promote collaborative habitat management efforts with the general public, conservation partners, private landowners, and land management agencies. Efforts are focused in priority areas in each of the management regions and include crucial areas essential for conservation of important species and communities and enhancement areas, which represent places where work should be conducted to manage or improve wildlife habitat.

In addition to these guiding documents, the WGFD has a number of tools, policies and protocols to protect and enhance native aquatic wildlife. Additional details on environmental commenting, aquatic wildlife stocking and transplant, and disease prevention can be found in the 2010 SWAP.

Interagency plans and agreements
The National Fish Habitat Action Plan (NFHAP) was developed by a coalition of fisheries professionals, state and federal agencies, tribes, foundations, conservation and angling groups, businesses and industries, all determined to reverse the declines of America's fish habitats. The WGFD is involved with three NFHAP partnerships, Great Plains Fish Habitat Partnership, the Western Native Trout Initiative, and the Desert Fishes Habitat Partnership. The Great Plains Fish Habitat Partnership covers much of the Platte River Basin. Additional information on Fish Habitat Partnerships can be found in the 2010 SWAP.

Ongoing and completed conservation actions
Numerous projects have been completed to benefit SGCN in the Platte River basin since the implementation of the 2010 SWAP (previous accomplishments are documented in the 2010 SWAP). Multiple sources of funding have been used to fund projects. Projects have been completed by department personnel and through contracting and granting with research partners. Accomplishments are listed under headings taken from the Recommended Conservation Actions (bold headings) in the 2010 SWAP. While accomplishments are not duplicated under more than one action they commonly address multiple actions. Although this list is not comprehensive of all actions, most of the significant initiatives are summarized below.

Secure and enhance populations and habitats in SGCN priority areas
Following a large wildfire and subsequent debris flows that eliminated almost all fish from the North Laramie River, the WGFD transplanted Hornyhead Chub to stream reaches they previously occupied (WGFD 2015).

Fill remaining data gaps for SGCN distribution.
WGFD biologists inventoried and assessed fish populations and habitats in southeastern Wyoming's prairie streams (Moan et al. 2011). Amongst other findings, numerous refinements were made to range distributions.

WGFD biologists completed surveys for Orangethroat Darter and other non-game native species in Lodgepole Creek. The surveys were successful to remove Orangethroat Darter from the NSSU list (WGFD 2012).

WGFD biologists completed a detailed inventory of fish and aquatic habitat in the Salt Creek drainage near Casper (Cook 2013). In addition to refining known range for several SGCN, the results suggested both positive and negative impacts of a historic diversion and passage barrier.

The WGFD conducted a project to inventory and assess amphibian and reptile populations and habitats in southeastern Wyoming (Snoberger and Walker 2013, 2014). Amongst other findings, Western Painted Turtle and Eastern Snapping Turtle were both documented.

The WGFD funded a project at Colorado State University to better understand the distribution, habitat, and ecology of Hornyhead Chub (Bestgen 2013).

The WGFD funded a research project at the University of Wyoming that determined endocrine disrupting compounds are not impacting fish or recruitment of fish in the Laramie River (Johnson 2014).

Describe the distribution and intactness of aquatic habitats
A diversion structure that is a likely barrier to upstream fish passage was documented on the Sweetwater River near Sweetwater Station in 2015. Bigmouth Shiners, an SGCN, were captured immediately downstream of the structure (WGFD 2016).

WGFD biologists carried out a project in 2014-2015 to determine the impacts of barriers and intermittency on native fish assemblages in Lodgepole and Horse creeks and the Laramie River (Compton and Hogberg *In preparation*)

Protect relatively intact riparian systems and restore those in proximity to SGCN priority areas
No projects reported.

Increase educational efforts about the ecological, economic, and social values of aquatic SGCN
The WGFD created, produced and disseminated posters detailing the states' native fishes, frogs, toads, snakes and lizards.

Continue aquatic habitat work in the basin
No projects reported.

Explore water management approaches that enhance fish habitat
No projects reported.

Continue building voucher collections for all aquatic wildlife
WGFD biologists collected numerous additional fish voucher specimens since the last SWAP (2010). All vouchers specimens are submitted to the Museum of Southwestern Biology, Albuquerque NM.

Complete the comprehensive survey for freshwater mussels
WGFD completed freshwater mussel distribution surveys in the Platte River drainage (Mathias 2015).

Increase connectivity where appropriate
No projects reported.

Recommended Conservation Actions

Secure, enhance, or establish SGCN populations

Work to reintroduce Sauger to the North Platte River above Glendo Reservoir.

Conduct study to determine most suitable transplant sites for Hornyhead Chub in the basin and conduct trial transplants where possible.

Evaluate the effects of newly introduced nonnative predators on SGCN in the basin.

Inventory, assess, or examine life history requirements of SGCN
Describe the distribution of native nongame fish in the mainstem North Platte River.

Describe the distribution and relative abundance of native fishes in the Sweetwater River drainage.

Survey to fill gaps in knowledge about native mussel distribution as described in Mathias (2015).

Conduct baseline gastropods surveys in the basin and identify needed actions to maintain or restore populations.

Determine the distribution and abundance of Plains Topminnow and Northern Plains Killifish in spring-fed wetland habitats of the Platte River Basin.

Determine if Ornate Box Turtles persist in the Platte River basin.

In the next significant drought cycle, inventory and map intermittency to better describe important habitat refuges in small plains streams.

Provide passage and reduce entrainment at barriers impacting SGCN
Collect physical measurements and log locations of natural and manmade barriers.

Continue populating the WGFD database to store physical measurements of barriers and record locations.

Work with North Laramie landowners to provide fish passage at North Laramie Canal Division Dam.

Begin to investigate fish passage opportunities at Lower Horse Creek water diversion structures.

Provide passage through Sweetwater River diversion structures within the Bigmouth Shiner's distribution.

Improve aquatic habitat for SGCN
Supply flow or other information to the State Engineer's Office and Water Development Office to facilitate adjudication of instream flow water rights.

Monitor instream flow segments for compliance with approved instream flow levels. Pursue compliance as needed when water is available and in priority.

Protect and/or enhance priority stream segments identified in Horse and Lodgepole creeks and the lower Laramie River as part of the prairie stream intermittency project (Compton and Hogberg *In preparation*).

Employ water management strategies that improve habitat for SGCN
Identify stream segments where habitat and available flow regimes indicate a need to file instream flow water rights for SGCN. As opportunities are identified, conduct needed studies and file for state-held instream flow water rights.

Identify fish and wildlife mitigation for new reservoirs as they are proposed including instream flow regimes and minimum fishery pools. Ensure that mitigation recommendations are included as conditions in applicable permits.

Increase educational efforts about the ecological, economic, and social values of aquatic SGCN
No actions identified.

Continue building voucher collections for aquatic wildlife
Continue to fill voids in voucher inventory for fish per WGFD protocol (Zafft and Bear 2009).

Voucher specimens of gastropods.

Monitoring

Establish standardized monitoring protocols and locations for native SGCN
Monitor newly established and/or expanded Hornyhead Chub and Sauger populations.

Monitor Hornyhead Chub populations in the Laramie and North Laramie Rivers.

Re-survey a sub-sample of selected sites from Moan et al. (2011) and Mathias (2015).

Monitor water quantity and temperature in areas containing important native SGCN populations.

Monitor for the establishment and spread of invasive species.

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Snake/Salt River Basin

Hoback River

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Watershed Description

Six major basins were identified for conservation planning purposes under this State Wildlife Action Plan (SWAP) using hydrographic boundaries and fisheries assemblage and management considerations. The basins each include one to four sub-regions (4-digit hydrologic unit code [HUC] watersheds). This approach allows the nesting of multiple spatial and temporal scales for planning and prioritizing conservation actions.

The Snake/Salt River basin corresponds with the Upper Snake sub-region. It includes two 6-digit HUCs: Snake Headwaters and Upper Snake River (Figure 9), eight sub-basins (8-digit HUCs) and twenty-nine watersheds (10-digit HUCs). These watersheds span an area of about 5,100 square miles in northwestern Wyoming's Lincoln, Teton, Sublette, and Park counties. Land ownership is predominantly public with only 8% privately held. These private lands, however, tend to be vital for aquatic wildlife along the riparian corridors. Public land is primarily managed by the U.S. Forest Service (69%) and National Park Service (Grand Teton National Park, 21%).

There are approximately 4,900 miles of streams on the USGS National Hydrography Dataset in the Snake/Salt River basin. Major drainages in the basin include the Salt, Hoback, Gros Ventre, Buffalo Fork and Snake rivers.

Additional information about the basins drainages, geography, geology, land forms, climate, dams, reservoirs and diversions, hydrology, habitat types, land use and classifications are detailed in the 2010 SWAP.

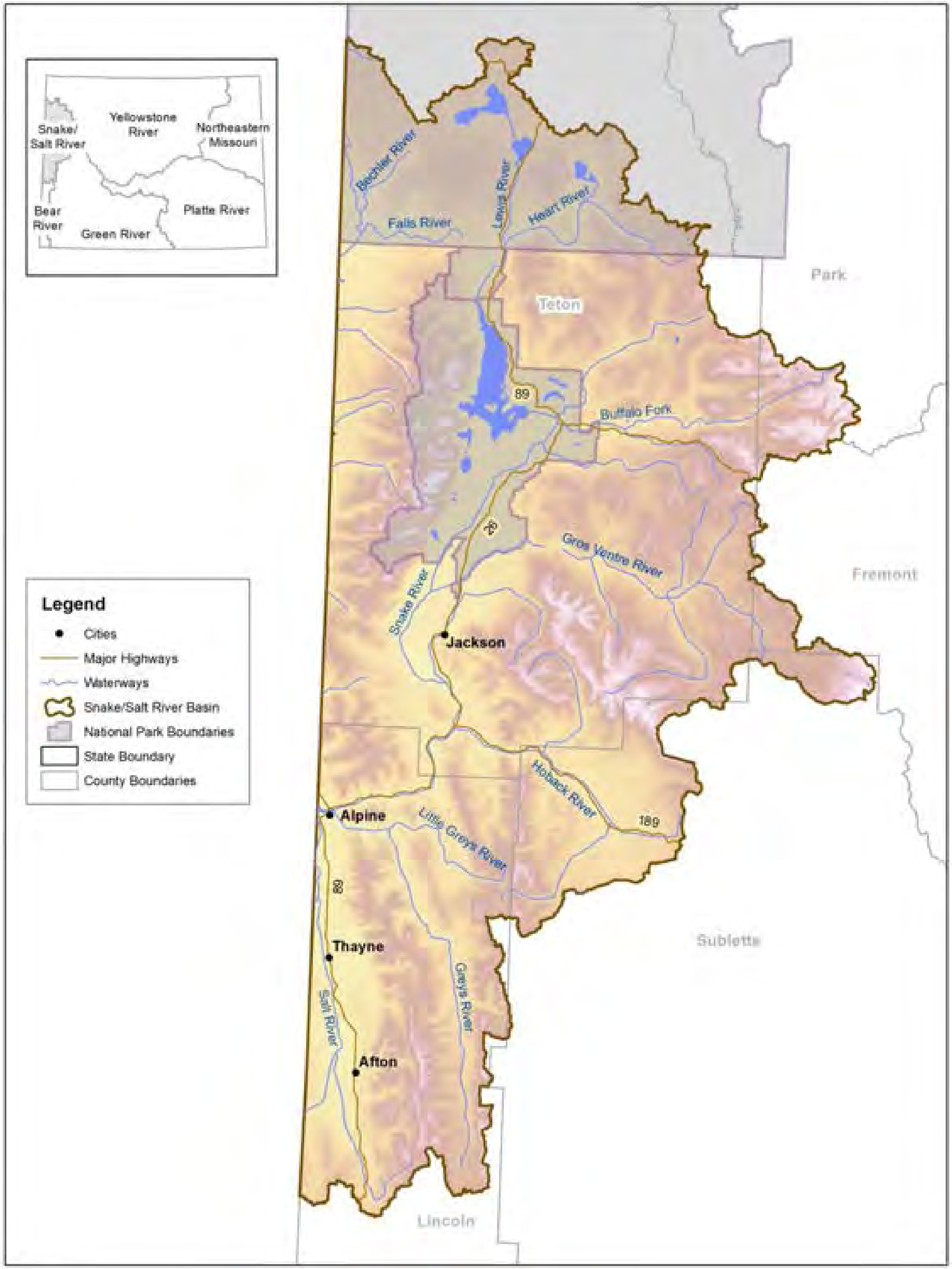

Figure 9. Snake/Salt River Basin.

Aquatic Wildlife

Fish

Twenty-three fish species are found in the basin. Cutthroat trout are represented by Yellowstone Cutthroat Trout *O. clarkii bouvieri* and an unnamed presumed subspecies, the fine-spotted or Snake River Cutthroat Trout *O. clarkii ssp.* Thirteen species or subspecies are native to the basin, and ten are introduced. The WGFD recognizes and manages fine-spotted Snake River Cutthroat Trout separately from other cutthroats. This distinction has been made within the WGFD management program since 1955.

The native gamefish community is composed only of Snake River and Yellowstone Cutthroat Trout and Mountain Whitefish. The nonnative gamefish community consists of seven species of introduced salmonids and chars. The nongame fish community consists of 10 native species and the introduced Fathead Minnow and White Sucker. Additionally, various tropical fish species have been illegally introduced into Kelly Warm Springs.

Simon (1951) surveyed 10 sites in the Snake/Salt River basin and documented the presence of all known native species, as well as Arctic Grayling. The Snake River Cutthroat Trout has been considered a distinct, undefined, fine-spotted variety of cutthroat trout (Behnke 1992).

Table 9. Fishes present in the Snake/Salt River basin. Species of Greatest Conservation Need (SGCN) are followed by an asterisk (*).

Native game	Native nongame	Nonnative game	Nonnative nongame
Mountain Whitefish	Bluehead Sucker*	Bear River Cutthroat Trout	Fathead Minnow
Snake River Cutthroat Trout*	Longnose Dace	Brook Trout	White Sucker
Yellowstone Cutthroat Trout*	Mottled Sculpin	Brown Trout	
	Mountain Sucker	Golden Trout	
	Northern Leatherside Chub*	Grayling	
	Paiute Sculpin	Kokanee Salmon	
	Redside Shiner	Lake Trout	
	Speckled Dace	Rainbow Trout	
	Utah Chub		
	Utah Sucker		

Four fishes, including both subspecies of cutthroat trout, are considered Species of Greatest Conservation Need (SGCN). The two cutthroat subspecies have long been the focus of fisheries management efforts in the basin. Bluehead Sucker and Northern Leatherside Chub are also SGCN.

No known native species have been extirpated from the watershed, but two introduced nongame species have been documented in the past decade. Fathead Minnow was first documented in the Snake River below Jackson Lake Dam in 2002 and in the Lower Salt basin in 2003. White Sucker have also been introduced in the basin although the timing and location is unknown. While White Sucker remain rare, White Sucker x Utah Sucker hybrids were common in samples recently analyzed (Mandeville et al. 2015).

Aquatic Reptiles

No turtles are native to the Snake/Salt River basin and none have been introduced.

Freshwater Mollusks and Crayfishes

Wyoming is still in the discovery phase in terms of its freshwater mussels and gastropods. Although fingernail and pill clams and aquatic gastropods are often encountered during invertebrate sampling, few published accounts exist (Beetle 1989, Henderson 1924, Hoke 1979, Hovingh 2004). Many native mussels, clams, and gastropods are considered SGCN by the WGFD due to a lack of information regarding status.

A single species of mussel, the Western Pearlshell, is known to inhabit the Snake/Salt River basin. Western Pearlshell are widespread and are not considered a SGCN (Mathias 2014).

Little is known about species present and distributions of gastropods in the basin. One native species, the Jackson Lake Springsnail, has been documented in the watershed. The nonnative New Zealand Mudsnail has been introduced to the basin above Jackson Lake. All of the native gastropods in the basin are considered SGCN.

The only crayfish species that has been documented in the Snake/Salt River basin is the Pilose Crayfish. This is a native species found during both recent surveys (Hubert 1988, Hubert 2010). There is no evidence of the presence of non-indigenous crayfishes in the Snake River drainage.

Table 10. Species of Greatest Conservation Need present in the Snake/Salt River Basin

Fish
Bluehead Sucker
Northern Leatherside Chub
Snake River Cutthroat Trout
Yellowstone Cutthroat Trout

Crustaceans
Pilose Crayfish

Mollusks
Jackson Lake Springsnail

Identification of Conservation Areas

Most of the Snake/Salt basin is of high conservation value for SGCN. Priority areas for conservation activities during the term of this plan are shown in Figure 10.

Aquatic conservation priorities in the watershed include, but are not limited to, the mainstem Snake and Salt River corridors, spring streams tributary to these rivers, the lower reaches of Pacific Creek, and Snake and Salt River tributaries that sustain wild cutthroat populations and Bluehead Suckers.

Additionally the Gros Ventre River drainage is a priority for both cutthroat trout and Northern Leatherside Chub.

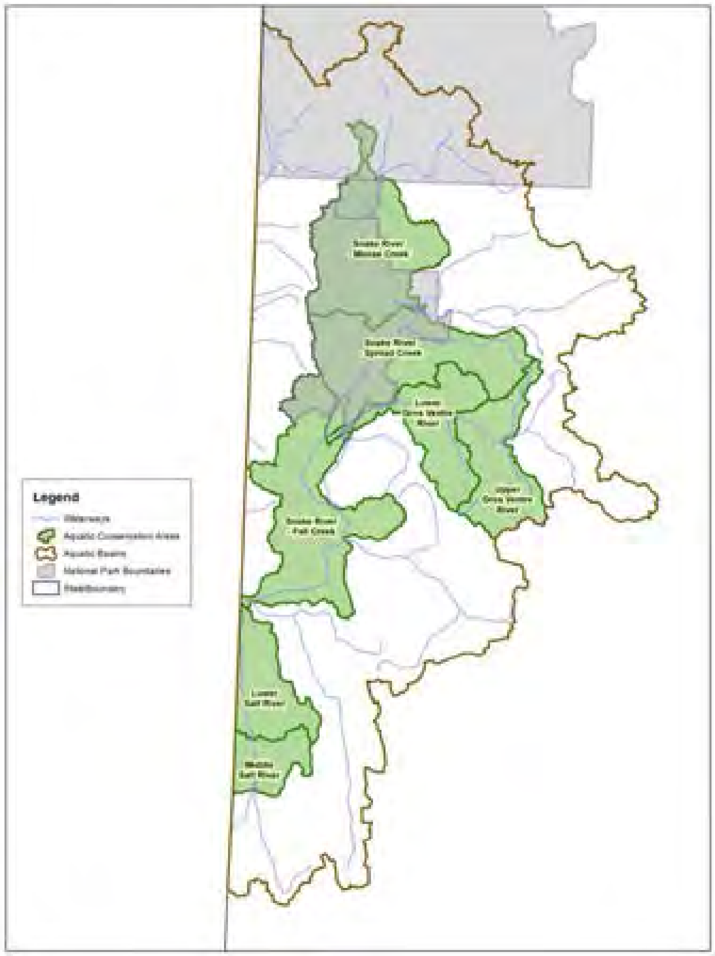

Figure 10. Aquatic Wildlife Conservation Areas in the Snake/Salt River Basin.

Threats

Water development/altered flow regimes – Moderate

Natural flow regimes in stream segments around the state have been altered by human activities, including irrigation diversions and water developments for enhanced water supply, hydropower, and flood control. These altered flow regimes are also a consequence of broad-scale changes in land use and management associated with agriculture, grazing, timber harvest, and housing development (see Wyoming Leading Wildlife Conservation Challenges – Disruption of Historic Disturbance Regimes). The majority of the Snake/Salt River basin is publicly owned. However, the developed areas in the Salt River drainage severely fragment the watershed and limit fish movement, mainly through stream dewatering. Lateral and longitudinal hydrologic connectivity is reduced and fish populations are physically restricted from habitats necessary to complete their life history in many parts of the drainage.

The combined effects of Jackson Lake Dam and the levee system have altered flow regimes, instream habitat, and riparian function. Levees were initially used in the 1950s to protect private property and now constrain the Snake River from Grand Teton National Park to south of Jackson. Jackson Lake Dam has altered flow regimes and blocked fish passage since the early 1900s. Outside the levees, spring creeks and cottonwood regeneration have been negatively affected by lack of flooding.

While water development can threaten native species, some introduced species, including popular sport fisheries, have thrived in the face of water development. The simplification of natural systems by human development tends to favor species with generalized and broad habitat requirements. Stable stream flow releases from dams, with relatively low peak flows and relatively high base flows, perpetuate productive sport fisheries like that found in the Snake River tailwater.

Altered flow regimes have also disconnected the Snake and Salt Rivers and their tributaries from floodplains. During and following extreme precipitation events, floodplains attenuate sediment and flood energy, reduce bank erosion, decrease vertical channel adjustment, and lessen fine sediment inputs into flowing waters. In addition, this lack of connection has reduced key cottonwood galleries' regeneration, lateral structure, and acreage size.

Residential development throughout the Snake River, Flat Creek and Salt River valleys are directly influencing groundwater levels and important spring creeks (Wyoming Water Development Office 2014). These developments often include ponds. Together, groundwater pumping and pond development have the potential to negatively impact water quality(including water temperatures), levels, bank stability and physical habitat quality and quantity in spring streams which serve as spawning and rearing areas for Snake River Cutthroat Trout.

Altered flow regimes from vegetational succession occur in watersheds like the Greys River where fire suppression has resulted in a lack of community and age class diversity. Conducting watershed scale vegetation treatments has become an important tool for enhancing wildlife, both terrestrial and aquatic. For example, aspen treatment projects in the Greys River drainage have the potential to increase water yield and improve spawning and migration of native fish.

Drought and climate change – Moderate
Climate change may increase air and surface water temperatures, alter the magnitude and seasonality of precipitation and runoff, and shift the reproductive phenology and distribution of plants and animals (Seavy et al. 2009) (see Wyoming Leading Wildlife Conservation Challenges – Climate Change).

Changes in precipitation patterns under various climate change scenarios are predicted to produce peak flows earlier in the yearly cycle and to lower base flows (Barnett et al. 2004). Drought lowers water tables, leading to reduced plant growth and reproduction. Riparian vegetation declines lead to lower bank stability, higher siltation and altered stream habitat quality and quantity. Lower water levels increase water temperatures and reduce habitat available to fish and other aquatic wildlife. All these conditions can be detrimental to the health and reproductive success of all aquatic wildlife species.

Invasive species – Moderate
Aquatic invasive species (AIS) present in the basin include the New Zealand Mudsnail. Additional descriptions and definitions of AIS can be found in the WGFD AIS management plan (WGFD 2010).

New Zealand Mudsnails were first discovered in 1996 in the Madison River in Yellowstone National Park. The mudsnail is spread by fish and birds, natural downstream dispersal, upstream through rheotactic behavior, and by humans on fishing gear. The pathway of introduction into Wyoming is unknown, but spread on recreational angling gear is likely given the first location of introduction (WGFD 2010). Currently, in the Salt/Snake River Basin, mudsnail occur in the Snake River upstream of Jackson Lake, and Polecat Creek. Mudsnail populations have decreased in abundance relative to first establishment, a trend observed elsewhere (Vinson et al. 2007).

In addition to species designated as AIS, several introduced game fishes are problematic in the basin. Nonnative Rainbow Trout present a substantial threat to Yellowstone and Snake River Cutthroat Trout through hybridization, while other introduced trout are predators and/or competitors that have proven successful at eliminating native cutthroat trout populations. While nonnative game fish may need to be controlled for conservation and restoration of natives in some areas, these same fish support popular fisheries that provide important recreational and economic benefits (WGFD 2010).

Other invasive species, such as zebra and quagga mussels and Silver Carp, are present in neighboring states and potentially very harmful to the aquatic wildlife in the basin. Through outreach and education, watercraft inspections, and monitoring, the harmful impacts of these and other invasive species may be prevented. Watercraft are inspected at key locations entering the basin at Alpine and Salt River Pass, and at major waters including Jackson Lake and the Snake River. Ten (10) waters in the basin are monitored annually to detect the presence of invasive species. These efforts to keep existing species in the basin from spreading to new waters, and other harmful species from entering the basin will continue.

Conservation Initiatives

Department plans and policies
The WGFD's Fish Division has developed basin management plans to guide management across the state. These plans provide background and history of aquatic wildlife management as well as management direction. These plans reference the SWAP and the Strategic Habitat Plan, attempting to incorporate management direction relevant to each basin.

Habitat management efforts are guided by the WGFD Strategic Habitat Plan (SHP) that is periodically revised and approved by the Wyoming Game and Fish Commission. The goal of the SHP is to conserve, enhance, and improve priority wildlife habitats while increasing wildlife-based recreation and public awareness of wildlife habitat issues and promotion of collaborative habitat management.

In addition to these guiding documents, the WGFD has a number of tools, policies and protocols to protect and enhance native aquatic wildlife. Additional information on Federal Wild and Scenic designations, state instream flow water rights, environmental commenting, aquatic wildlife stocking and transplant, and disease prevention can be found in the 2010 SWAP.

Interagency plans and agreements
The states of Idaho, Montana, Nevada, Utah, and Wyoming, along with the U.S. Forest Service and Grand Teton and Yellowstone National Parks, signed a Memorandum of Agreement (MOA) to jointly conserve, protect, and restore Yellowstone Cutthroat Trout populations within their historic range (Range-wide YCT Conservation Team 2009). As part of the agreement the interstate working group under the auspices of the 2000 MOA, completes periodic scheduled range-wide status assessments (Endicott et al. 2015).

The states of Idaho, Nevada, Utah, and Wyoming, along with the U.S. Forest Service, Bureau of Land Management, Bureau of Reclamation, National Park Service, Fish and Wildlife Service, Trout Unlimited, and The Nature Conservancy, signed a Conservation Agreement to jointly conserve, protect, and restore Northern Leatherside Chub populations within their historic range (UDWR 2009b). A range-wide conservation team meets annually to further conservation efforts. As part of the agreement the team is charged with producing status assessments for the species at five year intervals.

The states of Arizona, Colorado, Nevada, New Mexico, Utah and Wyoming and U.S. Fish and Wildlife Service, Bureau of Land Management, National Park Service, U.S. Bureau of Reclamation, Jicarilla Apache Nation, Southern Ute Indian Tribal Council, and U.S. Forest Service are signatories to a range-wide conservation agreement and strategy for Roundtail Chub, Bluehead Sucker and Flannelmouth Sucker (UDWR 2009a). As part of the agreement an interstate working group meets annually to discuss conservation needs and produces regular status assessments.

The National Fish Habitat Action Plan (NFHAP) was developed by a coalition of fisheries professionals, state and federal agencies, tribes, foundations, conservation and angling groups, businesses and industries, all determined to reverse the declines of America's fish habitats. The WGFD is involved with three NFHAP partnerships, Great Plains Fish Habitat Partnership, the Western Native Trout Initiative, and the Desert Fishes Habitat Partnership. The Western Native Trout Initiative covers the Snake/Salt Basin. Additional information on Fish Habitat Partnerships can be found in the 2010 SWAP.

Ongoing and completed conservation actions

Numerous projects have been completed to benefit SGCN in the Snake/Salt basin since the implementation of the 2010 SWAP (previous accomplishments are documented in the 2010 SWAP). Multiple sources of funding have been used to implement projects. Projects have been completed by department personnel and through contracting and granting with research partners. Accomplishments are listed under headings taken from the Recommended Conservation Actions (bold headings) in the 2010 SWAP. While accomplishments are not duplicated under more than one action they commonly address multiple actions. Although this list is not comprehensive of all actions, most of the significant initiatives are summarized below.

Protect and enhance Snake River tributary streams

WGFD biologists completed several efforts to improve the structure and function of stream segments and watershed features that benefit aquatic SGCN. These efforts are documented in annual Strategic Habitat Plan Accomplishments reports. Flat Creek near Jackson supports substantial Snake River Cutthroat Trout populations and natural channel design restoration work has been completed on 3.5 miles of stream on the National Elk Refuge to benefit all trout life stages (WGFD 2016).

Enhancement work has been conducted by WGFD biologists on Jackson Hole area spring streams on private lands including Fish Creek, Edmiston Spring Creek, Blue Crane Creek, and Spring Creek. This work includes channel narrowing, pool and gravel enhancement, and adding features to reduce fine sediment and benefit Snake River Cutthroat Trout spawning, fry and juvenile habitat (WGFD 2011, WGFD 2014).

WGFD biologists completed channel enhancements on Crow Creek in the Salt River drainage to benefit Snake River Cutthroat Trout (WGFD 2011). Project activities addressed channel form to improve pool diversity and function, gravel cleaning to benefit spawning and incubation, and riparian willow plantings to enhance shade and insect production.

Secure and enhance populations and habitats in SGCN priority areas

No reported projects

Enhance spawning runs of Snake River Cutthroat Trout

WGFD biologists planted eyed-eggs in suitable spawning streams to encourage future spawning runs of Snake River Cutthroat Trout.

Remove fish passage obstacles

WGFD biologists worked with partners and contributed funding to several projects to enhance fish passage and connectivity. These efforts are detailed in annual Strategic Habitat Plan Accomplishments reports (e.g. WGFD 2011).

WGFD biologists worked with partners to modernize irrigation infrastructure and remove a barrier on Spread Creek, tributary to the Snake River. Improved access to over 45 miles of stream for Snake River Cutthroat Trout and Bluehead Sucker was provided (WGFD 2011).

Irrigation diversions from various spring creeks near Jackson were improved to enhance Snake River Cutthroat Trout passage and limit entrainments while also benefitting water users. Example include the Spring Creek headgate (WGFD 2011), the Upper Spring Creek JA Williams passage project (WGFD 2012), and additional Upper Spring Creek passage work completed in 2013 (WGFD 2014).

WGFD funding assistance was provided to Trout Unlimited to remove a historic obstruction on the Gros Ventre River (WGFD 2014). Removing the Kelly (Newbold) Diversion structure improved upstream access to about 42 miles of the Gros Ventre River proper and additional tributary streams for Bluehead Sucker and Snake River Cutthroat Trout.

WGFD biologists worked with Trout Unlimited to improve fish passage at the East Side Diversion on the Salt River by creating a fish ladder.

WGFD biologists worked with Grand Teton National Park to install baffles in a Ditch Creek culvert under US HWY 26/89/191. The baffles will improve passage for all fish, but in particular Bluehead Sucker.

Evaluate the status and distribution of native aquatic wildlife assemblages with emphasis on Snake River Cutthroat Trout, Bluehead Sucker, and Northern Leatherside Chub.

WGFD biologists used state wildlife grant (SWG) funding to complete an inventory of Northern Leatherside Chub and their habitat associations in Wyoming (Schultz and Cavalli 2012). Surveys were conducted in Pacific Creek, Snake River spring creeks, and Buffalo Fork River in the Snake/Salt basin.

WGFD biologists used SWG funding to complete an evaluation of the distribution and movement of Bluehead Sucker in the Snake River drainage (Hines 2013). Bluehead Sucker distributed in summer and congregated in winter.

WGFD biologists conducted surveys to identify Bluehead Sucker spawning locations in the Snake River drainage per recommendations of Hines (2013). Potential spawning locations were located in Blackrock and Spread creeks (WGFD 2014).

WGFD biologists discovered a new locale for Northern Leatherside Chub in the Gros Ventre River drainage in 2014 (WGFD 2015). Additional inventories in the drainage expanded the known range of the species (WGFD 2016).

WGFD biologists conducted a statewide survey of Mountain Whitefish (SGCN in 2010 SWAP) from 2009 to 2013. A primary achievement of the study was the development of a sampling approach for assessing populations (Edwards 2014). The study demonstrated most populations are robust leading to the determination that a non SGCN status rank (NSS5) is appropriate.

Identify and reduce threats to native fish populations from nonnative species

WGFD biologists conducted an inventory of fisheries resources in the Hoback River drainage from 2008-2014(Miller 2015). Native species were more common than nonnatives in 83% of sites sampled.

WGFD biologists identified two lake populations of nonnative species that pose threats to native aquatic wildlife (Mystery Lake and Dime Lake). Plans to chemically rehabilitate these lakes to remove nonnative species are underway.

Implement existing plans and agreements to conserve SGCN

No reported projects

Increase educational efforts about the ecological, economic, and social values of aquatic SGCN

The WGFD created, produced and disseminated a poster detailing the states native fishes.

Explore water management approaches that enhance fish habitat
The WGFD completed studies and filed for instream flow water rights on 10 instream flow segments covering over 48 miles. These include two segments on Cliff Creek (Robertson 2011a), North Fork Fisherman Creek (Robertson 2011b), two segments on the Hoback River (Robertson 2011c, Robertson 2012a), Shoal Creek (Robertson 2011d), the Little Greys River (Robertson 2012b), Granite Creek (Robertson 2012c), Dell Creek (Robertson 2012d), and Willow Creek (Robertson 2012e).

Continue building voucher collections for all aquatic wildlife.
WGFD biologists collected numerous additional fish voucher specimens since the last SWAP (2010). All vouchers specimens are submitted to the Museum of Southwestern Biology, Albuquerque NM.

Complete the comprehensive survey for freshwater mussels
The WGFD conducted a SWG-funded project in 2011 to assess the distribution and abundance of native mussels. Inventory surveys were conducted at numerous sites in the Snake/Salt basin (Mathias 2014). Live Western Pearlshell were common and abundant at many sites.

Follow up on recommendations from the graduate research project on gastropods.
No reported projects

Monitor water resource impacts associated with human developments
No reported projects.

Recommended Conservation Actions

Secure, enhance, or establish SGCN populations
Continue to remove Rainbow Trout and cutthroat–rainbow hybrids from Laker Spring in the Salt River drainage and the Gros Ventre River.

Chemically remove nonnative trout from Dime and Mystery Lakes.

Describe and locate habitats, structures or stream conditions preferred by nonnative trout species.

Inventory, assess, or examine life history requirements of SGCN
Conduct a thorough investigation of the distribution of Northern Leatherside Chub and Bluehead Sucker in the Gros Ventre River drainage.

Juvenile habitat needs of Bluehead Sucker should be investigated in the drainage.

Conduct baseline gastropods surveys in the basin and identify needed actions to maintain or restore populations.

Survey to fill gaps in knowledge about native mussel distribution, particularly in the Hoback, Gros Ventre, Salt and Greys river drainages (Mathias 2014).

Conduct studies to better understand the life history of lesser understood native fishes in the basin.

Provide passage and reduce entrainment at barriers impacting SGCN
Identify barriers to fish passage in the drainage and prioritize structures to improve that have the greatest potential for benefiting aquatic species.

Identify and rank screening priorities to reduce fish loss to diversions.

Improve aquatic habitat for SGCN
Complete projects to maintain, restore or enhance salmonid spawning habitats in spring stream tributaries.

Conduct watershed scale vegetation treatments to benefit native species.

Complete assessment and stream restoration on lower Flat Creek to improve functions and benefit Snake River Cutthroat Trout.

Monitor instream flow segments for compliance with approved instream flow levels. Petition for stream regulation by the Board of Control as needed when water is available and in priority but not reaching the instream flow segment.

Assess sediment supply and stream stability of subdrainages throughout the Salt River watershed to direct future stream restoration efforts.

Employ water management strategies that improve habitat for SGCN

Identify opportunities to work with private water right holders to manage water diversions and uses with the goal of restoring natural flow regimes for fish and encouraging riparian vegetation recruitment. Where opportunities exist, develop cooperative strategies with landowners and other partners to implement strategies that are beneficial to wildlife.

Identify fish and wildlife mitigation for new reservoirs as they are proposed including instream flow regimes and minimum fishery pools. Ensure that mitigation recommendations are included as conditions in applicable state and federal permits.

File for new instream flow water rights on stream segments with native fishes or native fish habitat to secure habitat in suitable areas.

Continue building voucher collections for all aquatic wildlife
Continue to fill voids in voucher inventory for fish per WGFD protocol (Zafft and Bear, 2009).

Build gastropod voucher collection and find permanent repository.

Increase educational efforts about the ecological, economic, and social values of aquatic SGCN
No actions identified.

Monitoring

Routinely monitor SGCN populations
Monitor Snake River Cutthroat Trout spawning activity in important spring creeks tributary to the Snake and Salt Rivers.

Routinely monitor Snake River Cutthroat Trout populations in the mainstem Snake and Salt Rivers and important spawning tributaries. Continue monitoring the response of the wild Snake River Cutthroat Trout population in streams that are no longer stocked.

Establish standardized monitoring protocols and locations for native SGCN
Monitor Northern Leatherside Chub populations in Pacific Creek and Gros Ventre River on biennial schedule.

Conduct pre and post project implementation monitoring on aquatic habitat and passage projects that affect SGCN populations.

Develop a monitoring protocol for Bluehead Sucker in the Snake River drainage.

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Yellowstone River Basin

Bighorn River

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Watershed Description

Six major watersheds were identified for conservation planning purposes under this State Wildlife Action Plan (SWAP) using hydrographic boundaries and fisheries assemblage and management considerations. The watersheds each include one to four sub-regions (4-digit hydrologic unit code [HUC] watersheds). This approach allows the nesting of multiple spatial and temporal scales for planning and prioritizing conservation actions.

The Yellowstone River Basin includes portions of four 4-digit HUC subregions: the Missouri Headwaters in Yellowstone National Park (YNP; Madison and Gallatin Rivers), the Upper Yellowstone (also partly in YNP), the Bighorn River, and the Powder/Tongue River (Figure 11). A total of twenty-nine 8-digit HUC drainages are nested within these. These watersheds span over one-third of Wyoming, covering 34,167 square miles in northern Wyoming's Big Horn, Campbell, Fremont, Hot Springs, Johnson, Natrona, Park, Sheridan, and Washakie counties. Thirty-five percent of the land is privately held. Public land is managed primarily by the Bureau of Land Management (26% of total area), U.S. Forest Service (17%) and the National Park Service (7%). The Wind River Indian Reservation occupies 7% of the area.

There are approximately 38,600 miles of streams on the USGS National Hydrography Dataset in the Yellowstone River basin in Wyoming. Major river drainages in the basin include the Wind-Bighorn, Shoshone, Upper Yellowstone, Clarks Fork, Tongue and Powder.

Additional information about the basins drainages, geography, geology, land forms, climate, dams, reservoirs and diversions, hydrology, habitat types, land use and classifications are detailed in the 2010 SWAP.

Figure 11. Yellowstone River Basin.

Aquatic Wildlife

Fish

A detailed history of fish collections and surveys in this basin, which began in the mid 19th century is chronicled in the 2010 SWAP. These surveys and collections are the basis for describing the native fish community. The 2010 SWAP also includes a summary of fish introductions to the basin. Most introductions were conducted by the WGFD but others were illegal or inadvertent.

The Yellowstone River Basin has seven native game fish and 16 native nongame fish (Table 11). A total of 20 game fishes and 10 nongame fishes have been introduced to the basin (Table 11). The known fish assemblage of the Yellowstone River basin is shown in Table 11. Four game species and six nongame species are currently considered SGCN.

Most of the fish SGCN in the basin (Brassy Minnow, Flathead Chub, Goldeye, Plains Minnow, Sturgeon Chub, Western Silvery Minnow, Sauger and Shovelnose Sturgeon) belong to an assemblage associated with large turbid free flowing rivers such as the Powder and Bighorn.

Table 11. Fishes present in the Yellowstone River Basin. Species of Greatest Conservation Need (SGCN) are followed by an asterisk (*).

Native game	Native nongame	Nonnative game	Nonnative nongame
Burbot*	Brassy minnow*	Bear River Cutthroat Trout	Brook Stickleback
Channel Catfish	Creek chub	Black Bullhead	Common Carp
Mountain Whitefish	Fathead Minnow	Black Crappie	Emerald Shiner
Sauger*	Flathead Chub*	Bluegill	Golden Shiner
Shovelnose Sturgeon*	Goldeye*	Brook Trout	Goldfish
Stonecat	Lake Chub	Brown Trout	Grass Carp
Yellowstone Cutthroat Trout*	Longnose Dace	Colorado River Cutthroat Trout	Johnny Darter
	Longnose Sucker	Golden Trout	Mottled Sculpin
	Mountain Sucker	Grayling	Plains Killifish
	Plains Minnow*	Green Sunfish	Spottail Shiner
	River Carpsucker	Lake Trout	
	Sand Shiner	Largemouth Bass	
	Shorthead Redhorse	Pumpkinseed	
	Sturgeon Chub*	Rainbow Trout	
	Western Silvery Minnow*	Rock Bass	
	White Sucker	Smallmouth Bass	
		Snake River Cutthroat Trout	
		Walleye	
		White Crappie	
		Yellow Perch	

The native large river fish assemblage remains intact in the Powder River where habitat remains largely unaltered by reservoir construction and water diversion. However, in the Wind-Bighorn where water development has been substantial, Goldeye and Shovelnose Sturgeon have been extirpated (Shovelnose Sturgeon have subsequently been reintroduced), Plains Minnow were last documented in the 1990's (Patton 1997) and Sturgeon Chub were last observed in 2001.

Burbot are native to the basin but were historically only abundant in the less turbid and colder reaches of the Wind River and its tributaries. Water developments in the basin that have increased available cold lentic habitats have allowed Burbot to expand their range. Threats to Burbot include limited range, angler exploitation and loss of population connectivity. Burbot are infrequently observed in the Tongue, Powder, and warmer turbid reaches of the Big Horn.

Yellowstone Cutthroat Trout are native to colder headwater streams and rivers of the basin. Degradation of habitat due to factors including water diversion and increased sedimentation have impacted cutthroat distribution and abundance. However the primary threat to Yellowstone Cutthroat Trout persistence is nonnative salmonids. These nonnatives are well documented competitors for resources, predators of cutthroat and hybridizing species that diminish cutthroat genetic integrity.

Substantial additional information on research and prior management of SGCN in the Yellowstone River Basin are summarized in the 2010 Wyoming SWAP (WGFD 2010).

Aquatic Reptiles
Three turtles are found in the Yellowstone River basin, all of which are native. The Western Spiny Softshell and Western Painted Turtle are SGCN, but the Eastern Snapping Turtle is not. The Western Spiny Softshell is known from the Little Powder, Powder, Tongue, Nowood and Bighorn Rivers. The Western Painted Turtle is found in all of the major subdrainages in the Yellowstone River basin and is probably most common in Clear and Crazy Woman Creeks in the Powder River drainage. It is the only turtle species known from the Clarks Fork of the Yellowstone River in Wyoming. The Eastern Snapping Turtle is found in the Little Powder, Powder, Tongue, Little Bighorn, and Bighorn River drainages. The species has only been found in the downstream portions of the Little Bighorn and Bighorn River drainages, near the Montana state line.

Freshwater Mollusks and Crayfishes
Wyoming is still in the discovery phase in terms of its freshwater bivalve mollusks and gastropods. Although fingernail and pill clams and aquatic gastropods are often encountered during invertebrate sampling, few published accounts of mollusk collections exist (Beetle 1989, Henderson 1924, Hoke 1979, Hovingh 2004). Many native mussels, clams, and gastropods are considered SGCN due to a lack of information regarding status.

Two bivalve mussel species have been documented in the Yellowstone River basin. The Fatmucket is the most widespread. Populations are spread throughout the Powder, Tongue, and Wind-Bighorn river drainages. The Giant Floater exists in the Little Powder drainage near the Montana state line.

Most of what is known about species presence and distributions of gastropods in the basin are summarized in Beetle (1989) and Narr (2011). With one exception all gastropods in the basin are SGCN due to lack of adequate population and distribution information. Cave Physa are the only gastropod with enough information to assess status (NSS4).

Little information is available on the distribution of Wyoming crayfishes. Two species (*Orconectes* Calico and Virile Crayfish), both of which are native, have been documented in the Yellowstone River basin (Hubert 1988, 2010). The Calico Crayfish are considered SGCN while the more common Virile Crayfish are not.

Table 12. Species of Greatest Conservation Need present in the Yellowstone River Basin.

Fish
Brassy minnow
Burbot
Flathead Chub
Goldeye
Plains Minnow
Sauger
Shovelnose Sturgeon
Sturgeon Chub
Western Silvery Minnow
Yellowstone Cutthroat Trout

Aquatic Reptiles
Western Painted Turtle
Western Spiny Softshell Turtle

Crustaceans
Calico Crayfish

Mollusks
Giant Floater Mussel

Identification of Conservation Areas

To address needs of the diverse aquatic assemblage of the Yellowstone River basin, conservation areas were identified to include wide-ranging habitats from mountain lakes, coldwater streams, warmwater streams, and large rivers (Figure 12).

Conservation areas were identified using a number of available tools. Results from Stewart et al. (2015) guided prioritization of cool and warmwater habitats. Coldwater habitats in the basin were prioritized following conservation populations identified in the Yellowstone Cutthroat Trout Conservation Strategy (Range-Wide YCT Conservation Team 2009) and the known distribution of Burbot.

The Powder River conservation area includes the mainstem Powder River downstream of Kaycee, Wyoming, Clear Creek below Hwy 14/16, Crazy Woman Creek below Interstate 90, and the Little Powder River below the confluence of Cottonwood Creek.

The lower Nowood River, below Big Trails, Wyoming, is an important conservation area for native nongame species in the Bighorn River drainage. It is home to a diverse assemblage of fishes, including many SGCN (Bear 2009).

Priority areas for the conservation of native Yellowstone Cutthroat Trout are numerous and widespread. On the north and east slopes of the Bighorn Mountains, these include Lodgegrass Creek, the West Fork Little Bighorn River, Elkhorn Creek and Red Gulch creeks, the North and South forks of West Pass Creek in the Little Bighorn drainage, and the South Fork Little Tongue River.

In the Wind/Bighorn River drainage on the west side of the Bighorn Mountains, priorities include the North Fork Shoshone River drainage above Buffalo Bill Reservoir, Upper South Fork of the Shoshone River, Ishawooa Creek, Marquette Creek, Greybull and Wood River drainages, Trout Creek and Deer Creek (Porcupine Creek drainage), North and South Beaver Creeks (Shell Creek drainage), South Paintrock Creek, East Tensleep Creek, and the East Fork Wind River.

Figure 12. Aquatic Wildlife Conservation Areas in the Yellowstone River Basin.

In the upper Yellowstone River drainage, priorities include the Yellowstone River headwaters and tributaries, Crandall Creek and tributaries, Muddy Creek (tributary to Clarks Fork River), Littlerock Creek and Deep Lake.

To conserve Sauger in the Wind-Bighorn River drainage, the following areas have been identified below Boysen Dam: Big Horn Lake and the Bighorn River below the Lower Hanover Diversion south of Worland. Priorities above Boysen Dam are Boysen Reservoir to the upper extents of Sauger distribution. This includes the Wind River up to Diversion Dam, Popo Agie River up to confluence with North Fork Popo Agie River, Little Popo Agie River up to confluence with Willow Creek, and Little Wind River up to Sub-Agency Ditch Diversion.

To conserve Burbot in the Wind-Bighorn River drainage, the following areas have been identified: Bull Lake, Lower and Upper Dinwoody lakes, Torrey, Ring, and Trail lakes on Torrey Creek, Boysen Reservoir, Bighorn River and Big Horn Lake.

Priority drainages and habitats have not yet been defined for the conservation of aquatic reptiles, freshwater mollusks, or crayfishes.

Threats

Water development/altered flow regimes – Moderate

Natural flow regimes in stream segments around the state have been altered by human activities, including irrigation diversions municipal water supply, hydropower, fisheries and recreation, and flood control. Altered flow regimes below diversions and reservoirs are also a consequence of broad-scale changes in land use and management associated with agriculture, grazing, timber harvest, and housing development (see Wyoming Leading Wildlife Conservation Challenges – Disruption of Historic Disturbance Regimes). Lateral and longitudinal hydrologic connectivity and physical access by fish populations to all habitats necessary to complete their life history is limited throughout the drainage. In-channel obstructions and decreased stream flow associated with increased diversions have reduced some populations of native stream fishes.

The need for additional water for human use will intensify in the immediate future, and that trend will be especially evident in the western U.S. This trend has multi-faceted consequences for fish and wildlife and the habitats upon which they depend. In Wyoming, trans-basin water diversions are not uncommon within some drainages and are likely to be further proposed and pursued. Energy development, including hydropower development, may increase as the nation's electrical energy demands rise.

Warmer conditions with more erratic precipitation—which some predict for Wyoming's future climate—may heighten the need for additional water storage for municipal and agricultural purposes. The likely trend will be water development projects closer to the delivery point and conveyance via pipelines instead of stream channels. Additional emphasis will likely be placed on lining irrigation ditches and other practices to more efficiently use water for consumptive purposes. Additional scrutiny of existing water uses and water rights is also likely as evidenced by the Bighorn River general stream adjudication conducted by the Wyoming district court from 1997 to 2007. This action reviewed water claims and rights of over 20,000 users and resulted in the elimination of many historic water rights due to non-use. Though this action did not significantly change water uses in most streams and reservoirs, it illustrates the potential of future legal efforts to effectively modify water use in certain places. The net effect of all such water management practices will be to alter the timing, magnitude, and duration of natural hydrographs as well as the intra- and inter-annual variability in Wyoming's streams and associated riparian corridors (see Wyoming Leading Wildlife Conservation Challenges – Climate Change, and the Riparian habitat chapter). In other settings water conservation strategies may enhance stream flow in some segments of some streams.

While water development can threaten native species in some situations, some introduced species, including popular game fisheries, have thrived as a result of water development in some situations. The simplification of natural systems by human development tends to favor species with generalized and broad habitat requirements. For example, the Walleye fishery in Boysen Reservoir depends on the consistent deep water and forage production inherent in this manmade water body. Stable stream flow releases from dams, with relatively low peak flows and relatively high base flows, perpetuate productive game fisheries like trout fisheries below Boysen and the Shoshone River below Buffalo Bill Reservoir.

Drought and climate change – Moderate
Climate change may increase air and surface water temperatures, alter the magnitude and seasonality of precipitation and run-off, and shift the reproductive phenology and distribution of plants and animals (Seavy et al. 2009) (see Wyoming Leading Wildlife Conservation Challenges – Climate Change).

Changes in precipitation patterns under various climate change scenarios are predicted to produce peak flows earlier in the annual cycle and to lower base flows (Barnett et al. 2004). Extended low flow periods lowers water tables, leading to reduced plant growth and reproduction. Changes in riparian vegetation lead to lower bank stability, higher siltation and altered stream habitat quality and quantity. Lower water levels associated with reduced shading from riparian vegetation typically increases water temperatures and reduces the quality of habitat available to cool and cold water fish species and other aquatic wildlife.

Invasive species – Moderate
Several aquatic invasive species (AIS) are present in the basin, including the New Zealand mudsnail, curly pondweed, and Brook Stickleback. Additional descriptions and definitions of AIS can be found in the WGFD AIS management plan (WGFD 2010).

New Zealand mudsnails were first discovered in 1996 in the Madison River in Yellowstone National Park. The mudsnail is spread by fish and birds, natural downstream dispersal, upstream through rheotactic behavior, and by humans on fishing gear. The pathway of introduction into Wyoming is unknown, but spread on recreational angling gear is likely given the first location of introduction (WGFD 2010).

Currently, in the Yellowstone River Basin, mudsnail occur in Yellowstone National Park (Madison and Gardner rivers drainages), the Bighorn River from Boysen Dam to the town of Thermopolis, and the Shoshone River through the town of Cody. In the Bighorn and Shoshone rivers, mudsnail populations have decreased in abundance relative to first establishment, a trend observed elsewhere (Vinson et al. 2007). In 2014, a new population of New Zealand mudsnails was found at the boat ramp in Lake Cameahwait near Shoshoni. This represents this first new population of this invasive snail in the basin in over a decade.

Curly pondweed was introduced into the United States in the mid 1800's and is now widespread. Curly pondweed reproduces by seed which can be easily transferred in mud or water. It is introduced into new areas through boating, fishing, and water hauling, and as an ornamental plant . New populations continue to be discovered in Wyoming. In the Yellowstone River Basin, it is found in Boysen Reservoir, the Shoshone River near Cody, and Lake DeSmet.

The Brook Stickleback has been introduced to many states outside of its native range. Brook Stickleback are spread as a result of bait introductions or accidental introductions with aquaculture species. Juvenile fish and fish eggs may be difficult to see and can be moved in standing water in boats and bait buckets . Brook Stickleback are commonly found in the basin in the Shoshone River, Bighorn River, and Badwater drainages. A new population was found in 2015 in the South Fork Powder River, likely spread from the Badwater Creek drainage through movement of bait and water hauling.

In addition to species designated as AIS, several introduced game fishes are problematic in the basin. Nonnative rainbow trout present a substantial threat to Yellowstone Cutthroat Trout through hybridization, while other introduced trout are predators and/or competitors that have proven successful at eliminating Yellowstone Cutthroat Trout populations.

While nonnative game fish may need to be controlled for conservation and restoration of natives in some areas, these same fish support popular fisheries that provide important recreational and economic benefits (WGFD 2010).

Other invasive species, such as zebra and quagga mussels and silver carp, are present in neighboring states and potentially very harmful to the aquatic wildlife in the basin. Through outreach and education, watercraft inspections, and monitoring, the harmful impacts of these and other invasive species may be prevented. Watercraft are inspected at key locations entering the basin and at major waters in the basin, including Buffalo Bill Reservoir, Boysen Reservoir, Big Horn Lake, and Lake DeSmet. Twenty-three (23) waters in the basin are monitored annually to detect the presence of invasive species. These efforts to keep existing species in the basin from spreading to new waters, and other harmful species from entering the basin will continue.

Conservation Initiatives

Department plans and policies
The WGFD's Fish Division has developed basin management plans to guide management across the state. These plans provide background and history of aquatic wildlife management as well as management direction. These plans reference the SWAP and the Strategic Habitat Plan (SHP), attempting to incorporate management direction relevant to each basin.

Habitat management efforts are guided by the SHP that is regularly revised and approved by the Wyoming Game and Fish Commission. The SHP includes five goals: 1) Conserve and manage wildlife habitats that are crucial for maintaining terrestrial and aquatic wildlife populations for the present and future, 2) Enhance, improve, and manage priority wildlife habitats that have been degraded, 3) Increase wildlife-based recreation through habitat enhancements that maintain or increase productivity of wildlife, 4) Increase public awareness of wildlife habitat issues and the critical connection between healthy habitat and abundant wildlife populations, and 5) Promote collaborative habitat management efforts with the general public, conservation partners, private landowners, and land management agencies. Efforts are focused in priority areas in each of the management regions and include crucial areas essential for conservation of important species and communities and enhancement areas, which represent places where work should be conducted to manage or improve wildlife habitat.

In addition to these guiding documents, the WGFD has a number of tools, policies and protocols to protect and enhance native aquatic wildlife. Additional details on these tools, policies and protocols including environmental commenting, aquatic wildlife stocking and transplant, and disease prevention can be found in the 2010 SWAP.

Interagency plans and agreements
The states of Idaho, Montana, Nevada, Utah, and Wyoming, along with the U.S. Forest Service and Grand Teton and Yellowstone National Parks, signed a Memorandum of Agreement to jointly conserve, protect, and restore Yellowstone Cutthroat Trout populations within their historic range (Endicott et al. 2016). As part of the agreement the interstate working group under the auspices of the 2000 Memorandum of Agreement (MOA), completes range-wide status assessments (May et al. 2003, 2007).

The National Fish Habitat Action Plan (NFHAP) was developed by a coalition of fisheries professionals, state and federal agencies, tribes, foundations, conservation and angling groups, businesses and industries, all determined to reverse the declines of America's fish habitats. The WGFD is involved with three NFHAP partnerships, Great Plains Fish Habitat Partnership, the Western Native Trout Initiative, and the Desert Fishes Habitat Partnership. The first two cover the Yellowstone River Basin. Additional information on Fish Habitat Partnerships can be found in the 2010 SWAP.

Ongoing and completed conservation actions
Numerous projects have been completed to benefit SGCN in the Yellowstone River basin since the implementation of the 2010 SWAP (previous accomplishments are documented in the 2010 SWAP). Multiple sources of funding have been used to implement projects. Projects have been completed by department personnel and through contracting and granting with research partners. Accomplishments are listed under headings taken from the Recommended Conservation Actions in the 2010 SWAP. While accomplishments are not duplicated under more than one action they commonly address multiple actions. Although this list is not comprehensive of all actions, most of the significant initiatives are summarized below.

Secure and enhance populations and habitats in SGCN priority areas
WGFD biologists studied the fish community composition and habitat conditions of Crazy Woman Creek from 2004 to 2006 (Edwards

2013). Patterns of species abundance shifted but wasn't readily explainable with a decreasing abundance of sand shiner through the study period.

WGFD biologists in cooperation with the U.S. Fish and Wildlife Service, Montana Fish Wildlife and Parks and Shoshone and Arapaho tribes undertook attempts in the Wind-Bighorn drainage to bolster populations of Sauger by conducting stream-side spawning operations above and below Boysen reservoir between 2011 and 2016 (Hochhalter 2015).

WGFD biologists examined age and growth of Sauger in the Wind-Bighorn drainage in relation to environmental factors (Gerrity and Smith 2013). No consistent relationships were found between year-class strength and environmental factors.

WGFD biologists examined juvenile Sauger habitat use in the Wind River above Boysen Dam from 2014 – 2016. It was found that the upstream end of Boysen Reservoir (primarily Poison Creek Bay) and the Wind River upstream from Boysen Reservoir are nursery areas for juvenile Saugers (WGFD 2016).

WGFD biologists examined methods to capture larval Sauger from the Bighorn River. Sampling conducted in 2013 yielded 57 larval fish, none of which were Sauger (WGFD 2014). Sampling conducted in 2014 yielded 100 larval fish, of which four were Sauger (WGFD 2015).

The WGFD funded a research project at the University of Wyoming that determined endocrine disrupting compounds were not the cause of low Sauger recruitment in the Wind River (Johnson 2014).

WGFD biologists continued to monitor sites on the Powder River to assess changes in the fish community since a major WGFD study was conducted in 2004-2006 (WGFD 2010-2015).

The WGFD funded a research project at the University of Wyoming to investigate the natal origins of Shovelnose Sturgeon in the Bighorn River and Yellowstone Cutthroat Trout in Dead Indian Creek. The objectives of the study were to determine to what degree if any, stocking was playing in maintaining populations. Results for sturgeon were inconclusive but found cutthroat stocking was no longer necessary to sustain a viable population (Carleton 2013).

WGFD biologists studied the movement and life history strategies of Burbot in the Torrey Creek drainage. Glaid et al. (2016) determined that Torrey Creek upstream from Trail Lake is an important spawning and nursery area for the Torrey drainage Burbot population. Additionally, multiple life history strategies are likely utilized in the drainage.

The WGFD funded a research project at Colorado State University to investigate the impact of an illegal introduction of Walleye on Yellowstone Cutthroat Trout and Rainbow trout in Buffalo Bill Reservoir. Results suggest the combination of Lake Trout and Walleye predation may depress the wild Cutthroat and Rainbow Trout populations (Johnson and Johnson 2015).

The WGFD has been actively working to restore Yellowstone Cutthroat Trout in priority sub-drainages within the Yellowstone basin. Genetic purity of native cutthroat populations was assessed by Pisces Molecular, LLC (Boulder, CO), using the amplified fragment-length polymorphism (AFLP) technique. Since the previous SWAP (2010), genetically pure Yellowstone Cutthroat Trout populations were confirmed in the North Fork Shoshone drainage (Hunter Lake), and North Fork Popo Agie drainage (High Meadow Creek). Hybridization with other cutthroat trout sub-species were detected in North Fork Pop Agie and Lonesome Lake (Popo Agie drainage), Cedar Creek (Bighorn drainage) and Lodgegrass Creek (Little Bighorn drainage).

Since the previous SWAP (2010), chemical rehabilitation projects to remove nonnative salmonids and secure native cutthroat populations were completed on Soda Butte Creek in cooperation with Montana Fish Wildlife and Parks and Yellowstone National Park. Two projects proposed to chemically remove nonnatives and establish Yellowstone

Cutthroat Trout (Porcupine Creek in the Bighorn drainage and Eagle Creek in the Shoshone drainage) were postponed due to lagging public support.

WGFD biologists investigated Western Spiny Softshell abundance and population structure along the Bighorn River in 2010. Abundance of Spiny Softshell turtles was low (6 turtles in 76 trap nights) and all captured individuals were males. No other turtle species were captured. Habitat alteration could be impacting turtle assemblages in the Bighorn River drainage (WGFD 2011).

Complete status assessments of native species in the basin

WGFD biologists conducted a statewide survey of Mountain Whitefish (SGCN in 2010 SWAP) from 2009 to 2013. A primary achievement of the study was the development of a sampling approach for assessing populations (Edwards 2014). The study demonstrated most populations are robust leading to the determination that a non SGCN status rank (NSS5) is appropriate.

The WGFD funded a research project at Montana State University to investigate the influence of angler exploitation on Burbot populations in lakes in the Wind River drainage. While variable, exploitation was low for all but one lake during one year (Lewandoski 2015). Results suggest variability in Burbot abundance is likely better explained by factors other than angler exploitation.

Continue aquatic habitat work in the basin

WGFD biologists completed several efforts to improve the structure and function of stream segments and watershed features that benefit aquatic SGCN. River restoration improvements were completed on the WGFD's Spence Moriarty property including Bear Creek, Wiggins Fork and East Fork Wind River. These improvements to stream banks and channel bedform diversity reduce sediment and improve trout cover (e.g. WGFD 2013).

Explore water management approaches that enhance fish habitat

The WGFD completed studies on 12 instream flow segments covering over 42 miles. Instream flow water rights have been filed on nine of these including North and South Fork of Beaver Creeks (Robertson 2013a, Robertson 2013b), Dry Medicine Lodge Creek (Robertson 2013c), Buckskin Ed Creek (Robertson 2014a), Cedar Creek (Robertson 2014b), Lodge Grass Creek (Robertson 2014c), West Fork Little Bighorn River (Robertson 2014d), Soldier Creek (Robertson 2014e), and Trout Creek (Robertson 2014f). The other three completed studies have not yet resulted in filings for water rights; these include Crandall Creek (Robertson 2015a), Dead Indian Creek (Robertson 2015b), and Muddy Creek (Robertson 2015c).

Increase educational efforts about the ecological, economic, and social values of aquatic SGCN

The WGFD created, produced and disseminated a poster detailing the states native fishes.

Continue building voucher collections for all aquatic wildlife

WGFD biologists collected numerous additional fish voucher specimens since the last SWAP (2010). All vouchers specimens are submitted to the Museum of Southwestern Biology, Albuquerque NM.

Complete the comprehensive survey for freshwater mussels

The WGFD conducted two SWG-funded projects in 2012 and 2014-2015 to assess the distribution and abundance of native mussels. Inventory surveys were conducted in the Wind-Bighorn (Mathias 2015), and Powder and Tongue, (Mathias 2016). Live Fatmucket were documented in the Bighorn drainage (Mathias 2015). No evidence of mussels (live or dead) were found in the Powder River drainage (Mathias 2016). Live Fatmucket were documented in the Tongue River drainage (Mathias 2016).

Follow up on recommendations from the graduate research project on gastropods

No actions reported.

Increase connectivity where appropriate
WGFD biologists worked with partners and contributed funding to many projects to enhance fish passage and connectivity. These efforts are detailed in annual Strategic Habitat Plan Accomplishments reports (e.g., WGFD 2011).

WGFD biologists assessed a newly constructed fish passage channel around Kendrick Dam on Clear Creek (Powder River tributary). Many SGCN including Flathead Chub, Sauger, Goldeye, Plains Minnow and Western Silvery Minnow were documented passing the structure that had impeded upstream movement since 1911 (Bradshaw 2015).

The WGFD completed a fishway and diversion screen on Piney Creek at the PF1 Diversion in 2016, a tributary to Clear Creek (WGFD 2016). Earlier work in 2013-2014 improved passage upstream at the Dunlap Diversion on Piney Creek. Improved connectivity benefits about 10 fish species including possibly Brassy Minnow.

A diversion screen and passage project on the Nowood River has been under development and phased construction for several years (e.g. WGFD 2011). Dual cone screens have been installed in a diversion to limit entrainment of potentially 16 fish species. Improved passage at the diversion is being developed to potentially benefit Sauger and Shovelnose Sturgeon.

Passage projects led or partially funded by WGFD to benefit Yellowstone Cutthroat Trout include a fish ladder on the Greybull River, fish screens on diversions off Trout Creek in the North Fork Shoshone drainage, a fish screen on the Valley Ditch off the North Fork Shoshone River, screens and diversion reduction on Greybull River drainage tributaries, fish screen and diversion passage improvements on Bear Creek (East Fork Wind River tributary) at the Bear Creek and Thunderhead Diversions, diversion passage improvement at the East Fork Wind River diversion, and water use and diversion improvements on East Fork Wind River tributaries.

Yellowstone Cutthroat Trout entrainment studies were conducted by WGFD on diversion ditches from the Greybull River and tributary Francs Fork River (WGFD 2011), and on tributaries to the East Fork Wind River. These diversions were found to entrain sufficient numbers to warrant screening.

The WGFD used SWG funds to conduct a research project at the University of Wyoming to study the influence of outmigration and canal entrainment on Burbot populations in the upper Wind River. Researchers found water development is having variable but minimal effects on Burbot populations in the drainage (Underwood 2015).

Recommended Conservation Actions

Secure, enhance, or establish SGCN populations
Evaluate the feasibility of reducing populations or removing problematic nonnative fishes from the basin to enhance or expand SGCN.

Complete chemical rehabilitation projects to restore Yellowstone Cutthroat Trout within the species' native range. Complete scheduled projects in Soda Butte Creek, Eagle Creek (North Fork Shoshone) and other streams identified as priorities.

Complete analysis of alternatives for securing Yellowstone Cutthroat Trout in West Pass Creek by removing and constructing barriers and restoration stocking. Pursue implementation if feasible.

Survey streams above existing or potentially constructed barriers in the basin to determine potential for establishing Yellowstone Cutthroat Trout refugia.

Identify candidate streams for genetic refugia for Elkhorn Creek Yellowstone Cutthroat Trout.

Inventory, assess, or examine life history requirements of SGCN
Further determine the status, distribution, and habitat associations of turtles, mollusks, and crayfishes in the Yellowstone River basin.

Determine if Plains Minnow, Western Silvery Minnow, and Sturgeon Chub persist in the Bighorn River and document associated habitats.

Measure the degree of successful recruitment for Sauger stocked in the Wind River drainage via genetic parentage assignments and/or stable isotope analysis.

Conduct studies to better understand how migratory SGCN fishes use the Powder River Basin, particularly Sturgeon Chub, Western Silvery Minnow, Plains Minnow, Goldeye, Sauger, Shovelnose Sturgeon and Flathead Chub.

Complete assessment of natural recruitment potential of Shovelnose Sturgeon in the Bighorn River.

Examine the spatiotemporal pattern of Burbot occupancy in Big Horn Lake and the Bighorn River.

Examine spatial occurrence of Yellowstone Cutthroat Trout and Rainbow trout hybridization in the North Fork Shoshone drainage.

Evaluate the magnitude of Walleye and Sauger hybridization in the Bighorn River.

Investigate the distribution of Western Spiny Softshell, Western Painted and Eastern Snapping turtle in the Bighorn River drainage and possible reasons for anecdotal declines (WGFD 2011).

Conduct baseline gastropods surveys in the basin and identify needed actions to maintain or restore populations.

Survey to fill gaps in knowledge about native mussel distribution.

Provide passage and reduce entrainment at barriers impacting SGCN
Continue collecting physical measurements and logging locations of natural and manmade barriers.

Continue populating the WGFD database to store physical measurements at barriers and barrier locations.

Implement a passage solution at the Tongue River Interstate Diversion and evaluate entrainment.

Assess passage solutions and entrainment at the Lower Sunshine Diversion on the Wood River for potential modifications.

Improve road crossings and fish passage in Alkali, Meadow, Pine and Castle Creeks, Yellowstone Cutthroat Trout spawning tributaries to the East Fork Wind River.

Complete screening improvements and passage enhancements on Yellowstone Cutthroat Trout waters on the Departments Spence Moriarty unit (Bear Creek, Wiggins Fork, and East Fork Wind River) and manage diversions to minimize entrainment and maximize passage.

Maintain and operate the Kendrick fishway on lower Clear Creek and pursue passage solutions upstream in the basin to completely re-connect waters throughout this basin.

Improve aquatic habitat for SGCN
Continue discussions with irrigators to obtain fish passage past the next barrier upstream from Kendrick Dam in Clear Creek.

Monitor instream flow segments for compliance with approved instream flow levels. Pursue compliance as needed when water is available and in priority.

Complete aquatic habitat assessments within basins containing SGCN to identify areas aquatic habitat degradation and restoration projects to benefit SGCN.

Complete assessment and stream restoration projects within Upper and Middle Sunlight Creek subwatershed to improve habitat functions. Restoration will benefit Yellowstone Cutthroat Trout if coupled with chemical rehabilitation and reintroduction efforts.

Identify and complete habitat protection and improvement projects on private land along Marquette Creek to benefit Yellowstone Cutthroat Trout.

Complete assessment, stream restoration, and diversion structure improvement projects on Medicine Lodge and Paint Rock Creeks. Projects will reduce channel instability, sediment loads, and benefit downstream habitats for SGCN such as Sauger and Shovelnose Sturgeon.

Identify and complete watershed improvement projects in Shoshone watershed to reduce the sediment inputs into the Lower Shoshone River.

Participate in working groups and conduct habitat assessments to identify ways to reduce non-point sediment sources and identify future restoration projects within the Big Horn River watershed.

Complete habitat assessment, stream restoration and diversion structure improvement projects on Canyon Creek and South Paintrock Creek drainage to benefit Yellowstone Cutthroat Trout.

Continue in channel habitat enhancement efforts in the East Fork Wind River watershed to improve functions and benefit Yellowstone Cutthroat Trout.

Employ water management strategies that improve habitat for SGCN
Identify stream segments where habitat and available flow regimes indicate a need to file instream flow water rights for SGCN. As opportunities are identified, conduct studies and file for state-held instream flow water rights.

Increase educational efforts about the ecological, economic, and social values of aquatic SGCN
No actions identified.

Continue building voucher collections for aquatic wildlife
Continue to fill voids in voucher inventory for fish per WGFD protocol (Zafft and Bear 2009).

Build gastropod voucher collection and find permanent repository.

Monitoring

Establish standardized monitoring protocols and locations for SGCN
Monitor natural recruitment, density, and size structure of newly established and/or expanded Yellowstone cutthroat trout populations.

Use eDNA to determine if nonnative trout remain in Little Tongue River and Elkhorn Creek.

Monitor Sauger abundance, annual recruitment, and angler exploitation in the Bighorn/ Wind River drainage, including Boysen Reservoir, Bighorn River and Big Horn Lake.

Monitor Burbot populations in the Bighorn/ Wind River drainage, including Boysen Reservoir, Big Horn, Trail, Ring, and Torrey lakes.

Develop and implement a standardized monitoring protocol for Shovelnose Sturgeon in the Bighorn River.

Re-survey a sub-sample of selected sites from the Bighorn warm-water stream project (Bear 2009).

Monitor water quantity and temperature in areas containing important native SGCN populations.

Monitor the establishment and spread of invasive species.

Develop and implement a long-term monitoring plan for high priority sites in the Powder River drainage.

Monitor fish movements and entrainment where passage projects have been implemented or being planned in the South Fork Shoshone, Greybull River, Clear Creek, and East Fork Wind River drainages.

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Wyoming Species of Greatest Conservation Need

Element 1 of the Congressional guidelines for State Wildlife Action Plans (SWAPs) specifies that each state must provide "information on the distribution and abundance of species of wildlife, including low and declining populations as the state wildlife agency deems appropriate, that are indicative of the diversity and health of the state's wildlife." These species have been termed Species of Greatest Conservation Needs or SGCN.

Identifying SGCN

Over 800 species of wildlife exist in Wyoming. This figure does not include plants and terrestrial invertebrates, which do not fall within the Wyoming Game and Fish Department's (WGFD) jurisdiction. SGCN designation is intended to identify species whose conservation status warrants increased management attention, and funding, as well as consideration in conservation, land use, and development planning in Wyoming. SGCN designation can be derived from known population or habitat threats or a lack of sufficient information to adequately assess a species' status.

The WGFD's SGCN designation process is based upon its Native Species Status (NSS) classification system. This system compares population and limiting factor variables using a 16 cell matrix (Table 1).

The y-axis consists of population variables, which range on a continuum from populations declining with extirpation possible (row A) to populations that are widespread and expanding (row D). After identifying the appropriate row for a species population, the most appropriate limiting factor column is selected from the x-axis, ranging from limiting factors that are severe and worsening (column a) to limiting factors that are moderate and not likely to increase (column d). Limiting factors include habitat, human activity levels, genetics, invasive species, disease, environmental contaminants, and climate change (Table 2). Additional limiting factors may be identified in the future.

The matrix cell established by the intersection of the selected row and column identifies the NSS rank for a species. As a species moves from a placement closest to the upper left corner of the matrix (Aa/NSS1) toward the lower right corner (Dd/NSS7) the species' population status in Wyoming is considered more secure. Some combinations of population status and limiting factors are unlikely to occur and are not assigned an NSS rank. Notes on the SGCN designation are included with each species account.

This system cannot be used for classifying some species because necessary information is lacking. These species are placed in a separate status category as NSS Unknown (NSSU) until additional information is obtained. Species that receive an NSS rank of NSS1, NSS2, NSS3, NSS4, or NSSU were recommended to the Wyoming Game and Fish Commission to receive SGCN designation for the 2017 SWAP. NSSU species were recommended to receive the SGCN designation because obtaining a greater understanding regarding population numbers and distributions of these species is necessary in determining their conservation status, including responding to petitions for listing under the Endangered Species Act. Some species with naturally low numbers and limited distributions were not recommended to receive SGCN status if both the following qualifications were met:

1. The species in Wyoming is not experiencing known population declines or increasing threats, and
2. The species' population is abundant and secure throughout its range.

Only species that are legally considered wildlife in Wyoming, and are thought to breed within the state, were evaluated for SGCN status. Wyoming Statute 23-1-101 (a) (xiii) defines "wildlife" as all wild mammals, birds, fish, amphibians, reptiles, crustaceans and mollusks, and wild bison designated by the Wyoming Game and Fish Commission and the Wyoming Livestock Board within Wyoming. Plants and invertebrates (excluding crustaceans and mollusks) are outside the jurisdictional authority of the WGFD and were not considered for SGCN status.

The SGCN designation was applied at the most appropriate taxonomic level based on current management practices (see Appendix B for a description of taxonomic approach for mammals and birds). This was usually the species level. Examples of exceptions at the subspecies level included the Preble's jumping mouse, four subspecies of cutthroat trout,[1] and a number of reptiles and amphibians. Most mollusks and crustaceans were organized at the genus, family, or order level, based on shared morphology, habitats, threats, and limited information.[2] Basic life history information, population survey methods, and identification techniques for these mollusks and crustaceans is extremely limited. Consequently, addressing the conservation of these species at a lower taxonomic level is impractical until additional information is available.

[1] Bonneville, Yellowstone, Snake River, and Colorado River.
[2] Mollusk groups: aquatic snails, land snails, oreohelix mountain snails, pill clams, and stagnicola pondsnails. Crustacean groups: shrimp.

Table 1. 2017 SWAP Native Species Status Matrix

		Limiting Factors			
		a. **EXTREME** Limiting factors are severe and continue to increase in severity	**b.** **SEVERE** Limiting factors are severe and not increasing significantly	**c.** **MODERATE** Limiting factors are moderate and appear likely to increase in severity	**d.** **MINIMAL** Limiting factors are moderate and not likely to increase in severity
Population Status	**A.** **IMPERILED** Population size or distribution is restricted or declining and extirpation is possible	Aa NSS1	Ab NSS2	Ac NOT APPLICABLE	Ad NOT APPLICABLE
	B. **VULNERABLE** Population size or distribution is restricted or declining but extirpation is not imminent	Ba NSS2	Bb NSS3	Bc NSS4	Bd NOT APPLICABLE
	C. **STABLE** Population size and distribution is stable and the species is widely distributed	Ca NOT APPLICABLE	Cb NSS4	Cc NSS5	Cd NSS6
	D. **EXPANDING** Populations are expanding in number and/or distribution and the species is widely distributed	Da NOT APPLICABLE	Db NOT APPLICABLE	Dc NSS6	Dd NSS7

Table 2. Description of SWAP NSS Matrix Limiting Factors

Limiting Factors	**a.** **EXTREME** Limiting factors are severe and continue to increase in severity	**b.** **SEVERE** Limiting factors are severe and not increasing significantly	**c.** **MODERATE** Limiting factors are moderate and appear likely to increase in severity	**d.** **MINIMAL** Limiting factors are moderate and not likely to increase in severity
Habitat	Deteriorating Significant ongoing and increasing loss of habitat or extremely limited habitat	Restricted Significant loss of habitat	Vulnerable Habitat is vulnerable but not currently restricted; increases in habitat loss likely	Stable Habitat is secure and/or widespread
Human activity	Highly sensitive Disturbance significantly and increasingly impacting populations	Sensitive Disturbance significantly impacting populations	Adaptive Disturbance currently results in moderate population reductions; additional losses likely	Tolerant Species routinely occupies disturbed environments and habitats closely associated with humans
Genetics	Deteriorating Species significantly declining in genetic purity or ongoing hybridizations	Restricted Unaltered genetic base is severely restricted geographically or genetically	Vulnerable Unaltered genetic base is currently stable but vulnerable to hybridization or loss of genetic diversity	Stable Desired genetic base is secure and widespread
Invasive species	Deteriorating Invasive species causing significant and increasing population impacts and loss of habitat	Restricted Invasive species causing significant population impacts or loss of habitat	Vulnerable Invasive species impacts moderate but expected to increase in severity	Stable No current or expected impacts from invasive species
Others Disease Contaminants Climate change				

Changes in SGCN from 2005

The re-evaluation of SGCN for the revised 2017 SWAP resulted in 229 species receiving SGCN designation (Table 3). This included 80 birds, 51 mammals, 28 fish, 9 amphibians, 24 reptiles, 8 crustaceans, and 29 mollusks.[3]

SGCN Prioritization and Conservation Tiers

Due to resource limitations, it is not possible to provide equal attention to all of Wyoming's SGCN and achieve quantifiable conservation results. SWAPs are required to be coordinated with federal, state, and local agencies. Increasingly, these entities are looking to the SWAP for guidance in directing wildlife conservation activities.

By itself, the WGFD's NSS ranking system has limitations in conveying conservation priority. First, the NSS system does not take into account the issue of peripheral ranges. A species could be common and secure throughout its range, but receive a high NSS rank solely because Wyoming is on the periphery of its range. The NSS ranking system does not differentiate these species from species that have a substantial portion of their range in Wyoming and are facing increasing threats, or from species that have limited ranges in the state, but for which Wyoming is likely to play a significant role in national or international conservation. Secondly, NSS rank does not take into account science and wildlife management limitations or economic, social, or political factors, which are necessary to consider when designing conservation strategies. Lastly, the NSSU designation deviates from the numerical designation given to other NSS ranks. No differentiation is made between species where population data is lacking and threat levels are known to be increasing, and species with lacking survey data that are not believed to be facing increasing threats.

To address these shortcomings, an SGCN conservation prioritization system was developed. The system was designed to provide a clear and transparent mechanism to focus internal and external conservation efforts toward species where there is the greatest likelihood of preventing future listings under the Endangered Species Act and for which conservation activities will provide the greatest benefits for native species, natural habitats, and the state.

The following six variables were approved by the Wyoming Game and Fish Commission (1/28/2010) to evaluate the conservation priority of SGCN. Descriptions for each variable are found in Appendix A.

1. WGFD NSS rank.
2. Wyoming's contribution to the species' overall conservation.
3. Regulatory/monetary impacts of the species' listing under the Endangered Species Act.
4. Urgency of conservation action.
5. Ability to implement effective conservation actions.
6. The species' ecological or management role as keystone, indicator, or umbrella species.

Numerical scores were assigned to each of these variables and summed to provide a total score. SGCN were placed into one of three tiers based on their total score: Tier I – highest priority, Tier II – moderate priority, and Tier III – lowest priority. Prioritization scores were assigned by two or more WGFD biologists who have considerable knowledge about the SGCN. If the difference in total scores by any two individuals resulted in a species being placed in different tiers, then the relevant variables were discussed to reach consensus about the appropriate tier for the species. The tier for any SGCN may be reviewed annually if circumstances change or new data becomes available.

[3] Includes five groups of mollusks and one group of crustaceans. In the 2010 SWAP, 180 species receiving the SGCN designation. This included 56 birds, 46 mammals, 30 fish, 8 amphibians, 21 reptiles, 5 crustaceans, and 14 mollusks.

Species ranked NSS1 – NSS4 were treated differently than NSSU species. This was due to the lack of sufficient information about NSSU species to adequately assess some prioritization variables and also because of an absence of a numerical NSS rank. The prioritization system for NSS1 – NSS4 and NSSU is as follows:

NSS1 – NSS4

1. The NSS rank of the species is subtracted from 5 and multiplied by 6: [(5-NSS)×6]. This would result in scores of NSS1=24, NSS2=18, NSS3=12, NSS4=6.
2. The species is assigned a score of 1–10 based on the variable "Wyoming's contribution to the species' overall conservation"; 10 being the highest contribution and 1 being the lowest contribution. The WYNDD G rank (global chance of extinction) and Wyoming Conservation Contribution score were consulted in determining this score.
3. The species is assigned a score of 1–5; 5 being highest and 1 the lowest for each of the following variables:
   a. Regulatory/monetary impacts of the species' listing under the Endangered Species Act.
   b. Urgency of conservation action.
   c. Ability to implement effective conservation actions.
   d. The species' ecological or management role as a keystone, indicator, or umbrella species.

A species ranked NSS 1 – NSS4 has a maximum of 54 points. Species with a total score of 1–18 are Tier III, 19–36 are Tier II, 37–54 are Tier I.

NSSU

1. NSSU species are assigned a score of 1–12 based on the variable "Wyoming's contribution to the species' overall conservation"; 12 being the highest contribution and 1 being the lowest contribution.
2. Next, a score of 1–6 is assigned for each of the following variables; 6 being the highest and 1 the lowest:
   a. Regulatory/monetary impacts of the species' listing under the Endangered Species Act.
   b. Urgency of conservation action

An NSSU species can have a maximum of 24 points. Species with a total score of 1–8 are Tier III, 9–16 are Tier II, and 17–24 are Tier I.

TABLE 3. – Wyoming 2010 SGCN

(SGCN are organized by taxa, conservation, and priority tier and then alphabetized by common name).

New species not identified in 2010 SWAP
Includes multiple species

Taxa Group	Common Name	Scientific Name	NSS Rank	NSS Cell	Tier
Birds	Common Loon	*Gavia immer*	1	Aa	I
	Burrowing Owl	*Athene cunicularia*	U	U	I
	Mountain Plover	*Charadrius montanus*	U	U	I
	Northern Goshawk	*Accipiter gentilis*	U	U	I
	Trumpeter Swan	*Cygnus buccinator*	2	Ba	II
	American Bittern	*Botaurus lentiginosus*	3	Bb	II
	Ash-throated Flycatcher	*Myiarchus cinerascens*	3	Bb	II
	Bald Eagle	*Haliaeetus leucocephalus*	3	Bb	II
	Black Tern	*Chlidonias niger*	3	Bb	II
	Black-crowned Night-Heron	*Nycticorax nycticorax*	3	Bb	II
	Boreal Owl	*Aegolius funereus*	3	Bb	II
	Bushtit	*Psaltriparus minimus*	3	Bb	II
	Caspian Tern	*Hydroprogne caspia*	3	Bb	II
	Cattle Egret	*Bubulcus ibis*	3	Bb	II
	Forster's Tern	*Sterna forsteri*	3	Bb	II
	Harlequin Duck	*Histrionicus histrionicus*	3	Bb	II
	Juniper Titmouse	*Baeolophus ridgwayi*	3	Bb	II
	Long-billed Curlew	*Numenius americanus*	3	Bb	II
	Peregrine Falcon	*Falco peregrinus*	3	Bb	II
	Pygmy Nuthatch	*Sitta pygmaea*	3	Bb	II
	Snowy Egret	*Egretta thula*	3	Bb	II
	Woodhouse's Scrub-Jay	*Aphelocoma woodhouseii*	3	Bb	II
	White-faced Ibis	*Plegadis chihi*	3	Bb	II
	Williamson's Sapsucker	*Sphyrapicus thyroideus*	3	Bb	II
	American White Pelican	*Pelecanus erythrorhynchos*	4	Bc	II
	Baird's Sparrow	*Ammodramus bairdii*	4	Bc	II
	Black-billed Cuckoo	*Coccyzus erythropthalmus*	4	Bc	II
	Black-throated Gray Warbler	*Setophaga nigrescens*	4	Bc	II
	Bobolink	*Dolichonyx oryzivorus*	4	Bc	II
	Brewer's Sparrow	*Spizella breweri*	4	Bc	II
	Calliope Hummingbird	*Selasphorus calliope*	4	Bc	II

Chestnut-collared Longspur	*Calcarius ornatus*	4	Bc	II
Clark's Nutcracker	*Nucifraga columbiana*	4	Bc	II
Columbian Sharp-tailed Grouse	*Tympanuchus phasianellus columbianus*	4	Cb	II
Ferruginous Hawk	*Buteo regalis*	4	Cb	II
Golden Eagle	*Aquila chrysaetos*	4	Bc	II
Grasshopper Sparrow	*Ammodramus savannarum*	4	Bc	II
Great Blue Heron	*Ardea herodias*	4	Bc	II
Greater Sage-Grouse	*Centrocercus urophasianus*	4	Bc	II
Loggerhead Shrike	*Lanius ludovicianus*	4	Bc	II
MacGillivray's Warbler	*Geothlypis tolmiei*	4	Bc	II
McCown's Longspur	*Rhynchophanes mccownii*	4	Bc	II
Red Crossbill	*Loxia curvirostra*	4	Bc	II
Red-eyed Vireo	*Vireo olivaceus*	4	Bc	II
Red-headed Woodpecker	*Melanerpes erythrocephalus*	4	Bc	II
Rufous Hummingbird	*Selasphorus rufus*	4	Bc	II
Sage Thrasher	*Oreoscoptes montanus*	4	Bc	II
Sagebrush Sparrow	*Artemisiospiza nevadensis*	4	Bc	II
Short-eared Owl	*Asio flammeus*	4	Bc	II
Black Rosy-Finch	*Leucosticte atrata*	U	U	II
Black-backed Woodpecker	*Picoides arcticus*	U	U	II
Black-chinned Hummingbird	*Archilochus alexandri*	U	U	II
Brown-capped Rosy-Finch	*Leucosticte australis*	U	U	II
Clark's Grebe	*Aechmophorus clarkii*	U	U	II
Dickcissel	*Spiza americana*	U	U	II
Franklin's Gull	*Leucophaeus pipixcan*	U	U	II
Gray Vireo	*Vireo vicinior*	U	U	II
Great Gray Owl	*Strix nebulosa*	U	U	II
Lewis's Woodpecker	*Melanerpes lewis*	U	U	II
Northern Pygmy-Owl	*Glaucidium gnoma*	U	U	II
Scott's Oriole	*Icterus parisorum*	U	U	II
Swainson's Hawk	*Buteo swainsoni*	U	U	II
Upland Sandpiper	*Bartramia longicauda*	U	U	II
Virginia's Warbler	*Oreothlypis virginiae*	U	U	II
Western Grebe	*Aechmophorus occidentalis*	U	U	II
Yellow-billed Cuckoo	*Coccyzus americanus*	U	U	II
Willow Flycatcher	*Empidonax traillii*	3	Bb	III
American Kestrel	*Falco sparverius*	4	Bc	III
American Pipit	*Anthus rubescens*	4	Bc	III

	Bewick's Wren	*Thryomanes bewickii*	4	Bc	III
	Blue Grosbeak	*Passerina caerulea*	4	Bc	III
	Blue-gray Gnatcatcher	*Polioptila caerulea*	4	Bc	III
	Canyon Wren	*Catherpes mexicanus*	4	Bc	III
	Common Nighthawk	*Chordeiles minor*	4	Bc	III
	Common Yellowthroat	*Geothlypis trichas*	4	Bc	III
	Flammulated Owl	*Psiloscops flammeolus*	U	U	III
	Merlin	*Falco columbarius*	U	U	III
	Purple Martin	*Progne subis*	U	U	III
	Snowy Plover	*Charadrius nivosus*	U	U	III
	Virginia Rail	*Rallus limicola*	U	U	III
Mammals	Black-footed Ferret	*Mustela nigripes*	1	Aa	I
	Canada Lynx	*Lynx canadensis*	1	Aa	I
	Wyoming Pocket Gopher	*Thomomys clusius*	2	Ab	I
	American Pika	*Ochotona princeps*	2	Ba	II
	Northern Long-eared Myotis	*Myotis septentrionalis*	2	Ba	II
	Canyon Deermouse	*Peromyscus crinitus*	3	Bb	II
	Cliff Chipmunk	*Tamias dorsalis*	3	Bb	II
	Dwarf Shrew	*Sorex nanus*	3	Bb	II
	Eastern Spotted Skunk	*Spilogale putorius*	3	Bb	II
	Fringed Myotis	*Myotis thysanodes*	3	Bb	II
	Idaho Pocket Gopher	*Thomomys idahoensis*	3	Bb	II
	Little Brown Myotis	*Myotis lucifugus*	3	Bb	II
	Northern River Otter	*Lontra canadensis*	3	Bb	II
	Pallid Bat	*Antrozous pallidus*	3	Bb	II
	Piñon Deermouse	*Peromyscus truei*	3	Bb	II
	Plains Harvest Mouse	*Reithrodontomys montanus*	3	Bb	II
	Preble's Meadow Jumping Mouse	*Zapus hudsonius preblei*	3	Bb	II
	Pygmy Rabbit	*Brachylagus idahoensis*	3	Bb	II
	Sand Hills Pocket Gopher	*Geomys lutescens*	3	Bb	II
	Townsend's Big-eared Bat	*Corynorhinus townsendii*	3	Bb	II
	Water Vole	*Microtus richardsoni*	3	Bb	II
	Wolverine	*Gulo gulo*	3	Bb	II
	Bighorn Sheep	*Ovis canadensis*	4	Bc	II
	Black-tailed Prairie Dog	*Cynomys ludovicianus*	4	Cb	II
	Moose	*Alces americanus*	4	Bc	II
	Northern Flying Squirrel	*Glaucomys sabrinus*	4	Cb	II
	Sagebrush Vole	*Lemmiscus curtatus*	4	Cb	II

	Swift Fox	*Vulpes velox*	4	Cb	II
	Western Small-footed Myotis	*Myotis ciliolabrum*	4	Cb	II
	White-tailed Prairie Dog	*Cynomys leucurus*	4	Cb	II
	Abert's Squirrel	*Sciurus aberti*	4	Bc	III
	Eastern Red Bat	*Lasiurus borealis*	4	Bc	III
	Long-eared Myotis	*Myotis evotis*	4	Cb	III
	Long-legged Myotis	*Myotis volans*	4	Cb	III
	Meadow Jumping Mouse	*Zapus hudsonius*	4	Bc	III
	Olive-backed Pocket Mouse	*Perognathus fasciatus*	4	Cb	III
	Spotted Bat	*Euderma maculatum*	4	Bc	III
	Spotted Ground Squirrel	*Xerospermophilus spilosoma*	4	Bc	III
	Uinta Chipmunk	*Tamias umbrinus*	4	Bc	III
	Yellow-pine Chipmunk	*Tamias amoenus*	4	Bc	III
	Yuma Myotis	*Myotis yumanensis*	4	Cb	III
	American Pygmy Shrew	*Sorex hoyi*	U	U	III
	Great Basin Pocket Mouse	*Perognathus mollipilosus*	U	U	III
	Hayden's Shrew	*Sorex haydeni*	U	U	III
	Hispid Pocket Mouse	*Chaetodipus hispidus*	U	U	III
	Least Weasel	*Mustela nivalis*	U	U	III
	Plains Pocket Mouse	*Perognathus flavescens*	U	U	III
	Preble's Shrew	*Sorex preblei*	U	U	III
	Ringtail	*Bassariscus astutus*	U	U	III
	Silky Pocket Mouse	*Perognathus flavus*	U	U	III
	Western Spotted Skunk	*Spilogale gracilis*	U	U	III
Fish	Bluehead Sucker	*Catostomus discobolus*	1	Aa	I
	Flannelmouth Sucker	*Catostomus latipinnis*	1	Aa	I
	Hornyhead Chub	*Nocomis biguttatus*	1	Aa	I
	Kendall Warm Springs Dace	*Rhinichthys osculus thermalis*	1	Aa	I
	Roundtail Chub	*Gila robusta*	1	Aa	I
	Colorado River Cutthroat Trout	*Oncorhynchus clarkii pleuriticus*	2	Ba	II
	Finescale Dace	*Chrosomus neogaeus*	2	Ba	II
	Northern Pearl Dace	*Margariscus nachtriebi*	2	Ba	II
	Sturgeon Chub	*Macrhybopsis gelida*	2	Ab	II
	Suckermouth Minnow	*Phenacobius mirabilis*	2	Ab	II
	Western Silvery Minnow	*Hybognathus argyritis*	2	Ab	II
	Bonneville Cutthroat Trout	*Oncorhynchus clarkii utah*	3	Bb	II
	Burbot	*Lota lota*	3	Bb	II
	Goldeye	*Hiodon alosoides*	3	Bb	II

	Iowa Darter	*Etheostoma exile*	3	Bb	II
	Northern Leatherside Chub	*Lepidomeda copei*	3	Bb	II
	Northern Plains Killifish	*Fundulus kansae*	3	Bb	II
	Orangethroat Darter	*Etheostoma spectabile*	3	Bb	II
	Plains Minnow	*Hybognathus placitus*	3	Bb	II
	Plains Topminnow	*Fundulus sciadicus*	3	Bb	II
	Sauger	*Sander canadensis*	3	Bb	II
	Shovelnose Sturgeon	*Scaphirhynchus platorynchus*	3	Bb	II
	Snake River Cutthroat Trout	*Oncorhynchus clarkii spp.*	3	Bb	II
	Yellowstone Cutthroat Trout	*Oncorhynchus clarkii bouvieri*	3	Bb	II
	Bigmouth Shiner	*Notropis dorsalis*	4	Cb	III
	Brassy Minnow	*Hybognathus hankinsoni*	4	Bc	III
	Common Shiner	*Luxilus cornutus*	4	Bc	III
	Flathead Chub	*Platygobio gracilis*	4	Bc	III
Amphibians	Western Toad	*Anaxyrus boreas*	1	Aa	I
	Wyoming Toad	*Anaxyrus baxteri*	1	Aa	I
	Wood Frog	*Lithobates sylvaticus*	2	Ba	II
	Columbia Spotted Frog	*Rana luteiventris*	3	Bb	II
	Great Basin Spadefoot	*Spea intermontana*	4	Bc	II
	Northern Leopard Frog	*Lithobates pipiens*	4	Bc	II
	Plains Spadefoot	*Spea bombifrons*	4	Bc	II
	Great Plains Toad	*Anaxyrus cognatus*	U	U	II
	Western Tiger Salamander	*Ambystoma mavortium*	4	Bc	III
Reptiles	Midget Faded Rattlesnake	*Crotalus oreganus concolor*	1	Aa	I
	Northern Tree Lizard	*Urosaurus ornatus wrighti*	1	Aa	II
	Eastern Spiny Softshell	*Apalone spinifera spinifera*	2	Ba	II
	Great Basin Gophersnake	*Pituophis catenifer deserticola*	2	Ba	II
	Northern Rubber Boa	*Charina bottae*	3	Bb	II
	Pale Milksnake	*Lampropeltis triangulum multistriata*	3	Bb	II
	Smooth Greensnake	*Opheodrys vernalis*	3	Bb	II
	Greater Short-horned Lizard	*Phrynosoma hernandesi*	4	Bc	II
	Black Hills Red-bellied Snake	*Storeria occipitomaculata pahasapae*	U	U	II
	Desert Striped Whipsnake	*Coluber taeniatus taeniatus*	U	U	II
	Northern Many-lined Skink	*Plestiodon multivirgatus multivirgatus*	U	U	II
	Plains Hog-nosed Snake	*Heterodon nasicus*	U	U	II
	Prairie Lizard	*Sceloporus consobrinus*	U	U	II

	Prairie Racerunner	*Aspidoscelis sexlineata viridis*	U	U	II
	Plateau Fence Lizard	*Sceloporus tristichus*	4	Bc	III
	Prairie Rattlesnake	*Crotalus viridis*	4	Bc	III
	Western Painted Turtle	*Chrysemys picta bellii*	4	Bc	III
	Great Basin Skink	*Plestiodon skiltonianus utahensis*	U	U	III
	Great Plains Earless Lizard	*Holbrookia maculata maculata*	U	U	III
	Plains Box Turtle	*Terrapene ornata ornata*	U	U	III
	Plains Black-headed Snake	*Tantilla nigriceps*	U	U	III
	Plains Gartersnake	*Thamnophis radix*	U	U	III
	Red-sided Gartersnake	*Thamnophis sirtalis parietalis*	U	U	III
	Valley Gartersnake	*Thamnophis sirtalis fitchi*	U	U	III
Crustaceans	Pilose Crayfish	*Pacifastacus gambelii*	2	Ab	II
	Ringed Crayfish	*Orconectes neglectus*	3	Bb	II
	Constricted Fairy Shrimp	*Branchinecta constricta*	U	U	II
	Mackin Fairy Shrimp	*Streptocephalus mackini*	U	U	II
	Calico/Papershell Crayfish	*Orconectes immunis*	4	Bc	III
	Devil Crayfish	*Cambarus diogenes*	U	U	III
	Beavertail Fairy Shrimp	*Thamnocephalus platyurus*	U	U	III
	Fairy, Tadpole, and Clam Shrimp (many species)		U	U	III
Mollusks	Plain Pocketbook	*Lampsilis cardium*	1	Aa	I
	Green River Pebblesnail	*Fluminicola coloradoensis*	U	U	I
	Mountainsnails (many species)		U	U	I
	California Floater	*Anodonta californiensis*	1	Aa	II
	Cylindrical Papershell	*Anodontoides ferussacianus*	2	Ab	II
	Jackson Lake Springsnail	*Pyrgulopsis robusta*	2	Ba	II
	Cave Physa	*Physa spelunca*	4	Bc	II
	Cooper's Rocky Mountainsnail	*Oreohelix strigosa cooperi*	4	Bc	II
	Aquatic Snails (many species)		U	U	II
	Land Snails (many species)		U	U	II
	Pygmy Mountainsnail	*Oreohelix pygmaea*	U	U	II
	Yavapai Mountainsnail	*Oreohelix yavapai*	U	U	II
	Ash Gyro	*Gyraulus parvus*	U	U	III
	Creeping Ancylid	*Ferrissia rivularis*	U	U	III
	Dusky Fossaria	*Fossaria dalli*	U	U	III
	Forest Disc	*Discus whitneyi*	U	U	III

	Giant Floater	*Pyganodon grandis*	U	U	III
	Marsh Rams-horn	*Planorbella trivolvis*	U	U	III
	Multirib Vallonia	*Vallonia gracilicosta*	U	U	III
	Pewter Physa	*Physa acuta*	U	U	III
	Pill or Fingernail Clams (many species)		U	U	III
	Prairie Fossaria	*Fossaria bulimoides*	U	U	III
	Quick Gloss	*Zonitoides arboreus*	U	U	III
	Rocky Mountain Mountainsnail	*Oreohelix strigosa*	U	U	III
	Stagnicola Pond Snails (many species)		U	U	III
	Subalpine Mountainsnail	*Oreohelix subrudis*	U	U	III
	Tadpole Physa	*Physa gyrina*	U	U	III
	Umbilicate Sprite	*Promenetus umbilicatellus*	U	U	III
	Western Glass-snail	*Vitrina pellucida*	U	U	III

SGCN Accounts and Database

Each SGCN is included in the SWAP and has a species account that provides information on the species and its conservation needs. A database was created to store this information as part of the 2010 revision of the SWAP. The database is intended to advance SGCN conservation efforts by facilitating the updating, searching, reporting, tracking, and sharing of information.

New for the 2017 SWAP revision, mammal and birds species accounts were authored by WGFD and WYNDD biologists. Wildlife Management sections within the species accounts were solely authored by the WGFD. Drafts of mammal and bird species accounts were reviewed by the WGFD's Statewide Nongame Bird and Mammal Program Supervisor. Fish, reptile, amphibian, mollusk and crustacean species accounts were are continually updated by WGFD fish and herptile biologists and reviewed by the Fisheries Management Coordinator.

At present, fish, reptile, amphibian, mollusk and crustacean species account includes the following information:

- The species' common and scientific name.
- Abundance – Abundant, Common, Uncommon, Unknown.
- Status – WGFD NSS rank with an explanation of matrix row (limiting factor) and column (population status) classification, NatureServe G rank (global chance of extinction), and WYNDD S rank (state chance of extinction).
- Introduction – information on the species' continental and Wyoming distributions and history in Wyoming, including current and past management activities, legal status, and life history information.
- Habitat – habitat locations and characteristics.
- Problems – list of threats to the species or its habitat.
- Conservation Action – actions needed for the long term conservation of the species in Wyoming.
- Monitoring/Research – information on both existing and needed monitoring and research to evaluate the species' population status and the effectiveness of conservation actions.
- Recent developments – recent conservation activities, research, policy direction, or legal decisions that have bearing on the future conservation of the species.
- Reference – literature cited within the species account, as well as leading research and conservation plans.
- Range and Distribution Maps – WYNDD and WGFD worked collaboratively to update range and distribution maps for SGCN.

At present, bird and mammal species accounts include the following information:

- The species's common and scientific name
- Abundance – Abundant, Common, Uncommon, Unknown.
- Status – WGFD NSS rank with an explanation of matrix row (limiting factor) and column (population status) classification, NatureServe G rank (global chance of extinction), and WYNDD S rank (state chance of extinction).
- Taxonomy – Information including a discussion of the most recent taxonomic organization
- Description – Information describing noteworthy features of continental- and state-scale distribution.
- Habitat - This section describes habitat associations of the taxon, with emphasis on Wyoming habitats andhow habitat use here differs from elsewhere in the taxon's range.
- Phenology - A brief summary of key phenological characteristics of the taxon.
- Abundance - Provides estimates of abundance at national and statewide scales.

- Population Trends - This section discusses trends in populations within Wyoming, and how these relate to national trends.
- Intrinsic Vulnerability - This section discusses aspects of the taxon's life history that may make it sensitive to impacts from Extrinsic Stressors, thus affecting its persistence through time.
- Extrensic Stressors - This section discusses the type, degree, and severity of current and likely potential stressors, as well as how those stressors might affect the taxon's persistence in Wyoming.
- Key Activities in Wyoming - A brief summary of recent, current, or pending projects pertaining directly to the target taxon in Wyoming (or, if appropriate, in nearby areas).
- Ecological Information Needs - This section provides a brief list of priority information needs that would best enhance our ecological understanding of the target taxon in Wyoming.
- Management in Wyoming - This section is authored solely by the WGFD and describes current management practices, decisions, and priorities employed by that agency for the taxon in Wyoming, including a brief summary of current or recent management or conservation actions pertaining directly to the target taxon in Wyoming (or, if appropriate, throughout thetaxon's range).

SGCN Range Maps

For the purposes of the SWAP, range was defined as the best estimate of the total geographic space thought to be occupied by an individual species in Wyoming. The first step in creating SGCN range maps was to reference a set of North American range maps compiled by NatureServe (http://www.natureserve.org/getData/animalData.jsp). These maps were essentially hand-drawn polygons representing a compilation of published continental-scale range maps for each species. These maps were then modified to fit high-resolution, 10-digit watershed (HUC) boundaries from the National Hydrography Dataset (Simley and Carswell 2009). This step provided a common spatial unit—the 10-digit HUC—for all SGCN range maps.

The HUC-based range maps were then reviewed and modified by WYNDD zoologists to accommodate local knowledge and documented occurrences maintained in the WYNDD Biotics Database and the WGFD Wildlife Observation System (WOS). A series of meetings was then convened to allow state and regional experts to provide detailed comments and modifications. The occurrence of a species within each watershed was classified into five categories: Known Recent Resident, Suspected Recent Resident, Accidental Occupant, Historical Resident, or Never a Resident. For SWAP SGCN range mapping purposes, "Known Recent Resident" and "Suspected Recent Resident" HUCs were considered to be within a species' range,[4] while "Accidental Occupant," "Historical Occupant," and "Never a Resident" HUCs were considered outside a species' range. Species ranges were mapped as the combined boundaries of "Known Recent Resident" and "Suspected Recent Resident" HUCs. Additional information about the SGCN range mapping process can be found in Keinath et al. (2010a).

SGCN Distribution Maps

For the purposes of the SWAP, distribution is defined as a spatial subset of range. It refers to environments within a species' range that are suitable for that species' occupation. In contrast to "range," which considers species presence based solely on geographic space,

[4] "Known Recent Resident" indicates that the species is known to occur in a watershed based on recently documented observations and/or the knowledge of expert range mapping participants. Observations made in 1985 or later qualified as recent. "Suspected Recent Resident" indicates that range mapping participants were not aware of any recent (i.e., 1985 or later) observations of a species in a watershed, but they believed the species to occur in the watershed at the time of mapping based on species characteristics and probable suitability of habitat within the watershed.

"distribution" considers habitats where species could occur based on measured environmental characteristics. Given incomplete knowledge of species occurrence for most SGCN, species distributions were estimated by modeling suitable environments. The distribution model for a given SGCN was created by first attributing points of known occurrence for that species with multiple environmental measurements (e.g., elevation, mean annual precipitation, vegetation type), then by extrapolating this data to identify similar environments across Wyoming using established statistical techniques (e.g., Beauvais et al. 2006).

Points of known occurrence were obtained from the WYNDD Biotics Database, the WGFD WOS, and several ancillary datasets compiled by WYNDD specifically for this effort. These sources resulted in roughly 270,000 SGCN locations, which were systematically evaluated and filtered for accuracy and consistency following methods developed at WYNDD (Keinath et al. 2010b). Environmental measurements were derived from a variety of publically available sources and generally fell within six major categories: climate, hydrology, land cover, landscape structure, substrate, and terrain. Details on these sources of information and how they were applied to distribution maps can be found in Keinath et al. (2010b).

Maximum Entropy methods were used to select important environmental variables and summarize the environment at points of known SGCN occurrence (Phillips et al. 2006, Phillips and Dudik 2008, Keinath et al. 2010b). The result is a continuous model that estimates, for 30-meter cells across Wyoming, the probability of that cell being suitable habitat for the SGCN in question. To create maps for the SWAP, a binary threshold was specified that divided the continuous output into two categories: predicted presence and predicted absence.

The quality of distribution models was evaluated using multiple methods, both quantitative and qualitative, including prediction accuracy based on ten-fold cross-validation, statistics derived from receiver-operating characteristic analyses, evaluations of input data quality, and the expert opinion of biologists regarding how well final models reflected their understanding of species' distributions (Fielding and Bell 1997, Freeman and Moisen 2008). Validation statistics are provided for each SGCN by Keinath et al. (2010b).

Range maps tend to overestimate where a species occurs, since range polygons generally include some unsuitable habitat. In contrast, locations of documented occurrence usually drastically underestimate where a species occurs, particularly when systematic survey efforts are lacking, as is the case for most SGCN. For example, some small-mammal and reptile SGCN have ranges encompassing more than half of Wyoming, while there are only a handful of documented occurrences in the state. Distribution models are intended to bridge this gap by using occurrence data to quantify the environments where a species is known to occur and spatially map similar areas within that species' range. Thus, distribution maps identify areas where a species could potentially occur based on current information and should not be interpreted as depicting known occurrence. Models are only as good as the data used to create them, so models with few known occurrences and/or poor validation statistics (Keinath et al. 2010b) should be used with caution. Further, SGCN distribution models were created at the state-level scale and are only suitable for analyses conducted at a similar scale, such as identifying coarsely-defined areas of conservation concern or quantifying state-wide patterns of potential distribution. With the exception of SGCN added in the 2017 SWAP revision distribution maps are largely those that were presented in the 2010 SWAP.

SGCN Monitoring

High priority is placed on completing sufficient inventories on those SGCN whose status could not be adequately documented in Wyoming. Bird and mammal SGCN are reviewed annually by the Terrestrial Nongame Section of the WGFD. Species with sufficient distribution and general abundance data to indicate status are included in the "inventories adequate" ranking total. However, any species that has limiting factors which appear to be increasing in severity, or that has been petitioned for listing under the ESA must have a system implemented for monitoring population trends before it is included in the adequate ranking category. If such a monitoring program is lacking, WGFD develops proposals and solicits needed funding but does not include them in

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Appendix A

SGCN Prioritization Variable Descriptions

Descriptions are not intended to be exclusive, but to serve as a guide regarding the type of information that should be considered in providing a prioritization score.

WGFD NSS Rank – the Wyoming Game and Fish Department (WGFD) Native Species Status (NSS) rank is an evaluation of the Wyoming population status of a species, including its size and distribution, versus limiting factors such as habitat availability and intensity of threats. NSS rank also indentifies species where there is a lack of information to adequately assess conservation status.

Regulatory/Monetary Impacts – extent of potential regulatory or monetary impacts of a species' listing under the Endangered Species Act (ESA).

Consideration could include:

1. Size of the species' range and overlap with other land uses.
2. Current economic contribution of the species (both consumptive and non-consumptive).
3. Type of restrictions necessary to address the species' conservation needs.

Urgency of Conservation Action – accounts for issues associated with the immediacy of the need for conservation action. This variable would capture issues that either occurred subsequent to the designation of the species' NSS rank or that were not considered. These issues may include:

1. New threats.
2. Increases in severity of existing threats.
3. New data that show a significant, persistent decline in the species' population, distribution, or habitat.
4. Likelihood and immediacy of potential ESA listing.

5. Funding or partnership opportunities that are time limited.

Wyoming's Contribution to the Species' Overall Conservation – this variable would address the significance of the role that Wyoming would likely play in the species' overall conservation. It would take into consideration:

1. The Wyoming Natural Diversity Database (WYNDD) G rank (global chance of extinction) and Wyoming Conservation Contribution score.
2. The proportion of the species' overall range that is in Wyoming.
3. The health and size of the species' population in Wyoming compared to those in other portions of its range.
4. Population status and level of conservation activity in surrounding states and other portions of the species' range.

Ability to Implement Effective Conservation Actions – the ability to achieve quantifiable beneficial outcomes in stopping or reversing population declines for the species in Wyoming. This variable includes an evaluation of statutory, scientific, or technological limitations in reversing leading population and habitat threats.

The species' ecological or management role as a keystone, indicator species, or umbrella species. Indicator species are those species whose population status is a good indicator of the overall health of the habitat it occupies. A keystone species is a species that plays a significant role in shaping and defining the habitat in which it lives. Umbrella species are species selected for making conservation-related decisions, typically because protecting these species indirectly protects the many other species that make up the ecological community of its habitat.

Appendix B

Taxonomy of SGCN Bird and Mammals

Mammals

The Wyoming Game and Fish Department uses the Revised Checklist of North American Mammals North of Mexico (Bradley et al. 2014) as the taxonomic reference for mammals in Wyoming. The checklist, first published in 1973, undergoes periodic review and summarizes taxonomic changes that have occurred in the recognized mammalian fauna of North America. According to the checklist, the taxonomy of several mammalian groups remains unresolved at the species level; consequently it is difficult to provide support for elevating subspecies to specific status. Therefore, the WGFD gives no consideration to specific subspecies in Wyoming at this time, except for the Preble's meadow jumping mouse (*Zapus hudsonius preblei*). The taxonomy issue was resolved following the publication of the checklist by King et al. (2006); consequently this subspecies warrants specific status in this revised SWAP.

Bradley, R.D., L.K. Ammerman, R.J. Baker, J.A. Cook, R.C. Dowler, C. Jones, D.J. Schmidley, F.B. Stangl, R.A. Van Den Bussche, and B. Wursig. 2014. Revised checklist of North American mammals north of Mexico, 2014. Museum of Texas Tech University. Occasional papers 327.

King, T.L., M. S. Eackles, and C.C. Young. 2006. Microsatellite DNA markers for assessing phylogeographic and population structure in Preble's meadow jumping mice (*Zapus hudsonius preblei*) and cross-amplification among neighbouring taxa. Molecular Ecology 6:670-673.

Birds

The American Ornithologists' Union (AOU) Check-list of North American Birds, 7th Edition (AOU 1983) is the official source on the taxonomy of the birds of North and Middle America. In addition, AOU Supplements to the Check-list provide annual updates based on the most recent scientific findings, and are published each July in the scientific journal *The*

Auk. The Check-list of North American Birds and its supplements are produced by the AOU's North American Classification Committee (NACC), whose mission is to keep abreast of the systematics and distribution of the birds of North and Middle America in order to create a standard classification. The NACC favors using more than one area of evidence over single data sets for taxonomic changes at species and higher levels (e.g., multiple genetic loci, or genes plus other traits), and prefers to act conservatively in its treatments of taxonomy and nomenclature. Thus, without supporting data, the NACC may reject proposals that cause instability or that suggest taxonomic change without strong substantiation.

The Wyoming Game and Fish Department uses the AOU Check-list of North American Birds, along with its annual supplements, as the definitive source for avian scientific and common names, species codes, subspecies delineations, and order in which species appear on the official State list. This document recognizes the fifty-seventh supplement of the AOU checklist (AOU 2016)Currently, there are no occurrences of avian subspecies in Wyoming that would alter the Species of Greatest Conservation Need Tier ranking.

American Ornithologists' Union. 1983. Check-list of North American Birds. 7th edition. American Ornithologists' Union, Washington, D.C.

American Ornithologists' Union. 2016. Fifty-seventh supplement to the American Ornithologists' Union check list of North American Birds. Auk 133:544-560

Columbia Spotted Frog - Rana luteiventris

Abundance: Rare

Status: NSS3 (Bb) NatureServe: G4 S3

Population Status: Vulnerable due to restricted distribution. Populations appear stable, but declines have been documented in the Pacific NW, Nevada, and Utah.

Limiting Factor: Disease: chytrid fungus has been shown to affect populations of this species.

Comment: None.

Introduction

Columbia Spotted Frogs may be observed in Wyoming's NW mountain ranges and in the Bighorn Mountains. The Bighorn Mountain population is disjunct from other Spotted Frog populations and is concentrated around the Tongue River Watershed. Chytrid fungus was recently documented in the Bighorn Mountains. This is of concern for Columbia Spotted Frogs, as the Bighorn Mountain population represents a disjunct population and population declines could be detrimental to the species' persistence in this area. Spotted Frogs may become active in early May (Baxter and Stone 1985). However, time of emergence can be delayed by increased elevation and latitude. Following emergence, adults will travel to breeding locales. Breeding habitat consists primarily of permanent lentic habitats, but could include ephemeral pools (Reaser and Pilliod 2005). After ice recedes from breeding sites, females lay on average 600 eggs in shallow water. Tadpoles often mature in mid to late summer. Juveniles require two to five years to reach sexual maturity. Columbia Spotted Frogs remain close to water during the breeding season, but may wander after breeding is concluded (Patla and Keinath 2005). The preferred diet of this species includes earthworms, mollusks, and crustaceans. Columbia Spotted Frogs overwinter in springs, seeps, beaver dams, and soft pond substrates.

Habitat

Columbia Spotted Frogs can be found in foothill and montane zones within pooled to flowing wetlands, small streams, lake margins, moist forests, and moist meadows. Columbia Spotted Frogs remain close to water during the breeding season, but may wander after breeding is concluded (Patla and Keinath 2005).

Problems

- Habitat changes and other factors may be adversely affecting this species, but lack of data precludes identification of specific problems and development of management recommendations.
- Population status, distribution, habitat data, and disease status are lacking for this species.
- Alteration of aquatic habitats needed for breeding may adversely affect populations.

Conservation Actions

- A systematic study of this species should be conducted with respect to distribution, abundance, habitat associations, and disease status within Wyoming.
- Continue efforts to educate landowners and the public about the importance of amphibians.
- Develop management recommendations based on survey data.

Monitoring / Research

Conduct baseline surveys to gain better understanding of species distribution within the state. Conduct annual monitoring on Bighorn Mountain populations to ensure persistence and to test for chytrid fungus.

Recent Developments

Baseline surveys were conducted in the Shoshone National Forest in 2013 and 2014. Historical records of Columbia Spotted Frogs have been verified in the Bighorn National Forest (Estes-Zump et al. 2012). Chytrid fungus was recently documented in the Bighorn Mountains for the first time. This is of concern for Columbia Spotted Frogs, as the Bighorn Mountain population represents a disjunct population and population declines could be detrimental to the species' persistence in this area. Amphibians have received increased attention within Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

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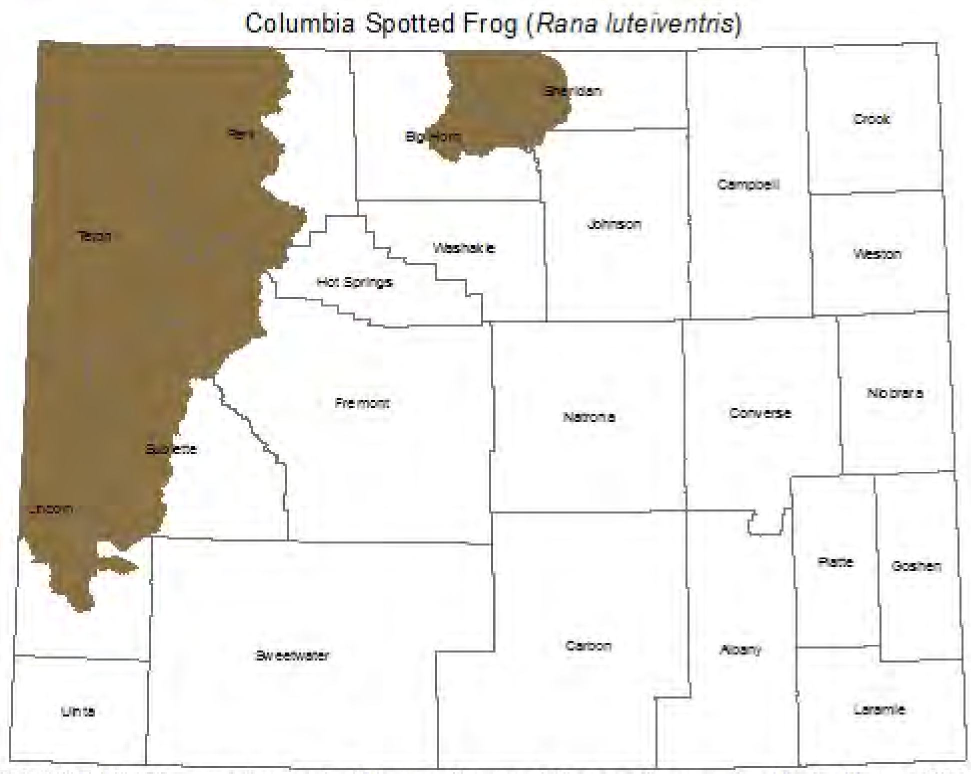

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Great Basin Spadefoot - Spea intermontana

Abundance: Abundant

Status: NSS4 (Bc) NatureServe: G5 S3

Population Status: Restricted distribution, population numbers appear abundant in places. Threats are moderate, but may be increasing across the landscape.

Limiting Factor: Habitat - requires water for breeding and loose soils for burrowing.

Comment: Changed from NSSU to NSS4(Bc) due to what we have learned about the species over the past 6 years.

Introduction

In Wyoming, the Great Basin Spadefoot's distribution includes most of Sweetwater County (including the Great Divide Basin) and parts of Fremont, Natrona, Lincoln, and Sublette Counties (Baxter and Stone 1985). Spadefoot toads are insectivorous and active primarily at night. As an adaptation to arid conditions, they live in underground burrows for most of the year, emerging only to breed or forage. They dig their own burrows or use those of small mammals. The Great Basin Spadefoot has a short "explosive" breeding season, depending on the availability of temporary and permanent water sources. In Wyoming, this season typically can be from April to July when water is available and temperatures are warm. During the breeding season, males produce mating calls that can carry at least 1.5km on quiet nights. Breeding aggregations are usually brief and may be triggered by rainfall (Stebbins 2003). The female deposits about 300 to 500 eggs in small packets of 20 to 40 eggs each (Morey 2005). Eggs probably hatch in 2 to 7 or more days. Tadpoles metamorphose in 36 to 60 days (Morey and Reznick 2004). The distance adults may travel from underground burrows to breeding sites is unknown, though they can at least travel several hundred meters.

Habitat

The Great Basin Spadefoot is a xeric-adapted amphibian. It lives in sagebrush flats and semidesert shrublands in Wyoming. It requires loose, sandy soil for burrowing and may make its own burrow or use pre-existing rodent burrows (Stebbins 2003). Great Basin Spadefoots also require permanent or temporary water sources for breeding (e.g., playas, springs, seeps, ponds, reservoirs, riverine areas, roadside puddles, irrigation ditches, rain pools, flooded fields). Breeding sites (water sources) may be variable and differ each year, depending on water levels and precipitation. Successful breeding usually occurs in wetlands or areas in wetlands that do not contain predatory fish.

Problems

- Population status, distribution, habitat data, and disease status are lacking for this species.
- Alteration of aquatic habitats needed for breeding may adversely affect populations.
- Alteration of terrestrial hibernating, foraging, and dispersal areas may adversely affect populations.
- Environmental pollutants (pesticides, herbicides, fertilizers, and other toxins) may adversely affect populations.
- Habitat fragmentation from roads may hinder movements (Buseck et al. 2005).
- Development could compact soils and limit burrowing.

Conservation Actions

- A systematic study of this species should be conducted with respect to distribution, abundance, habitat associations, and disease status within Wyoming.
- Develop management recommendations based on survey data.
- Continue efforts to educate landowners and the public about the importance of amphibians.

Monitoring / Research

Survey and monitor population distribution, status, and habitat associations within the Great Basin Spadefoot range in Wyoming.

Recent Developments

Surveys for Great Basin Spadefoots and their associated habitats were conducted in 2009 and 2010 in southwest Wyoming (Snoberger and Walker 2012). During these surveys, 50 previously unknown populations of Great Basin Spadefoots were documented, almost doubling the number of known populations in the state. The known range of the species was updated as a result of these observations (Snoberger and Walker 2012). Genetic samples for both Great Basin Spadefoots and Plains Spadefoots have been collected across the state since 2011 in order to determine if these species' ranges overlap or if these species interbreed. Amphibians have received increased attention within Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

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Snoberger, C.E. and Z.J. Walker. 2012. Great Basin Spadefoot surveys in southwest Wyoming 2009-2010. Wyoming Game and Fish Administrative Report. Cheyenne, Wyoming.

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

Great Plains Toad - Anaxyrus cognatus

Abundance: Unknown

Status: NSSU NatureServe: G5 S3

Population Status: Restricted distribution, population numbers and threats are unknown

Limiting Factor: Habitat: requires water for breeding and plains habitat.

Comment: Formerly Bufo cognatus.

Introduction

Great Plains Toads may be found in northeastern Wyoming, but have not been found west of the Continental Divide (Baxter and Stone 1985). This species probably inhabits most of the northeastern counties. Relatively little is known concerning abundance and distribution of this species within the state, though recent surveys greatly increased known populations in Wyoming. Great Plains Toads typically become active following heavy spring rains. After emergence, this species typically travels to breeding locales. Breeding may occur from May to July, depending on local precipitation events. Great Plains Toads are considered explosive breeders. Breeding activity is often triggered by heavy spring or summer rain events. Female Great Plains Toads will lay approximately 2000 eggs in a breeding. Females may produce multiple clutches in a given active season. Eggs typically hatch within 2-7 days, and larvae will metamorphose in 17-45 days. Adult Great Plains Toads forage nocturnally for moths, caterpillars, cutworms, flies, beetles, and other small invertebrates.

Habitat

The Great Plains Toad lives in the grasslands, sand hills and agricultural areas below 6,000 feet in elevation. Flooded ephemeral wetlands are the preferred breeding habitat, but permanent and slow moving waters may be utilized (Graves and Krupa 2005).

Problems

- Alteration of aquatic habitats needed for breeding may adversely affect populations.
- Habitat changes and other factors may be adversely affecting this species, but lack of data precludes identification of specific problems and development of management recommendations.
- Population status, distribution, habitat data, and disease status are lacking for this species.

Conservation Actions

- A systematic study of this species should be conducted with respect to distribution, abundance, habitat associations, and disease status within Wyoming.
- Continue efforts to educate landowners and the public about the importance of amphibians.
- Develop management recommendations based on survey data.

Monitoring / Research

Conduct baseline surveys to gain better understanding of species distribution within the state.

Recent Developments

Amphibian surveys were conducted in northern Wyoming in 2013 and 2014. During these surveys, many new populations of Great Plains Toads (>30) were documented via nocturnal auditory surveys. Of all the chytrid fungus samples tested from Wyoming since 2002, only one Great Plains Toad has tested positive for chytrid fungus (out of only four samples).
Amphibians have received increased attention within Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

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Great Plains Toad (*Anaxyrus cognatus*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Northern Leopard Frog - Lithobates pipiens

Abundance: Abundant, but declining

Status: NSS4 (Bc) NatureServe: G5 S3

Population Status: Once widely distributed, but rangewide declines have been documented. Some populations may be recovering. Extirpation is not eminent.

Limiting Factor: Habitat: declines in habitat quality have resulted in increased mortality. Similar or increased levels of chemical runoff (pesticides, herbicides, and household chemicals) likely to continue. However, no one factor can be attributed to species decline.

Comment: Changed from NSSU to NSS4(Bc) due to what we have learned about the species over the past 6 years. Formerly Rana pipiens.

Introduction

The Northern Leopard Frog is historically one of the most common and widespread anurans in the United States. However, populations are known to be declining throughout its range. Northern Leopard Frogs may be found throughout Wyoming, but have experienced documented declines in the Greater Yellowstone Ecosystem and Laramie plains. Northern Leopard Frogs become active after water temperatures exceed 50 degrees Fahrenheit. The breeding season can extend from mid-March through July. Females typically deposit 600-7,500 eggs in a tight oval mass (Rorabaugh 2005). Depending on temperature, larval metamorphosis often occurs 3-6 months following egg deposition. In higher elevations, tadpoles may not metamorphose before winter. In Wyoming, Northern Leopard Frogs are not believed to overwinter as tadpoles (Baxter and Stone 1985). Northern Leopard Frogs actively forage among sedges, cattails, and tall grasses. Primary food items are invertebrates (beetles, flies, ants, worms, snails, etc.); however adult frogs will sometimes consume voles, small birds, snakes, and other amphibians (Baxter and Stone 1985). Resting near pond and lake margins, this species will quickly leap into the water if alarmed. Northern Leopard Frogs are known to winter in ponds, buried in mud. In many cases, they use a shallow pond for breeding and deep pools to hibernate.

Habitat

The Northern Leopard Frog can be found in or near permanent water in the plains, foothills, and montane zones (Smith and Keinath 2007). They can range to over 8,500 feet in elevation. Their preferred habitats are swampy cattail marshes on the plains and beaver ponds in the foothills and montane zones.

Problems

- Habitat changes and other factors may be adversely affecting this species, but lack of data precludes identification of specific problems and development of management recommendations.
- Population status, distribution, habitat data, and disease status are lacking for this species.
- Alteration of aquatic habitats needed for breeding may adversely affect populations.

Conservation Actions

- A systematic study of this species should be conducted with respect to distribution, abundance, habitat associations, and disease status within Wyoming.
- Continue efforts to educate landowners and the public about the importance of amphibians.
- Develop management recommendations based on survey data.

Monitoring / Research

Conduct baseline surveys and chytrid sampling to gain better understanding of species distribution and disease status within the state. Monitoring should be conducted on known populations to ensure species viability.

Recent Developments

Baseline surveys have been conducted in southwest, southeast, and northern Wyoming to better understand herpetofaunal assemblages and distribution (Snoberger and Walker 2012, 2013, 2014). Many new populations (>35) were documented during these surveys. Northern Leopard Frogs have been tested for chytrid fungus across the state and several of these samples have tested positive for the fungus across the state. Chytrid-caused deaths have been documented in southeastern Wyoming (Snoberger and Walker 2013). Northern Leopard Frog monitoring has been conducted in the Powder River Watershed in conjunction with Coal Bed Methane discharge. Baseline surveys have been conducted for this species in Bighorn National Forest (Estes-Zump et al. 2012). Amphibians have received increased attention within Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

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Northern Leopard Frog (*Lithobates pipiens*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

Plains Spadefoot - Spea bombifrons

Abundance: Abundant

Status: NSS4 (Bc) NatureServe: G5 S4

Population Status: Widely distributed within known range, populations appear abundant in places. Limiting factors are moderate, but may be increasing across the landscape.

Limiting Factor: Habitat: requires water for breeding and loose soils for burrowing.

Comment: Changed from NSSU to NSS4(Bc) due to what we have learned about the species over the past 6 years.

Introduction

The Plains Spadefoot Wyoming range includes all eastern and central counties, as well as the Big Horn Basin (Baxter and Stone 1985). Within Natrona and Carbon Counties, the Plains Spadefoot's range meets the range of the Great Basin Spadefoot. However, ranges of these two species are thought to abut and not overlap. As an adaptation to arid habitats, Plains Spadefoots spend most of their lives in underground burrows. Because of this habit, spadefoots are commonly found in loose well drained soils. Plains Spadefoots emerge from their burrows during moist humid nights to forage on spiders, moths, ants, beetles, and other invertebrates. The Plains Spadefoot usually waits for heavy rains or irrigation runoff to fill roadside ponds, stock tanks, and other ephemeral pools before breeding. Although permanent bodies of water may be utilized for breeding, this species prefers ephemeral water. Breeding activity occurs from May through July. Eggs are deposited in elliptical masses of 250 or more ova. Egg masses are attached to submerged vegetation. Eggs hatch in two to three days and larvae usually complete transformation in 36 to 40 days.

Habitat

The Plains Spadefoot prefers plains grasslands and sagebrush communities below 6,000 feet in elevation. It prefers loose and well drained soils that can be found in floodplains, prairies, and loess hills (Farrar and Hey 2005).

Problems

- Alteration of aquatic habitats needed for breeding may adversely affect populations.
- Development could compact soils and limit burrowing.
- Habitat changes and other factors may be adversely affecting this species, but lack of data precludes identification of specific problems and development of management recommendations.
- Population status, distribution, habitat data, and disease status are lacking for this species.

Conservation Actions

- A systematic study of this species should be conducted with respect to distribution, abundance, habitat associations, and disease status within Wyoming.
- Continue efforts to educate landowners and the public about the importance of amphibians.
- Develop management recommendations based on survey data.

Monitoring / Research

Conduct baseline surveys to gain better understanding of species distribution within the state.

Recent Developments

Baseline surveys have been conducted in southeast and northern Wyoming to better understand herpetofaunal assemblages and distribution (Snoberger and Walker 2013). Many new populations were documented during these surveys. Genetic samples for both Plains Spadefoots and Great Basin Spadefoots have been collected across the state since 2011 in order to determine if these species' ranges overlap or if these species interbreed. Plains Spadefoots have been tested for chytrid fungus across the state. None of these samples have tested positive for the fungus thus far. Amphibians have received increased attention within Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

Baxter, G.T. and M.D. Stone. 1985. Amphibians and Reptiles of Wyoming. Second Edition. Wyoming Game and Fish Department, Cheyenne. 137pp.

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Plains Spadefoot (*Spea bombifrons*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Western Tiger Salamander - Ambystoma mavortium

Abundance: Common

Status: NSS4 (Bc) NatureServe: G5 S4

Population Status: Widely distributed, populations appear stable.

Limiting Factor: Habitat: habitat fragmentation and energy development have resulted in habitat loss. Disease is also a likely limiting factor for this species.

Comment: Changed to a SGCN species from the 2010 SWAP. Three subspecies are incorporated into this account. A. m. melanostictum, A. m. mavortium, and A. m. nebolosum.

Introduction

In Wyoming, the Western Tiger Salamander is found throughout the state at elevations lower than about 10,000 feet (Baxter and Stone 1985). Western Tiger Salamanders are primarily active from March to September. From March to June, adults migrate to temporary or permanent ponds with shallow water to breed. Eggs are adhered to submerged vegetation singly or in clusters of up to 20. Larvae are abundant in ponds from late May to August. Larval salamanders are sometimes referred to as waterdogs or mudpuppies. Larval transformation into adults may occur within a few months. However, in colder conditions larvae may overwinter and not mature until 2-3 years of growth. Larvae feed on aquatic invertebrates when small, but become predacious and sometimes cannibalistic when larger. Adults eat insects, earthworms, and other small invertebrates. Western Tiger Salamanders may remain in a paedomorphic form (an adult with larval characteristics). Three subspecies of the Western Tiger Salamander occur within the state. Because all subspecies have similar life histories and large integration zones, they have been reported at the species level.

Habitat

In Wyoming, Western Tiger Salamanders can be found in rodent burrows, cellars, window wells, and manure heaps, where they can escape desiccation (Baxter and Stone 1985). The adult form is primarily terrestrial except during the breeding season in the spring and summer. However, a fairly moist environment is required. Larvae may be found in intermittent streams, ponds, lakes, and stock troughs.

Problems

- Mountain lakes formerly inhabited by tiger salamanders may experience population declines after the stocking of trout, which can consume larval populations
- Under certain conditions, larval populations may be vulnerable to bacterial infections associated with livestock grazing
- Diseases such as Ambystoma tigrinum virus and Regina ranavirus have been implicated in massive die-off events. There are also reports of Batrachochytrium dendrobatides infections of tiger salamanders, although it is possible that they are sub-lethal
- Natural resource development, especially coal bed methane mining, has the potential to change the landscape in a manner that could negatively affect tiger salamanders
- Salamanders make large coordinated movements to breeding sites, which put them in danger of road mortalities. Interruption of normal movement paths can severely impact tiger salamander populations

Conservation Actions

- A systematic study of this species should be conducted with respect to distribution, abundance, habitat associations, and disease status within Wyoming.
- The disease status of the Western Tiger Salamander in Wyoming needs to be studied
- Continue efforts to educate landowners and the public about the importance of amphibians.
- Develop management recommendations based on survey data.

Monitoring/Research

Conduct baseline surveys to gain better understanding of species distribution within the state. Monitor known areas of ranavirus outbreak to determine effect of disease on local populations.

Recent Developments

Amphibians have received increased attention within Wyoming. Incidental observations are encouraged to be reported to the herpetology program. Ranavirus has been documented in populations of Western Tiger Salamander associated with Coal Bed Methane discharge in the Powder River drainage. Many new populations of Western Tiger Salamanders (>30) have been documented over the past seven years. Several of these populations have been tested for chytrid fungus and only six sites have tested positive for the fungus over the past 13 years.

References

Baxter, G.T. and M.D. Stone. 1985. Amphibians and Reptiles of Wyoming. Second Edition. Wyoming Game and Fish Department, Cheyenne. 137pp.

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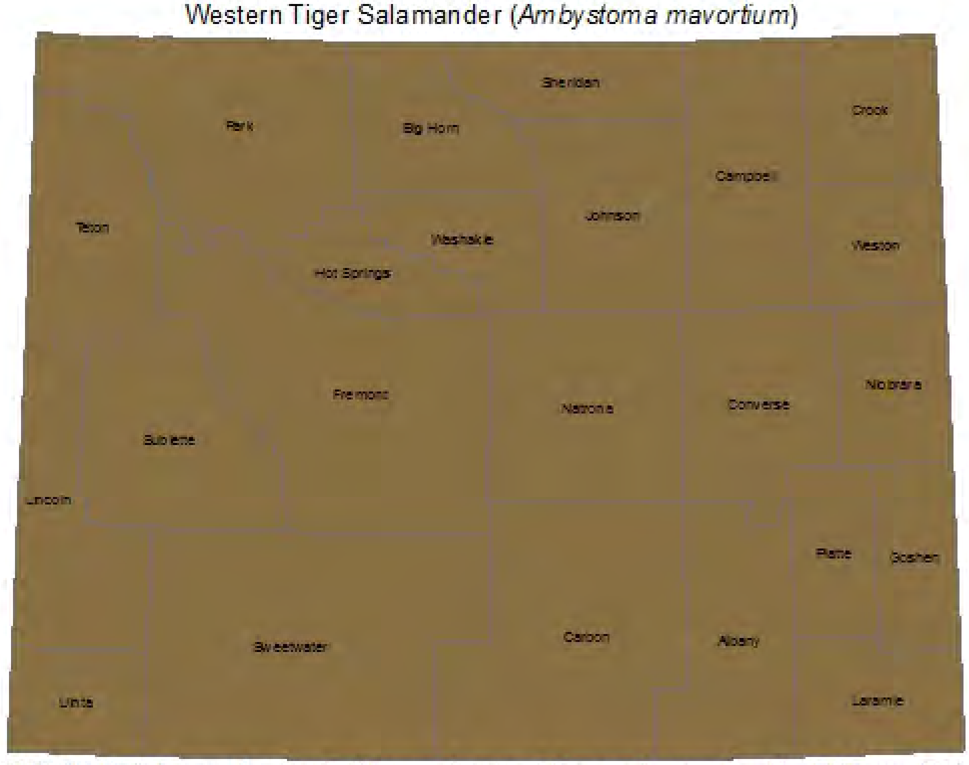
Western Tiger Salamander (*Ambystoma mavortium*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Western Toad (Boreal Toad) - Anaxyrus boreas boreas

Abundance: Extremely rare

Status: NSS1 (Aa) NatureServe: G4 S1

Population Status: Imperiled dut to greatly restricted numbers, extirpation is possible.

Limiting Factor: Disease: chytrid fungus (Batrachochytrium dendrobatidi) is thought to be the primary reason for recent mass die-offs.

Comment: The common name was changed from Boreal Toad to Western Toad.

Introduction

The Western (boreal) Toad is thought to have two distinctive population segments in Wyoming, a northern Rocky Mountain population and a southern Rocky Mountain population. The northern population is located in the western part of the state (Fremont, Hot Springs, Lincoln, Park, Sublette, and Uinta Counties, including Yellowstone National Park). The southern population is located in the southeastern portion of the state (Albany, Carbon and Laramie Counties). Although chytrid fungus is of concern throughout both population segments, southern populations are of increased concern. Mass die-offs have been attributed to chytrid fungus within the Laramie, Medicine Bow, and Sierra Madre Mountain ranges. Both geographic isolation and disease are significant concerns for the Southern Rocky Mountain population segment (Keinath and McGee 2005). In 2011, either the Eastern population or the Southern Rocky Mountain population of Western (boreal) Toads was petitioned to be listed as an endangered species under the Endangered Species Act as a distinct population segment and a listing decision should be made by 2017. Western (boreal) Toads typically emerge shortly after snow melt, and are often diurnally found in association with water. However, this species often nocturnally visits more terrestrial habitats to forage (Baxter and Stone 1985). Western (boreal) Toads feed primarily on ants, beetles, moths, and other invertebrates. Breeding can occur from April to early August depending on climatic conditions and elevation. On average, 5,200 eggs are deposited in double-rowed strings in shallow water. Egg incubation and development times are temperature dependent and may take as long as 92 and 45 days respectively. Due to long incubation times, some tadpoles may not metamorphose before winter (typically over 10,500 feet in elevation). It is not thought that tadpoles are able to overwinter in Wyoming (Baxter and Stone 1985).

Habitat

In Wyoming, the Western (boreal) Toad inhabits wet areas in foothills, montane, and subalpine zones from 6,500 to 11,500 feet in elevation (Baxter and Stone 1985). Western (boreal) Toads are usually found in association with water sources such as beaver ponds and streams. However, this species often nocturnally visits more terrestrial habitats to forage (Baxter and Stone 1985).

Problems

- Western (boreal) Toad populations appear to be in a state of severe decline. Factors that may contribute to perceived declines include habitat alteration, pollutants, climatic changes, and pathogens. However, at this time, chytrid fungus is considered to be the major contributing factor. In the southern Rocky Mountain population segment, this fungus has been linked to recent mass die-offs.

Conservation Actions

- A systematic study of this species should be conducted with respect to distribution, abundance, habitat associations, and disease status within Wyoming.
- With populations in decline, additional research needs to focus on methods to retain existing populations. Data from this research is required to create management strategys for recovery.
- The basic biology and transmission of Batrachochytrium dendrobatidis (chytrid) needs to be studied

Monitoring/Research

Monitoring should occur at known populations of Western (boreal) Toads. Surveys should incorporate protocols to examine chytrid fungus prevalence. Studies should be conducted that examine possible habitat factors resulting in Western (boreal) Toad decline and results should be incorporated into repatriation projects. Rangewide surveys should be conducted to discover previously unknown populations of Western (boreal) Toad.

Recent Developments

Annual monitoring of known populations has been performed in the Medicine Bow Mountains. Surveys were conducted within the Green River watershed to verify populations of Western (boreal) Toad after native fish restorations. Surveys were conducted in 2015, 2016, and 2017 in the Shoshone National Forest to verify Western (boreal) Toad populations, to test for chytrid fungus, and to collect genetic samples. Surveys were conducted to verify old observation records and to collect genetic samples in the Medicine Bow, Laramie, and Sierra Madre Mountain ranges. Surveys were conducted on the Bridger-Teton National Forest to document breeding locations and to collect genetic samples.
The Wyoming Game and Fish Department has contributed funding towards a study of the genetics of Western (boreal) Toads, with the hopes of better elucidating the boundaries of any potential distinct population segments. This information will hopefully assist in the potential Endangered Species Act listing.
A graduate project began in 2015 focusing on Western (boreal) Toads on the Bridger-Teton National Forest. The objectives of this project are to assess Western (boreal) Toad movement, habitat selection, disease status, and adult survival across a gradient of livestock grazing intensity.
Wyoming has participated with the Boreal Toad recovery program, which was initiated by the state of Colorado. The Wyoming Game and Fish Department is also working with several other state and federal agencies on rewriting the conservation plan for the Southern Rocky Mountain Boreal Toad population.

References

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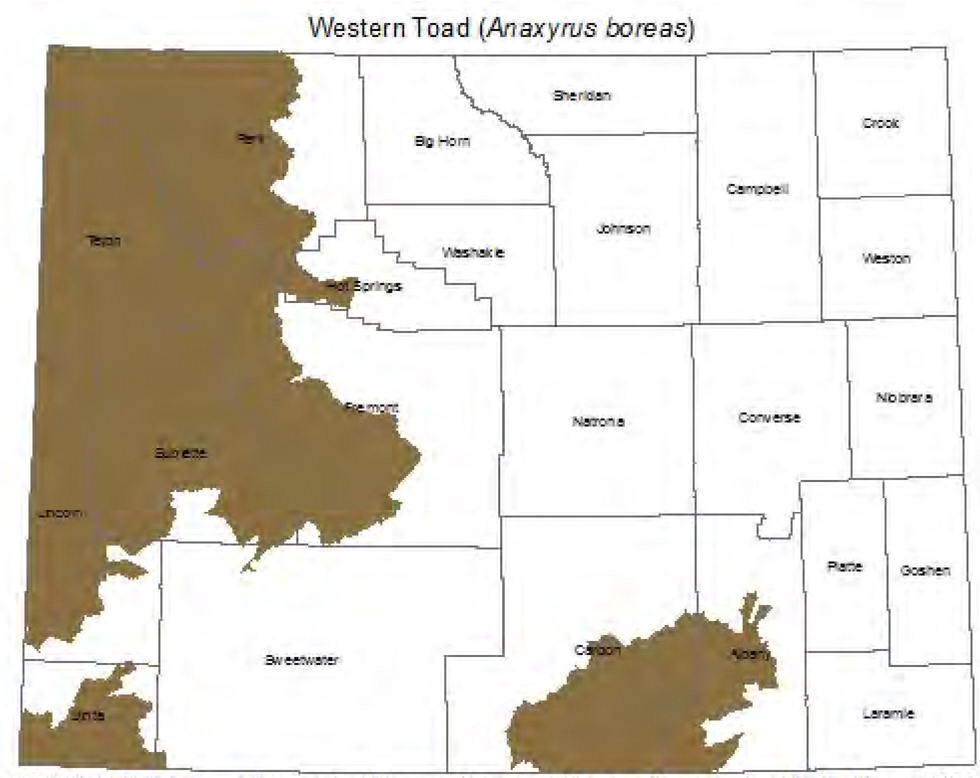

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Wood Frog - Lithobates sylvaticus

Abundance: Rare

Status: NSS2 (Ba) NatureServe: G5 S1

Population Status: Vulnerable due to greatly restricted distribution, but extirpation is not eminent.

Limiting Factor: Habitat: habitat fragmentation and other anthropogenic factors have resulted in declines of habitat quality and resulted in increased mortality. No one factor can be attributed to species decline.

Comment: Formerly Rana sylvatica.

Introduction

In Wyoming, Wood Frogs may be found in the Medicine Bow and Bighorn Mountains. Both of these populations are considered glacial relict populations (Muths et al. 2005). General appearance of this species varies upon location. Medicine Bow populations exhibit a white dorsal stripe, while Bighorn populations remain uniform in dorsal coloration. Wood Frogs typically emerge and begin breeding shortly after the snow and ice melts from high elevation ponds and lakes. This often occurs mid June to early July (Baxter and Stone 1985). Breeding habitats primarily consist of ephemeral fishless pools, but may include slow moving streams and beaver ponds. Eggs are typically deposited in communal clusters. Each egg mass contains approximately 300-1,500 ova (Redmer and Trauth 2005). In Wyoming, larval metamorphosis is often completed by early August (Baxter and Stone 1985). Juvenile males mature in 1-2 years, while females mature in 2-3 years (Redmer and Trauth 2005). Wood Frogs feed on insects, worms, spiders, and other invertebrates. Wood Frogs are a freeze tolerant species, and are the northernmost distributed anuran in North America. This species typically overwinters terrestrially near the soil surface.

Habitat

Wood frogs prefer beaver ponds, slowly moving streams, small lakes, wet meadows, and willow thickets in the montane zones. Populations are usually found around 9,000 feet in elevation. Breeding habitats primarily consist of ephemeral fishless pools, but may include slow moving streams and beaver ponds. This species typically overwinters terrestrially near the soil surface.

Problems

- Alteration of aquatic habitats needed for breeding may adversely affect populations.
- Habitat changes and other factors may be adversely affecting this species, but lack of data precludes identification of specific problems and development of management recommendations.
- Population status, distribution, habitat data, and disease status are lacking for some populations of this species.

Conservation Actions

- A systematic study of this species should be conducted with respect to distribution, abundance, habitat associations, and disease status within Wyoming.
- Continue efforts to educate landowners and the public about the importance of amphibians.
- Develop management recommendations based on survey data.

Monitoring / Research

Conduct baseline surveys and test for chytrid fungus to gain better understanding of species distribution and disease status within the state. Monitor known populations of Wood Frog within Wyoming's northern and southern populations.

Recent Developments

Surveys were performed in the Bighorn Mountains in an attempt to verify historic Wood Frog observations (Estes-Zumpf et al. 2012). Annual monitoring has been conducted in the Medicine Bow National Forest at known Wood Frog populations. Amphibians have received increased attention within Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

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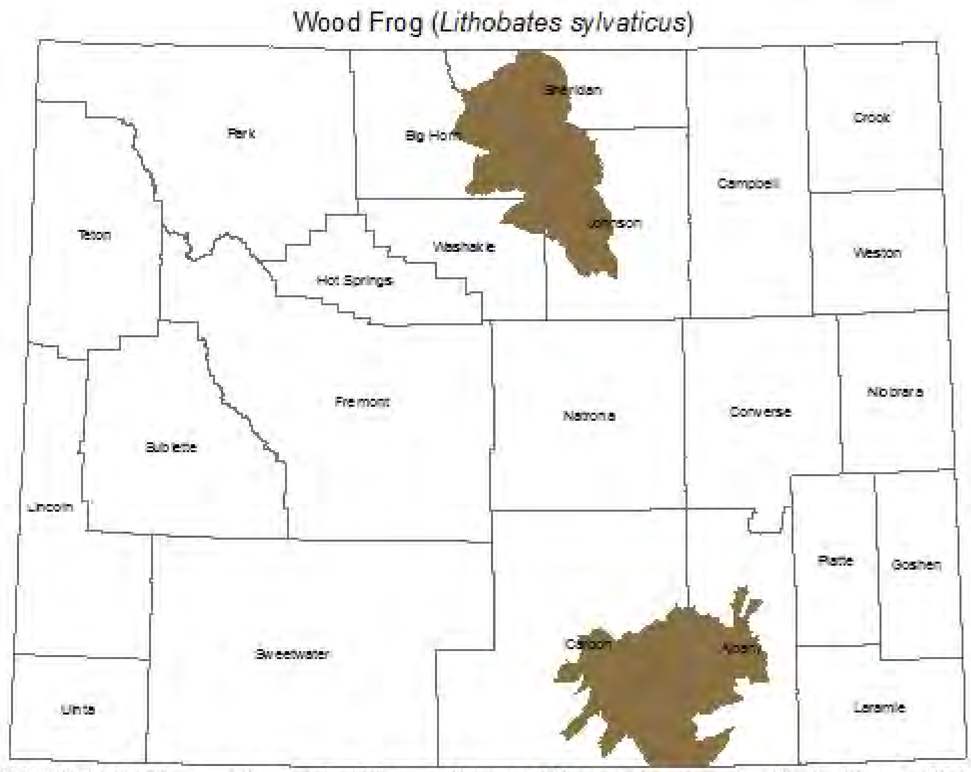

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Wyoming Toad - Anaxyrus baxteri

Abundance: Extremely rare

Status: NSS1 (Aa) NatureServe: G1 S1

Population Status: Imperiled due to greatly restricted numbers and distribution, extinction is possible. This species is federally listed as endangered.

Limiting Factor: Habitat: habitat modification, loss, and alterations in land use have resulted in severely restricted range.

Comment: Formerly Bufo baxteri.

Introduction

Wyoming Toads are currently restricted to Albany County, Wyoming. Historically, this species was observed in the floodplains of the Big and Little Laramie Rivers (Odum and Corn 2005). In the mid 1970's, Wyoming Toad populations experienced drastic declines. The exact cause of these declines is unknown, but possible causes include aerial spraying of pesticides, chytrid fungus, other diseases, and habitat alteration. Following this decline, the species was listed as federally endangered in 1984 (49 F.R. 1992, January 17, 1984) and was reported as possibly extinct in 1985. However, an isolated population of Wyoming Toad was discovered at Mortenson Lake in 1987. Today, this species is restricted in the wild to less than five sites in the Upper Laramie and Medicine Bow watersheds, including two Safe Harbor Agreement sites. Reproduction in the wild has only been documented at two sites since the species was listed. A captive breeding program has been implemented at ten institutions. Wild adults appear from hibernation when daytime temperatures reach approximately 70 degrees Fahrenheit (Baxter and Stone 1985). Breeding behavior typically occurs a week following emergence. Eggs are laid in shallow permanent waters. Egg masses contain 1,000 to 6,000 ova (Odum and Corn 2005). Wyoming Toad larvae typically transform by early August. Wyoming Toads feed upon beetles and other small invertebrates. Males are thought to reach sexual maturity at two years of age, while females are thought to reach maturity by three years.

Habitat

The Wyoming Toad lives in floodplains, ponds, and small seepage lakes in the mixed grass prairies (Baxter and Stone 1985, Geraud and Keinath 2004). Adults tend to restrict their habitat use to within 10m of the water (Odum and Corn 2005). Hibernating habitat for the Wyoming Toad is not well understood (Geraud and Keinath 2004).

Problems

- Wyoming Toads face a number of management issues. These include concerns for genetic health, disease, and habitat modification/destruction. Due to precipitous declines, retention of genetic diversity is an important issue. Current captive breeding programs are tasked to maximize genetic variation. Chytrid fungus is present in known populations of Wyoming Toad. This disease has been attributed to anuran decline. Habitat modification and anthropogenic factors such as irrigation, chemical application, and increased levels of human subsidized predators are factors that also may affect Wyoming Toad populations. Additionally, recovery efforts are hampered by low survivalship and lack of ideal recovery sites.

Conservation Actions

- Follow conservation actions as outlined in USFWS Wyoming Toad Recovery Plan.
- Perform research on how to better manage wild and captive populations.
- Expand and improve reintroduction success (i.e. adult survival, reproduction) at Safe Harbor sites.

Monitoring / Research

Continue annual monitoring of known and suspected populations of Wyoming Toad. Perform research on vitamin deficiency in captive populations of Wyoming Toad. Continue monitoring prevalence of chytrid fungus at known Wyoming Toad populations. Conduct research on hibernacula and survivalship of adult toads.

Recent Developments

The Wyoming Natural Diversity Database's (WYNDD's) developed protocol to standardize Wyoming Toad surveys. Sites with Wyoming Toads have been surveyed annually using this protocol since 2008 to determine the success of reintroduction efforts and to monitor population numbers. All adult Wyoming Toads are marked and tested for chytrid fungus. Water temperature monitoring was also initiated at known Wyoming Toad survey sites. Currently, the range of the Wyoming Toad is limited to Mortenson Lake and Porter Lake, where most of the reintroductions have taken place. Porter Lake is a Safe Harbor site.

In 2012, a study was conducted using soft releases for reintroduction of Wyoming Toads at Mortenson Lake. Tadpoles were protected using mesh cages and toadlets were protected using small corrals. Since the beginning of this study, the number of Wyoming Toads found at Mortenson Lake has greatly increased. There are currently over 600 Wyoming Toads at the ten Wyoming Toad breeding locations. Several of these facilities are improving and greatly increasing their output, with large expansions planned at two of the existing breeding facilities.

The Wyoming Toad Revised Recovery Plan was updated and finalized in 2015 (U.S. Fish and Wildlife Service 2015). The ultimate recovery objective in the this plan is to restore a minimum of 5 self-sustaining populations within and/or nearby the historical range, and subsequently to delist the Wyoming Toad. The USFWS is currently proposing to establish a Wyoming Toad Conservation Area that would expand the boundaries of the existing National Wildlife Refuges in the area (Bamforth, Mortenson Lake, and Hutton Lake). Under this proposal, the USFWS would work with private landowners to conserve Wyoming Toads by acquiring perpetual conservation easements and fee-title land purchases from willing sellers.

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Wyoming Toad (*Anaxyrus baxteri*)
Park
Big Horn
Sheridan
Crook
Campbell
Teton
Washakie
Johnson
Weston
Hot Springs
Fremont
Natrona
Converse
Niobrara
Sublette
Lincoln
Platte
Goshen
Sweetwater
Carbon
Albany
Laramie
Uinta
SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

American Bittern
Botaurus lentiginosus

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: Sensitive
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: Bird of Conservation Concern
WGFD: NSS3 (Bb), Tier II
WYNDD: G4, S2S3
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: Not ranked

STATUS AND RANK COMMENTS
The Wyoming Natural Diversity Database has assigned American Bittern (*Botaurus lentiginosus*) a state conservation rank ranging from S2 (Imperiled) to S3 (Vulnerable) because of uncertainty about population trends for this species in Wyoming.

NATURAL HISTORY

Taxonomy:
There are no recognized subspecies of American Bittern [1, 2].

Description:
Identification of American Bittern is possible in the field. The species is similar in shape to most herons, but smaller. Males and females are identical in plumage. The head has a brown cap, yellow eye, and a long dagger like bill. The species has a large white throat patch, and a black patch running down both sides of the neck. Adults are brown above with fine black flecking, and heavily streaked on the underside with brown and white. Juveniles are generally similar to the adult, but lack the black patches on the neck [1, 3]. The only similar species in Wyoming is juvenile Black-crowned Night-Heron (*Nycticorax nycticorax*). Juvenile Black-crowned Night-Heron lacks black neck patches, and are darker brown overall than American Bittern [1].

Distribution & Range:
During the breeding season, American Bittern is found throughout the northern half of the United States and across much of Canada. In the intermountain west, including Wyoming, the species is locally distributed where appropriate wetland habitat exists. The range of the species has slowly shifted northward from its historical distribution [1]. The species migrates south in winter were it is broadly distributed throughout Mexico and portions of several Central American countries as well across the southern United States from California to Florida [1].

Habitat:
Primary foraging habitat for the American Bittern includes freshwater marshes with tall, emergent vegetation [1]. Breeding habitat includes wetlands and adjacent upland grassy habitats. Appropriate breeding habitat is characterized by proximity to suitable foraging areas, and an overall area of at least 3 ha [4]. Studies conducted outside Wyoming suggest the species prefers habitat with 30–70% emergent vegetation cover averaging 69–133 cm tall, and 10–50% open water with an average depth of 24–56 cm [5, 6]. Habitat associations have not been studied in Wyoming, but are expected to be similar to other mountain states [4]. Habitat use during migration is similar to summer habitat use. In winter, a wider variety of wetland habitats are used, including brackish coastal marshes [1].

Phenology:
In Wyoming, spring arrival of American Bittern occurs from late April to May [7]. Nesting phenology of the species has not been studied in Wyoming, and little studied elsewhere. Incubation lasts 24 to 28 days. Young stay in the nest for one to two weeks, and then remain near the nest area until two to four weeks of age [1]. Age at fledging is unknown. Fall migration occurs in October, with the latest migrants leaving by November [7].

Diet:
The primary foods of American Bittern are insects, amphibians, crayfish, small fish, and small mammals [1].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
There are no robust estimates of abundance available for American Bittern in Wyoming. The species has a statewide abundance rank of VERY RARE and appears to be uncommon within suitable environments in the occupied area [8]. From 1968–2015, annual Wyoming Breeding Bird Survey (BBS) detections of American Bittern ranged from 0 to 6, with none recorded in most years [9]. American Bittern was not detected during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [10]. While surveys conducted as part of the BBS and IMBCR programs may occasional detect this species, neither is specifically designed to capture bittern observations.

Population Trends:
Historic: LARGE DECLINE
Recent: UNKNOWN
Historic large declines of American Bittern in parts of its range resulted from the drainage and conversion of wetlands [4]. Survey-wide trend data from the North American BBS indicate that American Bittern numbers experienced a non-significant annual decline of 0.64% from 1966–2013, and a statistically significant annual increase of 3.18% from 2003–2013 [11]. Robust population trends are not available for American Bittern in Wyoming because the species is infrequently detected during monitoring efforts. Wyoming BBS trend data suggest that American Bittern experienced annual declines from 1968–2013 and from 2003–2013, but these state estimates have low credibility and are not statistically significant [11].

Intrinsic Vulnerability:
HIGH VULNERABILITY
American Bittern is restricted to undisturbed wetland habitats that are larger than 3 ha, which are rare in Wyoming [4]. Because American Bittern is reliant on these habitats, it is susceptible to changes in localized management. Factors that affect habitat suitability include invasion of exotic vegetation, grazing, and other anthropogenic forms of ground disturbance [4]. American Bittern may show sensitivity to toxin bioaccumulation [1, 4]. Wetlands are often susceptible to accumulating chemical runoff from herbicide and pesticide application, among other forms of pollution. More information is needed to determine direct chemical impacts on this species. Bioaccumulation of toxins has been shown to affect species related to American Bittern, and their prey items [4].

Extrinsic Stressors:
MODERATELY STRESSED
The most prevalent threat to American Bittern is continued loss and degradation of wetland habitats. Drainage and conversion of wetland habitat and degradation of upland areas around wetlands by agriculture and livestock use are ongoing threats. These activities reduce habitat quality and size of wetlands. Disturbance of breeding sites by human activities can cause nest and territory abandonment. Changes to water quality within wetlands such as siltation, eutrophication, and herbicide contamination negatively affect the species through habitat destruction and by reducing prey availability [4]. Additionally, American Bittern has been shown to decline with increasing amounts of human recreational activities [4].

KEY ACTIVITIES IN WYOMING
Annual surveys for American Bittern are conducted by the Wyoming Game and Fish Department (WGFD) using standardized call-playback techniques. Initial monitoring was conducted at Cokeville Meadows National Wildlife Refuge (NWR) in western Wyoming. These surveys began in 2007. In 2015, additional monitoring routes were established at Yellowtail Wildlife Habitat Management Area (WHMA), Table Mountain WHMA, Dad Wetland, and Hutton Lake NWR. There are currently 10 established American Bittern monitoring routes across Wyoming. While monitoring data are limited, results suggest an increasing population at Cokeville Meadows NWR[12]. In addition to these species specific surveys, WGFD implemented secretive marsh bird surveys in Wyoming in 2015. Additionally, monitoring is needed to ascertain population trends in the state. Wetland restoration efforts are ongoing in Western Wyoming, specifically within the Green River watershed. Habitat restoration efforts could increase habitat for American Bittern within the state.

ECOLOGICAL INFORMATION NEEDS
Very little is known about the ecology of American Bittern in Wyoming. The extent of the distribution of the species in the state is unknown [4]. Nesting phenology is unknown. Population size and population trends in Wyoming are unknown.

MANAGEMENT IN WYOMING
This section authored solely by WGFD; Zachary J. Walker. American Bittern is classified as a Species of Greatest Conservation Need in Wyoming due to limited breeding habitat, breeding habitat modification, and lack of information. Due to low detection rates and specific habitat requirements, American Bittern is currently monitored in Wyoming by using standardized marsh

bird monitoring protocols. Annual monitoring should be continued within the state at established sites. New monitoring routes should be implemented as funding and personnel allow. Management should maintain suitable undisturbed wetland habitat within the state. Wetland management could include promoting tall emergent vegetation and shallow water, limiting water fluctuations during the breeding season, and protecting wetlands from degradation and pollution [13, 14]. In areas where American Bittern is known to nest; mangers should limit mowing, burning, and grazing to a 2–5 year cycle.

CONTRIBUTORS

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Douglas A. Keinath, WYNDD

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Figure 1: An American Bittern at Meeboer Lake, Albany County, Wyoming. (Photo courtesy of Shawn Billerman)

Figure 2: North American range of *Botaurus lentiginosus*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Potential American Bittern habitat in Grand Teton National Park, near Moran Bay. (Photo courtesy of Michael T. Wickens)

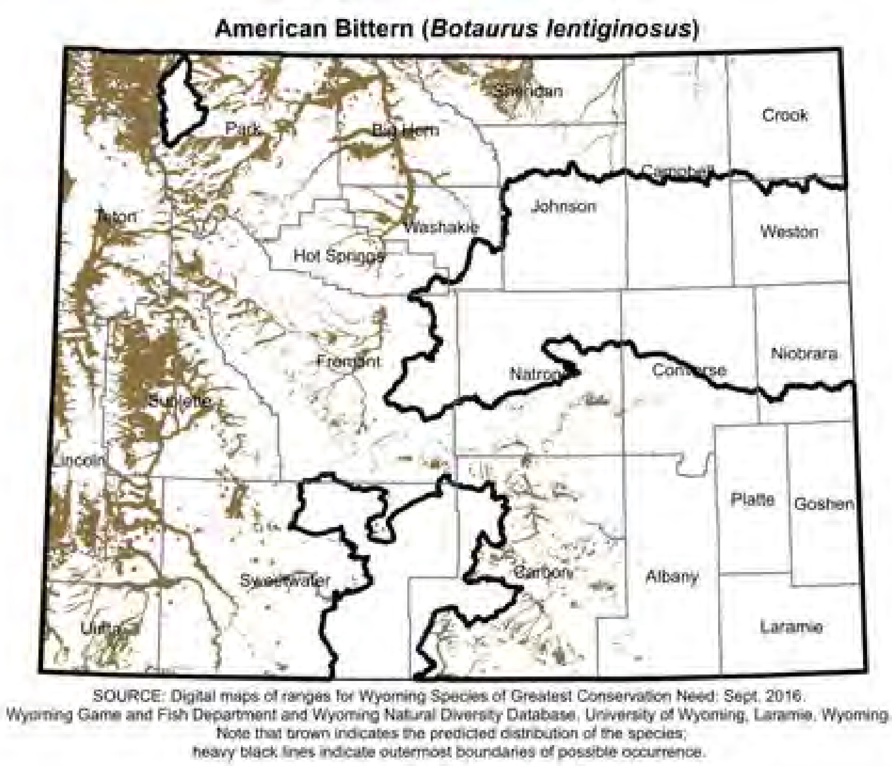

Figure 4: Range and predicted distribution of *Botaurus lentiginosus* in Wyoming.

American Kestrel
Falco sparverius

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS4 (Bc), Tier III
WYNDD: G5, S5
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 11

STATUS AND RANK COMMENTS
American Kestrel (*Falco sparverius*; kestrel) does not have any additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY
Taxonomy:
American Kestrel is one of 13 kestrel species found throughout the world and thought to be the most recently evolved [1, 2]. Seventeen subspecies have been recognized [3]. *F. s. sparverius* breeds across North America, except for the southeastern United States where *F. s. paulus* is resident from southern Louisiana east to Florida [4, 5]. Only *F. s. sparverius* is found in Wyoming [6].

Description:
Identification of American Kestrel is possible in the field. American Kestrel is the smallest falcon in North American, with long, narrow, pointed wings; a small, toothed bill; and a long, square-tipped tail. It is approximately the size of a Mourning Dove (*Zenaida aurita*) with females averaging larger than males. Kestrels are easily identified due to their bright colors and tendency to perch on wires and poles in open habitat. While foraging, they often hover facing into the wind using their wings and tails to stay in one place. Both males and females have two bold, black, vertical lines on their pale faces (one forming a “mustache” and the other extending through the auricular region), black “eye-spots” on the nape, and rusty colored backs with black spots (males) or barring (females). The male has slate-blue wings with black spots, while the female’s wings are reddish-brown with black barring. Males have a rufous tail with a black subterminal band and a light terminal band that ranges from white to rufous. Females also have a rufous tail but it is completely barred with black. Underparts of males range from buff to orange with varying amounts of black spotting on the sides and belly, while female underparts are ivory to buff with substantial brown streaking on the breast and belly [2].

Distribution & Range:
American Kestrel is a common summer resident in Wyoming, with breeding documented in all 28 latitude/longitude degree blocks in the state [7]. It is the most widespread North American falcon, with a breeding range extending from central Alaska through most of forested Canada south through most of North, Central, and South America to Tierra del Fuego and the West Indies [2, 8]. Northern birds from Alaska, Canada, and parts of the northern United States migrate south in winter to the southern United States and Mexico with some birds moving perhaps as far as Panama and northern South America [8]. A male kestrel nesting in Jackson, Wyoming marked with a GPS Pinpoint tag in 2015 wintered approximately 130 km south of Mexico City (R. Crandall, pers. comm.).

Habitat:
In Wyoming, breeding occurs usually below 2,590 m, but migrants can be found at higher elevations. American Kestrel breeds statewide in a variety of open and semi-open habitats that also contain trees, cliffs, or other man-made structures that provide nesting cavities [6]. Kestrels will use nest boxes and often nest close to human habitation [6]. Range-wide, they can be found in a variety of semi-open habitats including meadows, grasslands, deserts, agricultural fields, cottonwood riparian, open parkland, and urban areas. Habitat is characterized by short ground vegetation, either in small or large patches, with suitable trees or other structures to provide perches and nest cavities [2].

Phenology:
A few American Kestrels winter in Wyoming, but most breeding birds return in April and May [6]. Males arrive on territories before females often reusing the same territory in multiple years [9]. When a female arrives, males initiate aerial displays, courtship feeding and lead females to different nest cavities for her selection [2]. The species lays a clutch usually consisting of 4–5 eggs [10]. Most eggs are laid every other day but can be 1 or 3 days apart [10]. Kestrels readily renest if a clutch is lost. Incubation duration is usually 30 days, with young typically fledging at age 28–31 days [2]. Young are dependent on adults for food for about 12–14 days post-fledging. Siblings stay together during the first 2 weeks and then associate with other nonrelated juveniles 2–3 weeks after fledging [11].

Diet:
The main foods taken by kestrels include terrestrial arthropods and small vertebrates [12]. Primarily a “sit and wait” diurnal predator, individuals can use the same perch all day or change locations frequently [2]. Hover-hunting is much less common [13]. Insect prey species include grasshoppers (Orthoptera), cicadas (Cicadidae), beetles (Coleoptera), dragonflies (Odonata), spiders (Arachnida), and butterflies and moths (Lepidoptera) [12]. Small mammalian prey includes voles and mice (Cricetidae, Muridae), shrews (Scoricidae), and bats (Chiroptera). Birds taken are mostly small passerines [12]. Diet varies by season and location. Mean diet composition based on number of prey items from 6 food-habits studies in the United States and Canada was 74% invertebrates, 16% mammals, 9% birds, and 1% herptiles [12].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: COMMON

The total wintering population of American Kestrel is estimated to be 236,000 in the United States and southern Canada [9]. The North American breeding population is estimated to be greater than 1.2 million pairs [14]. Using North American Breeding Bird Survey (BBS) data, the Partners in Flight Science Committee estimated the global population of American Kestrel to be 4 million birds [15]. Approximately 2.1% of the global population, or approximately 90,000 birds, is estimated to breed in Wyoming [16]. The statewide rank of COMMON is based on the relatively large area of the state known to be occupied in any given season, and the large coverage of suitable habitat within that area. Within suitable habitat in the occupied area, American Kestrel also appears to be common and is usually encountered during surveys that could be expected to indicate its presence [7]. American Kestrel density (number of birds per square km) and population size estimates for Wyoming are available from the Integrated Monitoring in Bird Conservation Regions (IMBCR) program for the years 2009–2015 [17].

Population Trends:
Historic: UNKNOWN
Recent: MODERATE DECLINE
Statistically significant population trends calculated from BBS data from 1968–2013 indicate that American Kestrel numbers in Wyoming declined by 1.30% annually (95% CI: -2.08 to -0.53) [18]. Trends from BBS data from 1966–2008 in the Northern Rockies Bird Conservation Region (BCR 10) indicated a 55% population decline (N = 202 routes), while in the Badlands and Prairies Conservation Region (BCR 17) a smaller decline of 3% was estimated (N = 96 routes) [18, 19].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
As North America's most abundant bird of prey, with a distribution across most of North America, American Kestrel would appear to be a species at little to no risk. However, BBS data have shown steep declines in breeding adults in a number of widespread regions from New England to the Rocky Mountains [18, 19]. Many aspects of its life history increase the vulnerability of the American Kestrel compared to other raptor species: it is the smallest North American falcon and a secondary cavity nester that is vulnerable to disease. It also forages on insects and small mammals which can expose it to a variety of contaminants and secondary poisoning. It also can nest and forage close to human developments and busy roads which expose it to additional hazards.

Extrinsic Stressors:
MODERATELY STRESSED
Although causes for population declines have not been determined, four major factors have been suggested: 1) habitat loss such as conversion of agricultural fields to urbanization or habitat degradation/change (succession of fields to forests) which can lead to a lack of nesting cavities or greatly reduce food resources, 2) contaminants such as flame retardant chemicals and pesticides which can impact reproductive success or cause direct mortality, 3) increased predation by other raptors especially Cooper's Hawk which has been increasing in numbers in some areas of the country, and 4) exposure to the West Nile virus to which kestrels are highly susceptible [2, 9, 19]. Other possible factors for population declines include decreases in Northern Flicker nesting populations which would reduce the number of nesting cavities, vehicle collisions as kestrels often forage on wires along roadways, and climate change effects that can result in drought and disruption of traditional movement and breeding patterns [2, 19]. It has also

been shown that captive kestrels have reduced hatching success and other physiological changes after exposure to electric and magnetic fields from electrical transmission lines [2]. Take for falconry or from shooting are thought to be minimal [2].

KEY ACTIVITIES IN WYOMING

The Wyoming Game and Fish Department (WGFD) designates American Kestrel as a Species of Greatest Conservation Need (SGCN). Current statewide activities for monitoring population trends for American Kestrel in Wyoming include the BBS program conducted on 108 established routes since 1968 and the multi-partner IMBCR program initiated in 2009. Trend data are available on the United States Geological Survey BBS website [18], and occupancy, density, population estimates, and decision support tools are available through the Rocky Mountain Avian Data Center [17]. The only ongoing research on kestrels in Wyoming is the Teton Kestrel Project by Craighead Beringia South, a nonprofit wildlife research institute in Jackson, Wyoming [20]. This multi-year project is focused on monitoring known territories of kestrels using natural cavities and over 50 nest boxes throughout the county on private lands to support monitoring, research, and education objectives (Ross Crandall, pers. comm.).

ECOLOGICAL INFORMATION NEEDS

Although American Kestrel has been studied extensively in some areas, information on this species in Wyoming is lacking. In order to understand apparent ongoing declines, data are needed on adult and juvenile survivorship, nest site and habitat selection, prey use, availability of suitable cavities for nesting, causes of mortality, identification of wintering areas and migration routes, and how contaminants, predation and disease may be affecting the state's breeding population.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Susan M. Patla. The WGFD classifies American Kestrel as a SGCN due to limitations on the availability of large diameter trees and snags for nesting and perch sites (lack of available cavities can result in population declines); elimination of mature coniferous forest habitat from beetle kill, disease, and logging; and the effects of climate change, which can reduce nesting habitat. Given the lack of ecological information on American Kestrel in Wyoming, research projects that focus on collecting basic data on survivorship, productivity, movements, and bird health should be encouraged at different sites across the state. BBS and IMBCR data should also be reviewed to determine if additional survey work is needed to better document population trend in the state. The need to maintain an adequate supply and distribution of older aspen and conifer trees across the state that will support robust populations of nesting woodpeckers (primary cavity nesters), specifically in close proximity to open areas used by American Kestrel for hunting, should be a key objective of forest habitat projects. Where natural cavities are known to be in short supply, constructed nest boxes could provide additional nest sites but would require annual maintenance.

CONTRIBUTORS

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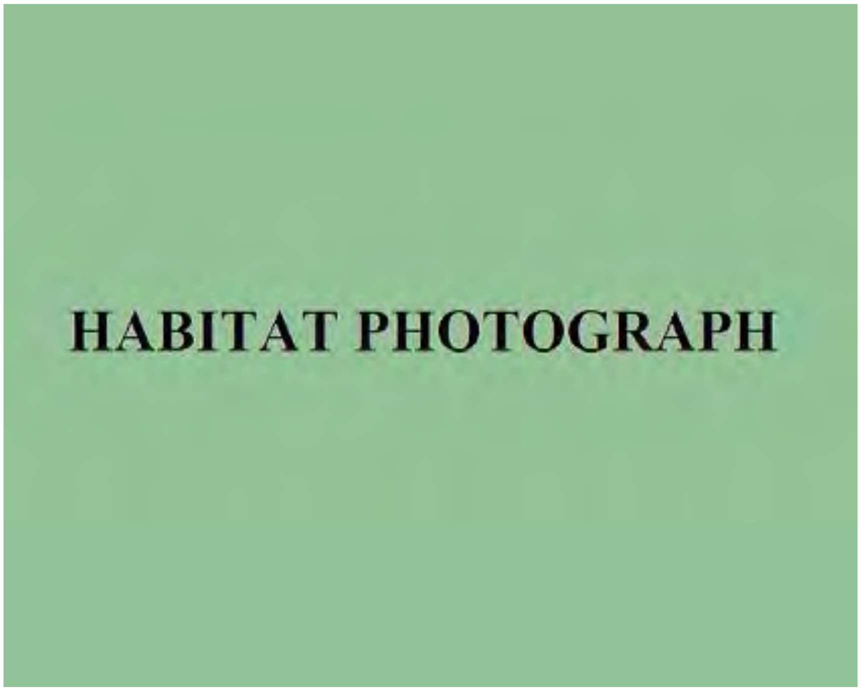
Figure 1: Adult American Kestrels: male (top) in Laramie County, Wyoming and female (bottom) in Boulder County, Colorado. (Photos courtesy of Pete Arnold (top) and Bill Schmoker (bottom))

Figure 2: North American range of *Falco sparverius*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

ꕤ Wyoming Species Account ꕤ



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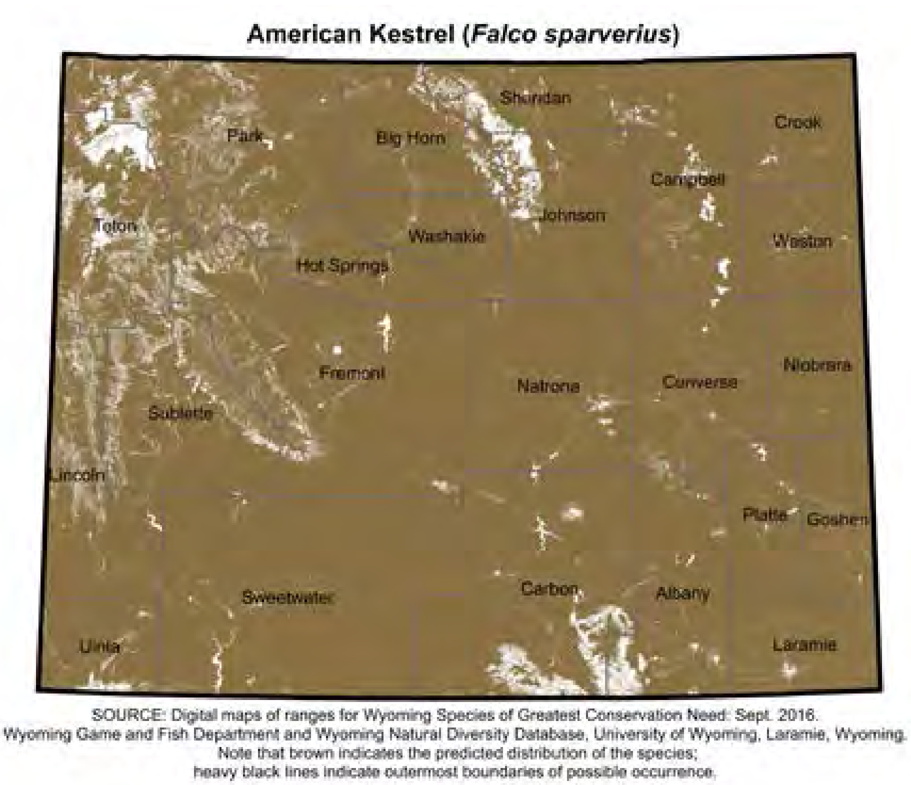

Figure 4: Range and predicted distribution of *Falco sparverius* in Wyoming.

American Pipit
Anthus rubescens

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS4 (Bc), Tier III
WYNDD: G5, S2
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 9

STATUS AND RANK COMMENTS
American Pipit (*Anthus rubescens*) does not have any additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:
American Pipit has four recognized subspecies based on differences in body size, plumage color and pattern, and leg color [1-9], although inclusion of the Siberian subspecies is disputed [10]. The subspecies likely to be found breeding in Wyoming is *A. r. alticola* [10].

Description:
American Pipit is a small (15–17 cm) ground-dwelling songbird that typically inhabits sparsely vegetated or open habitat and is identifiable in the field [10]. It has a short, slender bill; long legs; and elongated hallux nails (hind claws). Adult males and females are difficult to distinguish visually. American Pipit has grayish-brown upperparts, a faintly or boldly streaked underside, and pale lores. Juveniles are more streaked than adults, but molt by late summer or early fall to look similar to adults. Pipits can be distinguished from other ground-dwelling passerines that occur in the same habitat by their slender bill, tail feathers that have an outer white edge, and bobbing tail motion. The only other pipit in Wyoming is Sprague's Pipit (*A. spragueii*), which has a shorter tail, streaked or scaled upperparts, bright pink legs, lighter colored faced which lacks a dark auricular patch, and does not exhibit the tail bob that the American Pipit does. Additionally, in the winter, American Pipit is found in sizable flocks while Sprague's Pipit is typically solitary. American Pipit is more often found in wetter habitats (i.e., muddy fields, pond edges) than Sprague's Pipit (i.e., dry, grassy areas).

Distribution & Range:
American Pipit migrates through Wyoming in the spring and fall and is a summer resident. The species has been observed in 27 of Wyoming's 28 latitude/longitude degree blocks, of which confirmed or suspected breeding has been documented in only 6 [11]. Most observations of American Pipit in Wyoming have occurred at lower elevations during spring and fall migration [11]. American Pipit winters along the Atlantic and Pacific Coasts, in the southern United States, and throughout Mexico [10].

Habitat:
In Wyoming, American Pipit is found in alpine meadows composed of sedges (*Carex* spp.), Dwarf Willow (*Salix herbacea*), and hairgrass (*Deschampsia* spp.), as well as in fell fields associated with plants such as catchfly (*Silene* spp.), clover (*Trifolium* spp.), phlox (*Phlox* spp.), and sandwort (*Arenaria* spp.) [12]. American Pipit has also been recorded at 2,900 m in high elevation subalpine meadows in Wyoming [13]. During migration, American Pipit has been reported in Black-tailed Prairie Dog (*Cynomys ludovicianus*) colonies [14], dry vernal pools [15], plowed fields, stubble fields, mud flats, and river courses [16]. Winter habitat is similar to that used during migration.

Phenology:
In the spring, American Pipit migrates to alpine meadows between April and mid-May in Wyoming [17]. It moves to lower elevations in the fall, from mid-September to late October. Pair formation in Wyoming begins early to mid-May, and nesting begins as soon as snow and meltwater withdraw [10]. The first and only clutch is initiated in June in Wyoming, with peak hatching occurring late June to mid-July [17-19]. Less than 0.35% of clutches were initiated after 15 July in Wyoming [19, 20]. Egg laying is triggered by air temperature and typically begins one to three days after nest completion [17, 21]. Usually one egg is laid per day, but a day is sometimes skipped [10]. Incubation period is 14 days [17, 21]. In Wyoming, hatching occurs in late June and throughout July [17, 18]. Nestlings are altricial at hatching and leave the nest after 14 days [10, 17].

Diet:
The majority of the American Pipit diet consists of arthropods, primarily insects, although seed consumption is documented in the fall and winter [16, 17, 22]. Types of animals consumed include: spiders, flies, butterflies and moths, grasshoppers, ants, mayflies, lacewings, dragonflies, caddisflies, and stoneflies [22-28]. It is possible that American Pipit eats snow to obtain water [10].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD BUT PATCHY
Wyoming: UNCOMMON
Using North American Breeding Bird Survey (BBS) data, the Partners in Flight Science Committee estimated the global population of American Pipit to be 20 million birds [29]. Although a population estimate is not listed for Wyoming due to the limited number of BBS routes on which this species is detected, Wyoming's estimated percent of the global population is 0.60% [30]. An estimated 131,823 pairs (range of estimates: 35,022–241,945) was given for Colorado [31]. The statewide rank of UNCOMMON is based on the limited area of the state known to be occupied in any given season, and the relatively small coverage of suitable habitat within that area. However, within suitable habitat in the occupied area, American Pipit appears to be

common and is usually encountered during surveys that could be expected to indicate its presence [11].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Population trends are not available for American Pipit in Wyoming due to low detection rates during monitoring surveys. Currently, there are no North American BBS trend data for American Pipit due to a lack of observations. Nationwide Christmas Bird Count results suggest a significant decline in the west (CA, OR), and slight, but non-significant declines in the central (NM, TX) and eastern regions (FL, GA) [10].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
American Pipit is moderately vulnerable due to its use of subalpine, alpine, and arctic habitats for breeding [10]. Declines in the quality and availability of these environments in Wyoming would likely have detrimental impacts on American Pipit.

Extrinsic Stressors:
MODERATELY STRESSED
Stressors to American Pipit include climate change, natural weather events, and human disturbance/visitation. Subalpine, alpine, and arctic habitats are being altered by climate change, thereby reducing the available breeding habitat of American Pipit. In the Beartooth Mountains of Wyoming, a snow storm buried nests for over 24 hours, killing 79% and 7% of nestlings in alpine and subalpine habitats, respectively [13]. Larger clutch sizes are produced with earlier nesting dates [20]. Later nest initiation caused by poor weather conditions could cause decreased clutch size and/or nest failure. Additionally, American Pipit will sometimes abandon nests during nest building, egg laying, and in early incubation stages if disturbed, but rarely, if ever, abandons nestlings [17]. Sites that are visited by human researchers more frequently have recorded a higher number of lost nests due to predation than sites visited less frequently [32]. Nest markers used by researchers, such as flags or wooden stakes, have been targeted by Common Ravens (*Corvus corax*) that successfully flush incubating and brooding females from marked nests [10].

KEY ACTIVITIES IN WYOMING

The Wyoming Game and Fish Department (WGFD) classifies American Pipit as a Species of Greatest Conservation Need (SGCN). Current statewide efforts for monitoring annual detections and population trends of breeding birds in Wyoming are not robust enough to support estimates of occupancy, density, or population trend for American Pipit. No systematic survey for American Pipit has been conducted in Wyoming, and there are no new or on-going research or monitoring projects designed specifically for this species in the state.

ECOLOGICAL INFORMATION NEEDS

Factors that may affect populations of American Pipit include incompatible human activities in fragile alpine grassland and tundra habitats, such as livestock grazing, particularly by domestic sheep; outdoor recreation; and mining activities [33]. In addition, climate change could alter alpine environments by raising the treeline elevation, which may lead to local population extinctions [10, 33].

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. The WGFD classifies American Pipit as a SGCN due to insufficient information on population status and trends and limited alpine grassland breeding habitat in the state. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [34] and the multi-partner Integrated Monitoring in Bird Conservation Regions [35]. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, American Pipit may require a targeted, species-specific survey method to obtain these data.

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Figure 1: Adult American Pipit in Larimer County, Colorado. (Photo courtesy of Shawn Billerman)

Figure 2: North American range of *Anthus rubescens*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

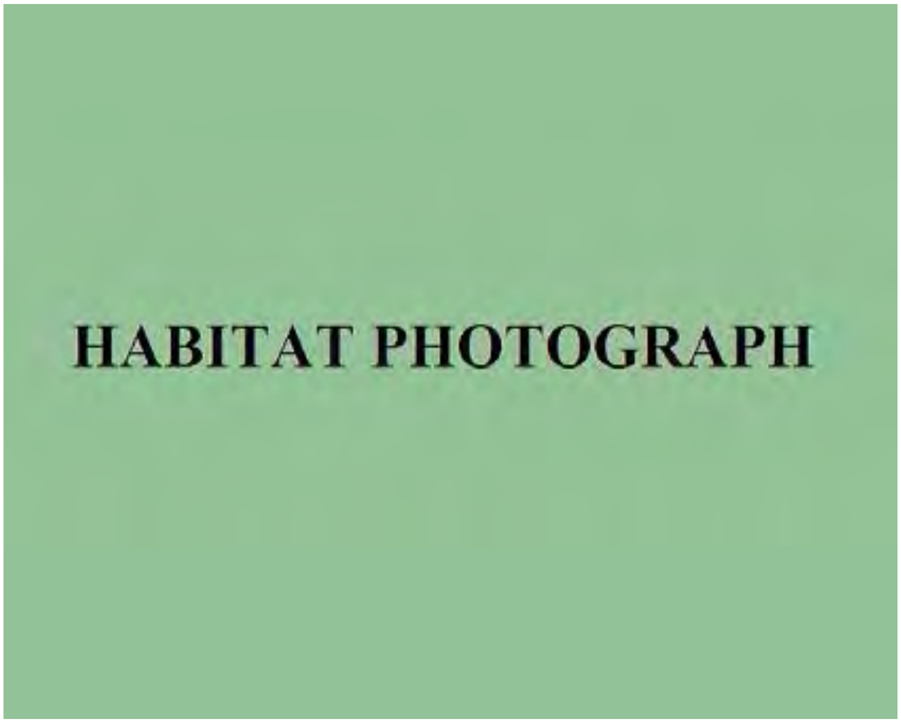

Figure 3: Photo not available.

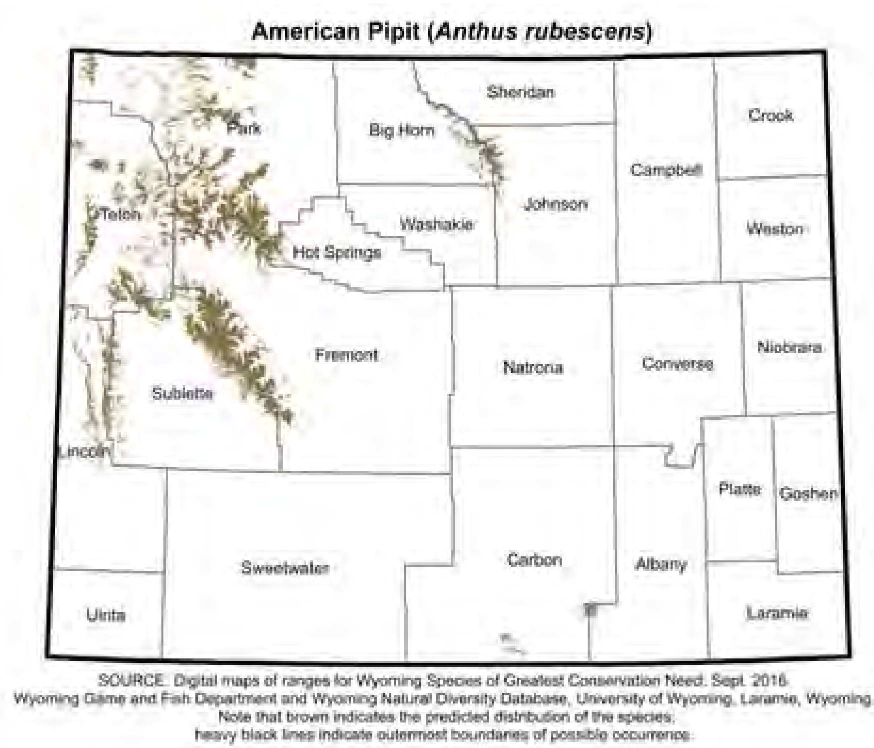

Figure 4: Range and predicted distribution of *Anthus rubescens* in Wyoming.

American White Pelican

Pelecanus erythrorhynchos

REGULATORY STATUS

USFWS: Migratory Bird
USFS R2: No Special Status
USFS R4: No Special Status
Wyoming BLM: No Special Status
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS4 (Bc), Tier II
WYNDD: G4, S3S4
    Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: Not ranked

STATUS AND RANK COMMENTS

American White Pelican (*Pelecanus erythrorhynchos*) has been assigned a range of state conservation ranks by the Wyoming Natural Diversity Database because of uncertainties about the species' abundance and population trends in Wyoming.

NATURAL HISTORY

Taxonomy:

There are no recognized subspecies of American White Pelican.

Description:

Identification of American White Pelican is possible in the field. Males and females are nearly identical in appearance and appearance remains largely the same year round. The species is 1.2–1.6 m in length, has an all-white body, black wing tips, and orange head and feet. The bill is very large, with a distensible pouch underneath. During the breeding season, a horn-like keel is present on the top of the upper mandible [1]. Juveniles have a dusky-brown head, neck, and back, with scattered dusky-brown feathers on the wings and tail. The species takes three years to reach full adult plumage [2]. The species is unlikely to be confused with any other species in Wyoming.

Distribution & Range:

During the breeding season, American White Pelican is patchily distributed across western North America. Similarly, the species is scattered across Wyoming during the breeding season, potentially occurring wherever appropriate habitat exists. American White Pelican has been documented in all of Wyoming's 28 latitude/longitude degree blocks, with confirmed breeding occurring in only 4 of those degree blocks [3]. The species migrates to southern North America for the winter. Range contractions or expansions have not been observed. However, some breeding colonies have been lost in Washington and California, while new breeding colonies have been established elsewhere. In Wyoming, breeding colonies have been documented in Yellowstone National Park and in Fremont, Carbon, and Albany counties [3-5].

Habitat:
Across the species' range, American White Pelican uses various freshwater habitats during the breeding season. These include but are not limited to marshes, lakes, and rivers. Breeding colonies are found on isolated islands within these habitats. Foraging areas typically consist of shallow waters in marshes, ponds, and streams, and are often over 50 km away from the breeding colony. In Wyoming, two of the larger breeding colonies are found on Yellowstone Lake and Pathfinder National Wildlife Refuge. During migration, habitat use is similar to that during the breeding season. During winter, the species is typically restricted to coastal estuarine habitats [4, 6].

Phenology:
American White Pelican arrives in Wyoming in April. The nesting cycle begins in late April to early May, and is generally synchronized within a colony. Normally, 2 eggs are laid, and incubation lasts approximately 30 days. Young remain in the nest for 2–3 weeks and then leave the nest to form crèches with other young. Young first begin to fly at 9–10 weeks of age, and fledge from the colony at 10 weeks of age. Fall migration likely begins in late August and lasts through October [4, 6].

Diet:
American White Pelican primarily consumes fish during the breeding season. Occasionally, aquatic amphibians and crayfish are taken. Diet during migration and winter is largely unknown [4].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: UNCOMMON
Abundance of American White Pelican in Wyoming is difficult to determine due to the nomadic nature of the species and annual variation in occupancy of individual breeding colonies. Since 2001, an estimated 500 to 1,300 individuals have occupied Yellowstone Lake while up to 1,500 individuals have occupied Pathfinder Reservoir. Small colonies and non-breeding individuals are scattered across Wyoming [6, 7]. The statewide rank of UNCOMMON is based on the limited area of the state known to be occupied in any given season, and the relatively small coverage of suitable habitat within that area. However, within suitable habitat in the occupied area, American White Pelican appears to be common and is usually encountered during surveys that could be expected to indicate its presence [3].

Population Trends:
Historic: LARGE DECLINE
Recent: UNKNOWN
Population trends are not available for American White Pelican in Wyoming due to a limited distribution in the state and low detection rates during monitoring surveys. Currently, there are no robust North American Breeding Bird Survey (BBS) trend data for American White Pelican in Wyoming due to an limited observation sample size (N = 33 routes; 1968–2013) and data that fall within a credibility category containing important deficiencies [8]. However, BBS trend data for the western region, United States, and survey-wide suggest population increases, although

these data fall within a credibility category containing deficiencies, so must be interpreted with caution [8]. Prior to the 1960s, large, long-term declines were observed [4, 8]. Annual monitoring for nesting American White Pelicans occurs in Yellowstone National Park, where one colony exists. In 2014, 307 American White Pelican nest attempts produced 276 fledglings; however, this number has declined since the early 1990s likely due to declines in cutthroat trout [9].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
American White Pelican is vulnerable due to restrictive breeding habitat. Specifically, suitable breeding habitat is restricted to islands in various freshwater habitats in Wyoming. Availability of these habitats may limit the species in Wyoming. The species may also be limited by its reproductive capacity. The species is only able to raise one or two young annually. Additionally, nest success within a colony can be highly variable, ranging from complete failure, to nearly complete success. However, the species has a long life expectancy and lifetime reproduction may be relatively high [4].

Extrinsic Stressors:
MODERATELY STRESSED
Environmental and human factors can affect populations of American White Pelican, making it moderately vulnerable. The species is highly sensitive to human disturbances at breeding colonies. Boat traffic and low flying aircraft can cause nest desertion. Fluctuating water levels at reservoirs can also negatively affect breeding colonies. Increasing water levels during the breeding season can flood and destroy nests, while decreasing water levels can connect islands where breeding colonies occur to mainland habitats, allowing predators to access nest sites [4]. Naturally occurring runoff and drought conditions may have similar effects on breeding colonies. Effects of both flooding and drought conditions have been observed at Bamforth National Wildlife Refuge in Albany County. Complete colony nesting failure was observed in 1986, 1987, 1989, and 1990. The frequency and severity of droughts may occur more frequently due to climate change, which may threaten the long-term viability of breeding colonies [6, 10].

KEY ACTIVITIES IN WYOMING

American White Pelican is listed as a Species of Greatest Conservation Need (SGCN) in Wyoming by the Wyoming Game and Fish Department (WGFD), and as a Level II Priority Species requiring monitoring action in the Wyoming Bird Conservation Plan [11]. Since 1984, WGFD has conducted annual or periodic monitoring at the most important and productive sites for colonial waterbird SGCN to determine species presence and distribution, and to estimate number of nesting pairs. Annual surveys were conducted by state and federal agencies from 2002 to 2006 on colonial waterbirds, including American White Pelican. The goals of these surveys were to estimate breeding colony size and occupancy status [12-16]. The most recent effort was the culmination of a multi-year cooperative agreement between the WGFD and the U.S. Fish and Wildlife Service (USFWS) to conduct an intensive survey of all historic, known, potential, and new colonial waterbird breeding sites statewide as part of a western range-wide effort to track population size, trends, and locations of breeding colonial waterbirds in the western United States [17, 18]. A total of 90 sites were evaluated in Wyoming; 86 potential colonial waterbird nesting sites and 4 known nesting sites. A lack of adequate emergent vegetation to provide secure nesting areas for colonial waterbirds was noted at most potential sites visited. In 2014, an online Atlas of western colonial waterbird nesting sites was produced with data collected and submitted by participating states [19]. Every 3–5 years, WGFD personnel visit known colonial waterbird nesting sites outside of Yellowstone National Park to evaluate water level conditions, determine species present at each site, and estimate the number of nesting pairs of colonial waterbirds. There are currently no research projects designed specifically for American White Pelican in Wyoming.

ECOLOGICAL INFORMATION NEEDS

Abundances of American White Pelican have been increasing and new breeding colonies have been documented in portions of the species range, and new colonies continue to be found in the state. Breeding productivity and sizes of these new colonies in Wyoming are unknown.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. American White Pelican is classified as a SGCN in Wyoming due to a restricted breeding distribution and limited information on population trends. The colonial nature of American White Pelican and other waterbirds makes these species particularly vulnerable across their range to loss or degradation of nesting sites, stochastic weather events such as drought and flooding, changing land use practices, pollution, and climate change. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [8] and Integrated Monitoring in Bird Conservation Regions [20] programs. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, colonial waterbirds are one of the species groups that warrant a targeted, species-specific survey method approach to obtain these data. WGFD conducted inventories of nesting colonial waterbirds, including American White Pelican, from 1984–1986 [21, 22]. In 1990, WGFD summarized all information presently known on colonial nesting waterbirds in Wyoming [23]. Since 1984, WGFD has conducted annual or periodic monitoring at the most important and productive sites for colonial waterbird SGCN. Results have shown American White Pelican nesting consistently at three sites in Wyoming; Bamforth Lake near Laramie, Pathfinder Reservoir near Casper, and Yellowstone Lake in Yellowstone National Park [3]. Due to their sensitivity to human disturbance during the nesting season, the survey technique used for colonial waterbirds is minimally invasive and provides only an estimate of the number of breeding pairs and coarse habitat associations of each waterbird species present in the colony. Actual nests, eggs, or young are not located or counted to prevent colony disruption and reduce predation risk. From 2009–2012, WGFD and USFWS cooperated to conduct a rigorous survey of all historic, known, potential, and new colonial waterbird breeding sites statewide as part of a western range-wide effort to track population size, trends, and locations of breeding colonial waterbirds in the western United States [17, 18]. A total of 90 sites were evaluated in Wyoming; 86 potential colonial waterbird nesting sites and 4 known nesting sites. A lack of adequate emergent vegetation to provide secure nesting areas for colonial waterbirds was noted at most potential sites visited. An online Atlas of western colonial waterbird nesting sites was produced with data collected and submitted by participating states [19]. Best management practices to benefit American White Pelican include maintaining large, high quality wetland complexes; keeping water levels stable during the nesting season; maintaining ample foraging areas within range of nesting colonies; installing and maintaining nesting islands where needed; protecting any colony site used by American White Pelican; keeping human disturbance to a minimum during the breeding season and maintaining a minimum disturbance-free buffer zone of 100–180 m; and monitoring colony sites every 3–5 years to determine American White Pelican presence and estimate number of nesting pairs [11].

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Figure 1: Adult American White Pelican in summer plumage in Weld County, Colorado. (Photo courtesy of Bill Schmoker)

Figure 2: North American range of *Pelecanus erythrorhynchos*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: American White Pelican foraging habitat at the A & M Reservoir in southwest Wyoming. (Photo courtesy of Lusha Tronstad)

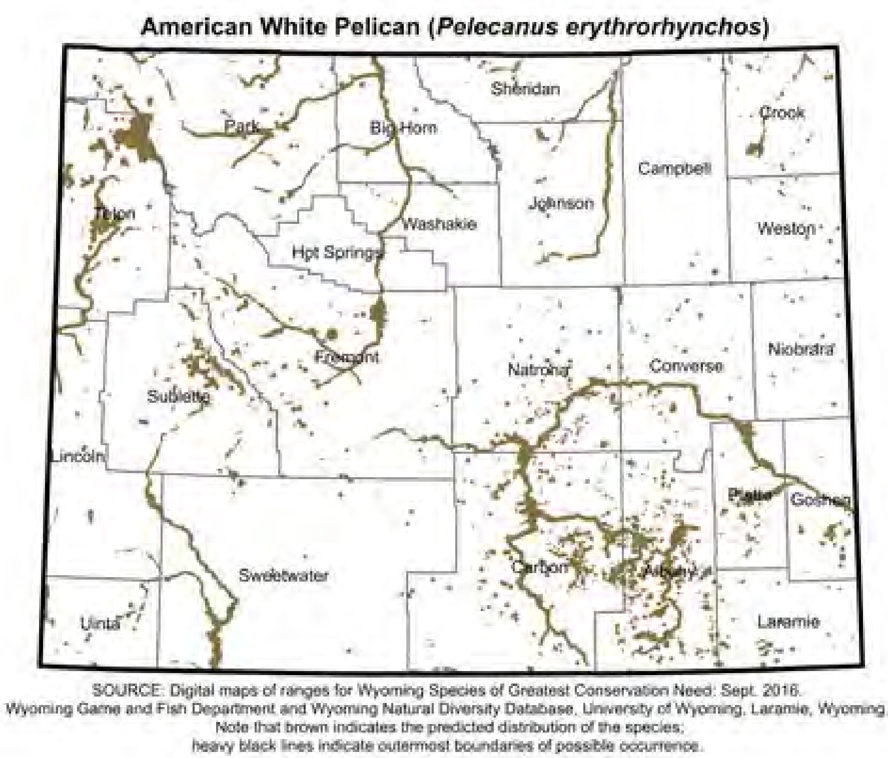

Figure 4: Range and predicted distribution of *Pelecanus erythrorhynchos* in Wyoming.


Figure 5: Adult American White Pelican in breeding condition (note keel on upper mandible) in Laramie County, Wyoming. (Photo courtesy of Pete Arnold)

Ash-throated Flycatcher
Myiarchus cinerascens

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G5, S1S2
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 9

STATUS AND RANK COMMENTS
The Wyoming Natural Diversity Database has assigned Ash-throated Flycatcher (*Myiarchus cinerascens*) a state conservation rank ranging from S1 (Critically Imperiled) to S2 (Imperiled) because of uncertainty about the extent of the species' breeding range, amount of occupied habitat, and population trends in Wyoming.

NATURAL HISTORY
Taxonomy:
There are two subspecies of Ash-throated Flycatcher, but only *M. c. cinerascens* is found in Wyoming [1, 2].

Description:
Identification of Ash-throated Flycatcher is possible in the field. Adults weigh roughly 27 g, range in length from 19–21.5 cm, and have a wingspan of 30–32 cm [1, 3]. Males, females, and juveniles are nearly identical in appearance. Ash-throated Flycatcher has a brownish-gray back and head with a bushy crest; pale gray throat and breast; very light yellow belly; some rufous coloration on the primaries and tail feathers; and a dark bill, eyes, and legs [1, 3]. Other flycatchers in the genus *Myiarchus* are similar in appearance to Ash-throated Flycatcher but are unlikely to be found in Wyoming [4].

Distribution & Range:
During the breeding season, Ash-throated Flycatcher is found in the western and southwestern United States, northern Baja Peninsula, and inland Mexico [1]. Local expansions have occurred on the periphery of the species' range, including Wyoming [1, 4]. Southwestern Wyoming is on the northeastern edge of the core breeding distribution of Ash-throated Flycatcher, which is a summer resident in the state [4, 5]. Confirmed or suspected breeding has been documented in just 3 of the state's 28 latitude/longitude degree blocks, all is southwestern and southcentral Wyoming

[5]. Disjunct populations have more recently been identified in Fremont and Natrona counties in central Wyoming [4]; however, there are no known breeding records from those areas [5]. Ash-throated Flycatcher migrates out of Wyoming for the winter and overwinters from extreme southern California and southwestern Arizona to northern Central America [1].

Habitat:
Across its continental distribution, Ash-throated Flycatcher inhabits a variety of arid and semi-arid environments including desert scrub, riparian corridors, and open woodlands dominated by piñon (*Pinus* spp.), juniper (*Juniperus* spp.), and oak (*Quercus* spp.) [1]. In Wyoming, the species is found in mature Utah Juniper (*J. osteosperma*) woodlands [1, 4], where it is most frequently observed on steep hillsides or heavily-eroded lowlands with large trees and an open understory [4, 6]. Ash-throated Flycatcher is an opportunistic secondary cavity nester; nest are commonly ≥ 0.3 m above the ground in natural and woodpecker-excavated cavities as well cavities in a wide variety of man-made structures and objects [1]. Nests have been documented in natural tree cavities in southwestern Wyoming [6]. Nest cavities are lined with fine plant materials, feathers, wild and domestic animal hair, and other scavenged soft materials [1].

Phenology:
Spring arrival of Ash-throated Flycatcher in Wyoming likely occurs in early May [4]. Nesting chronology in Wyoming is unknown, but egg laying probably occurs 1–3 weeks after arrival on the breeding grounds. In other parts of its distribution, incubation lasts 14–16 days and fledging occurs at 13–17 days of age. Parental care continues for up to 2 weeks after fledging [1]. Ash-throated Flycatcher is predominantly a single brood species, although two broods may be produced in some southern, low-elevation areas where breeding seasons are longer [1]. Fall migration from Wyoming likely occurs before early September [4].

Diet:
Ash-throated Flycatcher predominantly consumes arthropods, some fruit, and infrequently small reptiles and mammals such as lizards and mice [1].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
Ash-throated Flycatcher has a statewide abundance rank of VERY RARE, and its abundance within suitable environments in the occupied area is unknown [5]. In 2013, Partners in Flight estimated the Wyoming population of Ash-throated Flycatcher to be around 400 individuals [7]; however, this abundance estimate is based primarily on Breeding Bird Survey (BBS) data and should be viewed with caution due to the low detection rate of this species in the state. From 1968–2015, annual Wyoming BBS detections of Ash-throated Flycatcher ranged from 0 to 35, with none recorded in most years [8]. Only 5 Ash-throated Flycatchers were detected during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [9]. More targeted surveys in juniper woodland habitat may be necessary to adequately detect Ash-throated Flycatcher in Wyoming.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN

Robust population trends are not available for Ash-throated Flycatcher in Wyoming because the species is infrequently detected during monitoring efforts. Survey-wide trend data from the North American BBS indicate that Ash-throated Flycatcher numbers experienced a statistically significant annual increase of 0.92% from 1966–2013 and a non-significant annual increase of 0.70% from 2003–2013 [10].

Intrinsic Vulnerability:
HIGH VULNERABILITY
Ash-throated Flycatcher has high intrinsic vulnerability in Wyoming due to low abundance, a narrow range of breeding habitats, and potentially restrictive nesting habits. Although it is found in a variety of habitat types across its continental distribution, Ash-throated Flycatcher is only known to breed in Utah Juniper woodlands in Wyoming. Mature juniper forests are rare in the state [11], which likely limits the breeding distribution of this species. Breeding can be limited by the availability of suitable nest cavities in some environments [1]. Ash-throated Flycatcher will also nest in cavities of a variety of man-made structures; however, this adaptive behavior has not been documented in Wyoming.

Extrinsic Stressors:
MODERATELY STRESSED
Ash-throated Flycatcher breeds in Utah Juniper woodlands in Wyoming, and natural and anthropogenic disturbances to this environment could negatively impact the species. Piñon and juniper woodlands have been expanding in many areas of the western United States since the mid-1800s [12]; however, Wyoming is predicted to lose a majority of its Utah Juniper woodlands over the next century due to changing climate [13]. Existing juniper woodlands in the state are potentially vulnerable to changes in fire regime; invasive species such as Cheatgrass (*Bromus tectorum*); drought and climate change; habitat fragmentation; and human disturbance, including juniper removal and thinning programs [11]. In addition, juniper woodlands in southwestern Wyoming are often associated with rocky habitats, which are threatened by potential energy development and exposure to anthropogenic disturbances from recreational activities [11, 14]. Practices that remove large, mature juniper trees and snags from the landscape may reduce the availability of natural and woodpecker-excavated cavities for breeding Ash-throated Flycatchers. The species is likely impacted by other disturbances that alter woodland habitat structure (i.e., fire, grazing, invasive plants, etc.) [1], but research on exactly how these stressors affect Ash-throated Flycatcher is limited, conducted in other habitat types, and shows mixed effects [15, 16]. Currently, it is not known how these potential stressors impact Ash-throated Flycatcher in Wyoming.

KEY ACTIVITIES IN WYOMING

Ash-throated Flycatcher is classified as a Species of Greatest Conservation Need by the Wyoming Game and Fish Department (WGFD), and as a Level II Priority Bird Species requiring monitoring in the Wyoming Bird Conservation Plan [17]. Current statewide activities for monitoring annual detections and population trends for Ash-throated Flycatcher in Wyoming include the BBS program conducted on 108 established routes since 1968 [10], and the multi-agency IMBCR program initiated in 2009 [9]. In 2016, the WGFD began a two-year project designed to collect data on the distribution, relative abundance, and habitat use of piñon-juniper obligate species, including Ash-throated Flycatcher, in the woodlands of southwestern Wyoming.

Ecological Information Needs

There is a general lack of knowledge about Ash-throated Flycatcher in Wyoming, and the species would benefit from research to determine its detailed distribution, abundance, and breeding phenology. Nothing is known about nest success or fledgling survival in the state. The populations in Natrona and Fremont counties should be studied, since confirmation of breeding in those areas would represent a northward expansion of the known breeding distribution of Ash-throated Flycatcher in Wyoming. Likewise, breeding has recently been documented in the Nebraska panhandle within 3.2 km of Wyoming, which could suggest the possibility of breeding in southeastern Wyoming [18]. Additional research is needed to determine how Ash-throated Flycatcher populations in Wyoming might respond to natural and anthropogenic disturbances to existing habitat.

Management in Wyoming

This section authored solely by WGFD; Andrea C. Orabona. Ash-throated Flycatcher is classified as a SGCN in Wyoming due to a need for robust information on breeding status and population trend in Wyoming; limited distribution of required breeding habitat; loss, degradation, and fragmentation of Utah Juniper habitat due to industrial developments; and incompatible management practices [11]. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the Breeding Bird Survey [10] and Integrated Monitoring in Bird Conservation Regions [9]. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, Ash-throated Flycatcher needs a targeted, species-specific survey method approach to obtain these data. Initial work and written species accounts on avian Utah Juniper obligate species, including Ash-throated Flycatcher, occurred in 1988 [19]. However, higher priorities and limited personnel and funding precluded conducting additional work on these species. Best management practices to benefit Ash-throated Flycatcher include implementing a sufficient monitoring technique; maintaining mature stands of Utah Juniper habitat where Ash-throated Flycatcher nests, including herbaceous vegetation and shrubs for foraging, and abundant snags for perching; implementing prescribed and natural fire management to maintain savannah-like stands of juniper woodlands in areas occupied by Ash-throated Flycatcher; and coordinating Utah Juniper management to provide a mosaic of juniper woodland conditions [20].

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Figure 1: Adult Ash-throated Flycatcher in-hand in Cibola National Wildlife Refuge, California. (Photo courtesy of Carolyn Anderson)

Figure 2: North American range of *Myiarchus cinerascens*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Ash-throated Flycatcher habitat in southwestern Wyoming, dominated by Utah Juniper. (Photo courtesy of Leah H. Yandow, WGFD)

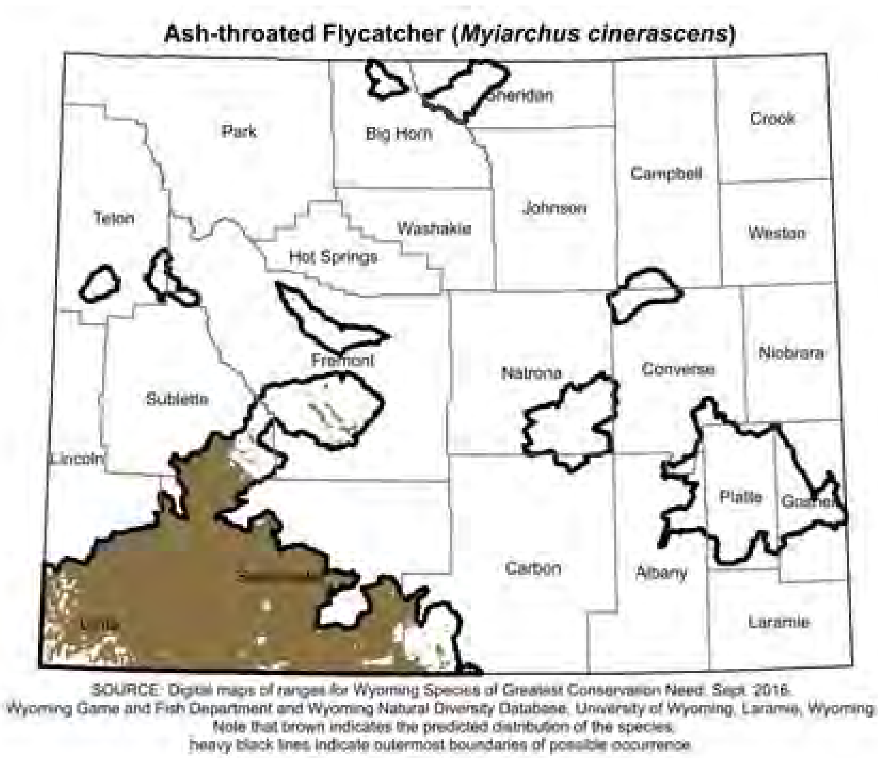

Figure 4: Range and predicted distribution of *Myiarchus cinerascens* in Wyoming.

Baird's Sparrow
Ammodramus bairdii

REGULATORY STATUS
USFWS: Listing Not Warranted; Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: Sensitive
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: Bird of Conservation Concern
WGFD: NSS4 (Bc), Tier II
WYNDD: G4, S1
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 15

STATUS AND RANK COMMENTS
Baird's Sparrow (*Ammodramus bairdii*) does not have any additional regulatory status or conservation rank considerations in the United States beyond those listed above. As is summarized in Jones and Green (1998), Wiggins (2006), and Committee on the Status of Endangered Wildlife in Canada (2012) [1-3], the species was proposed for listing under the Federal Endangered Species Act in the United States and under COSEWIC in Canada. In 1991, the United States determined that lack of data made listing questionable. It was re-proposed for listing as Threatened in 1997, but the listing was denied in 1999. In Canada, COSEWIC designated Baird's Sparrow as Threatened in 1989 due to steep declines in the early 1980s, prepared a recovery plan in 1993, and delisted the species in 1996 due to improved population numbers, primarily in Saskatchewan. In May 2012, Baird's Sparrow was placed in a higher risk category in Canada after reassessment, and is now considered a special concern species, meaning that it may become threatened or endangered due to a combination of biological characteristics and identified threats to the species.

NATURAL HISTORY

Taxonomy:
There are no subspecies recognized for Baird's Sparrow [4]. The genus *Ammodramus* is a group of species that are both morphologically and genetically diverse, thus they may not form a natural group, and the sound relationships between species in this genus are inadequately resolved [5-7]. The most recent genetic evidence suggests that Baird's Sparrows and Henslow's Sparrows (*A. henslowii*) were once closely related among the grassland sparrows, but that the species diverged long ago [6].

Description:
Identification of Baird's Sparrow is possible in the field by knowledgeable observers. Baird's Sparrow is a small (length 12 cm, mass 19 g), brownish sparrow with streaks [4]. Similar species that occur in Wyoming are Savannah Sparrow (*Passerculus sandwichensis*), Grasshopper Sparrow (*A. savannarum*), and LeConte's Sparrow (*A. leconteii*). Baird's Sparrow has a somewhat flat head; a heavy bill; yellow-ochre color on the head and supercilium; an ochre median crown stripe; a dark throat stripe and dark border along the upper and lower borders of the ear coverts; a buff colored neck collar with thin blackish streaks; upperparts with blackish and pale brownish markings; tan wings; a long, slightly notched tail with thin whitish edges on the rectrices; whitish underparts with blackish streaking on the breast and flanks; and no central breast spot [4]. The iris is brown; bill and gape are brownish with a pale-flesh color on the lower mandible; and legs and feet are a pale-flesh color [8]. Males and females are similar in appearance; however, females show a bit more streaking on the breast and less distinct coloring on the crown and face (W. Godfrey, pers. comm.). Juveniles resemble adults, with the exception of heavier streaking on the underparts and a scalier appearance on the upperparts [4].

Distribution & Range:
The breeding range of Baird's Sparrow extends north from southeastern Montana and northwestern South Dakota into south-central Canada [4]. Baird's Sparrow has been documented in 11 of Wyoming's 28 latitude/longitude degree blocks, with circumstantial evidence of breeding noted in 3 of those 11 degree blocks [9]. Baird's Sparrow is a summer resident in Wyoming and winters in the extreme southwestern United States and northern Mexico [4].

Habitat:
Baird's Sparrow is an area sensitive species [10]. Across its breeding range, the species prefers large expanses of ungrazed or moderately grazed native prairie habitats comprised of a mosaic of grass species and little shrub cover (exact species vary depending on the province or state of occurrence) [11-14]. Specific habitat associations have not been described in Wyoming, but species locations have all occurred in areas of the state with mixed grass habitats, although these sites are more limited than those in the neighboring states of Montana and South Dakota where the species is more prevalent [9, 15]. Studies from northwestern North Dakota show that Baird's Sparrow breeding territories are comprised of grasslands with litter up to 2 cm deep; < 10% woody cover; a relatively high forb content (29%); mid-height vegetation with a mean height of 23 cm; a patchy distribution of forbs, grasses, and bare soil; a greater litter depth within (1.19 cm) than outside (0.87 cm) territories; and < 75% shrub cover [16].

Phenology:
Baird's Sparrow is a complete short- to medium-distance migrant, breeding in the northern Great Plains of the United States and wintering in the desert grasslands of the extreme southwestern United States and into northern and central Mexico [17, 18]. In Wyoming, there are only nine reports of Baird's Sparrow during spring migration, from 25 April to 30 May [15]. During the summer breeding season, Baird's Sparrow appears to occur regularly in Wyoming, but sightings are either very rare or are rarely reported, and confirmed evidence of breeding is needed. Approximately 20 Baird's Sparrow sightings have been reported during the summer [15], but only 3 of these were vetted by the WBRC and accepted as circumstantial evidence of breeding in Albany (8 June), Converse (3 June), and Laramie (16 June) Counties [9, 19]. Elsewhere in its range, Baird's Sparrow initiates egg laying from late May to early June, but this can vary both geographically and by year [4]. In neighboring South Dakota, clutches were initiated from 13 June

to 24 July [20]. Clutches are typically comprised of 4 (sometimes 5) eggs, but can range from 3–6 [4, 21]. Second broods have been confirmed in southwestern Manitoba [22] and north-central Montana (S. Jones, pers. comm.).

Diet:
During the breeding season, Baird's Sparrow consumes invertebrates and insects, including beetles (*Coleoptera*), grasshoppers (*Orthoptera*), and caterpillar larvae (*Lepidoptera*), as well as a variety of grass seeds, weed seeds, and waste grains [23]. Young are fed entirely insects [21]. Baird's Sparrow forages on the ground and is mostly hidden from view, gleaning items from between clumps of grass, over litter, and from the stems of grasses and forbs [4].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
Using North American Breeding Bird Survey (BBS) data, the Partners in Flight Science Committee estimated the global population of Baird's Sparrow to be 2 million birds [24]. Approximately 0.40% of the global population, or an estimated 8,000 birds, breed in Wyoming [25]. However, these estimates should be viewed with caution due to the low number of detections of the species in Wyoming. The statewide rank of RARE is based on the limited area of the state known to be occupied in any given season, and the relatively small coverage of suitable habitat within that area. Within suitable habitat in the occupied area, Baird's Sparrow also appears to be uncommon, occurring in relatively low densities and requiring intensive survey efforts to detect the species [9]. Baird's Sparrow has not been detected in Wyoming during Integrated Monitoring in Bird Conservation Regions (IMBCR) survey efforts; thus, density and population size estimates are not available [26].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Population trends are not available for Baird's Sparrow in Wyoming due to a limited distribution in the state and low detection rates during monitoring surveys. Currently, there are no robust BBS trend data for Baird's Sparrow in Wyoming due to an extremely limited observation sample size (N = 7 routes; 1968–2013) [27]. Survey-wide, Baird's Sparrow declined significantly by 2.93% between 1966–2013 but no trend was observed between 2003–2013 [27].

Intrinsic Vulnerability:
HIGH VULNERABILITY
Baird's Sparrow is a grasslands specialist endemic to the northern Great Plains [4, 28]. Loss of breeding habitat through degradation and fragmentation has impacted this species [1, 2, 4, 28]. Small grassland fragments can decrease nesting productivity and lead to nest parasitism. Suitable habitat is limited to native grasslands with some use of hay fields, seeded pastures, stubble fields, and retired croplands [1, 28]. Baird's Sparrow is shown to be positively associated with native grasses and negatively associate with Smooth Brome (*Bromus inermis*) [1]. Improper habitat management and lack of disturbance has led to decreased habitat availability for Baird's Sparrow.

Extrinsic Stressors:
MODERATELY STRESSED
Baird's Sparrow is highly impacted by degradation of native prairie [1, 2, 4, 28]. Total area of mixed-grass prairie has declined an estimated 30–99% in the US, with less than 0.01% of prairie habitat protected throughout the United States [29]. A majority of habitat loss has come from grassland conversion to agriculture [2]. Grassland fragment size is important to Baird's Sparrow populations, and even small conversions may be significant [28]. Overgrazing and poor range management has additionally been attributed to Baird's Sparrow declines [1]. Nest parasitism may impact Baird's Sparrow populations. Although brood parasitism rates are reported as low, reproductive success is significantly reduced when nests are parasitized [2]. Climate change and changes in drought frequency could impact Baird's Sparrow. Invasion of exotic grasses has been shown to additionally create unsuitable habitat [2].

KEY ACTIVITIES IN WYOMING

The Wyoming Game and Fish Department (WGFD) classifies the Baird's Sparrow as a Species of Greatest Conservation Need (SGCN). The species is not adequately monitored by current national or regional avian monitoring efforts in Wyoming, including the IMBCR program initiated in 2009 (0 detections since initiation) [26] or the BBS program conducted on 108 established routes since 1968 [27]. No systematic survey of Baird's Sparrow has been conducted in Wyoming, and there are no new or on-going research or monitoring projects designed specifically for this species in the state. Observations of this species are reported to the WGFD and vetted through the Wyoming Bird Records Committee (WBRC). Baird's Sparrow is a species for which the WBRC requests documentation on all sightings in the state.

ECOLOGICAL INFORMATION NEEDS

Information is needed on Baird's Sparrow distribution, specific habitat associations, and population status in Wyoming.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Baird's Sparrow is classified as a SGCN in Wyoming due to insufficient information on breeding, distribution, and population status and trends. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [27] and the multi-partner IMBCR [26]. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, Baird's Sparrow may require a targeted, species-specific survey method to obtain these data. Best management practices to benefit Baird's Sparrow include managing for large expanses of ungrazed or moderately grazed native prairie habitats comprised of a mosaic of grass species and little shrub cover [11-14]. While high intensity livestock grazing can be detrimental to Baird's Sparrow, low to moderate rotational grazing, light fall burning, delayed spring mowing, and minimal insecticide use can be used as habitat management tools [30].

CONTRIBUTORS

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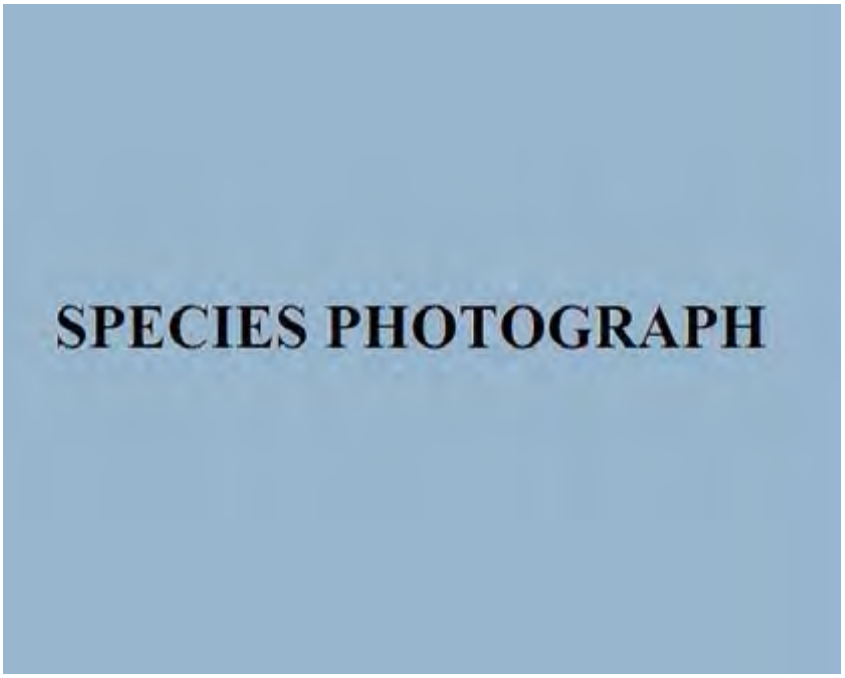

Figure 1: Photo not available.

Figure 2: North American range of *Ammodramus bairdii*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

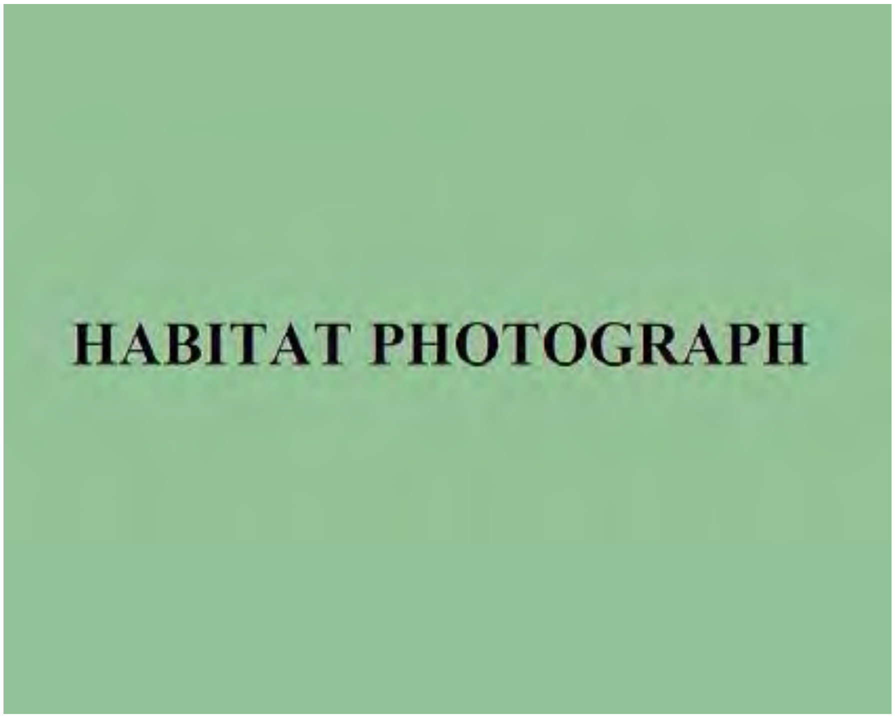

Figure 3: Photo not available.

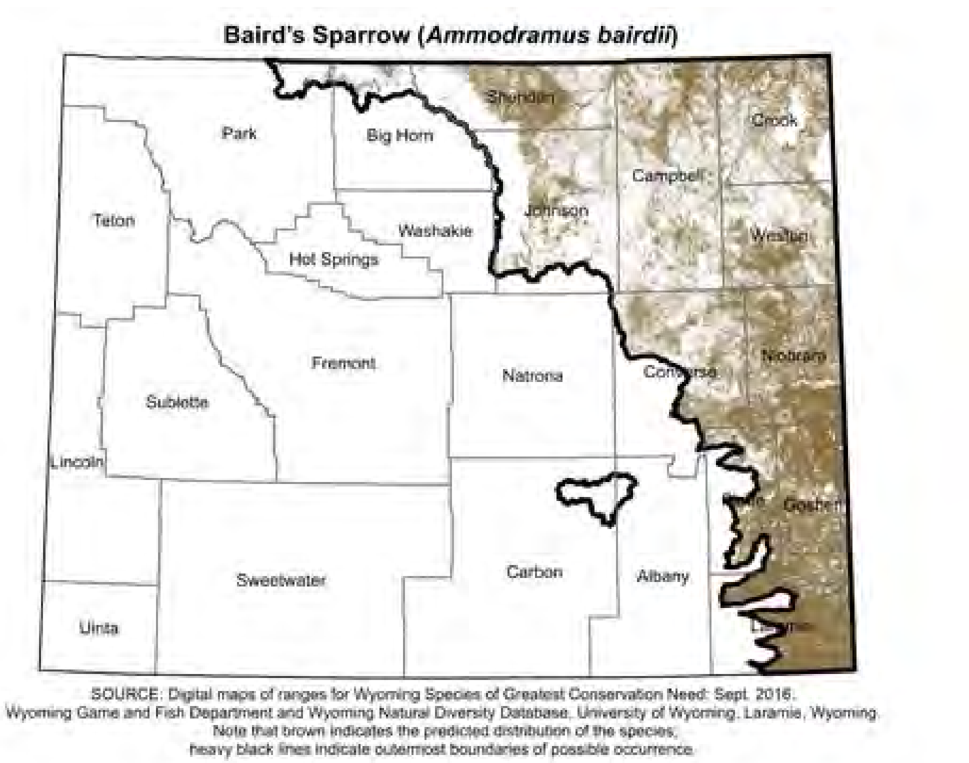

Figure 4: Range and predicted distribution of *Ammodramus bairdii* in Wyoming.

Bald Eagle

Haliaeetus leucocephalus

REGULATORY STATUS

USFWS: Delisted; Migratory Bird
USFS R2: Sensitive
USFS R4: Sensitive
Wyoming BLM: Sensitive
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: Bird of Conservation Concern
WGFD: NSS3 (Bb), Tier II
WYNDD: G5, S4B/S5N
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 9

STATUS AND RANK COMMENTS

Bald Eagle (*Haliaeetus leucocephalus*) is provided international protection under the Federal Migratory Bird Treaty Act of 1918, as amended [1]. In 1940, Bald Eagle was provided protection under the Bald and Golden Eagle Protection Act [2]. In 1966, the southern subspecies was listed as federally endangered under the Endangered Species Preservation Act; the entire population in the contiguous United States was listed as endangered in 1978 under the 1973 Endangered Species Act (ESA). A significant increase in numbers of nesting pairs, productivity, and distribution allowed Bald Eagle to be reclassified from Endangered to Threatened in 1995 under the ESA [3]. Bald Eagle was delisted in 2007, and numbers are considered to be stable to increasing across its range [4]. The species has been assigned different state conservation ranks by the Wyoming Natural Diversity Database for the breeding season and nonbreeding season because the abundance of the species is different between seasons.

NATURAL HISTORY

Taxonomy:

Bald Eagle is a member of the family Accipitridae, which includes kites, eagles, harriers, and hawks [5]. There are two subspecies of Bald Eagle; *H. l. alascanus* is found north of 40 degrees latitude across North America, including Wyoming, while *H. l. leucocephalus* is found south of 40 degrees latitude in the Gulf coast states [6].

Description:

Bald Eagle is the second largest bird of prey in North America; only the California Condor (*Gymnogyps californianus*) is larger. Bald Eagle reaches full adult plumage at age 5.5 years [7]. Identification is possible in the field. Adults are characterized by a distinctive white head and tail, dark brown body and wings, and large yellow beak and legs. Body size is variable throughout the species' range; larger individuals occur in the northern portion of the range and smaller birds occur in the southeast and southwest regions of the United States [6]. Sexual dimorphism of plumage does not occur; however, females are approximately 25% larger than males [8]. Total length ranges from 71–96 cm, wingspan ranges from 168–244 cm, and body mass ranges from 3.0–6.3 kg [8]. Juvenile Bald Eagle plumage is similar to that of an adult Golden Eagle (*Aquila chrysaetos*), with the exception of unfeathered lower tarsi in juvenile Bald Eagles. Juvenile Bald Eagles have a dark brown head, body, wings, tail, and irises; white mottling on the underwings and belly; and a blackish gray cere and beak [6]. Appearance of older immature Bald Eagles changes considerably and progressively between the juvenile and full adult plumages. The head molts progressively from dark brown to white; the beak and cere change progressively from blackish gray to yellow; the iris changes from dark brown to buffy brown to cream to yellow; and the body of immature Bald Eagles varies in the amount and distribution of white mottling [6].

Distribution & Range:
During the breeding season, Bald Eagle occupies aquatic habitats with forested shorelines or cliffs in Alaska, across most of Canada, in the Pacific Northwest, in the Rocky Mountain states, in the northern portion of the Midwest, and along the eastern coast [6]. Breeding has not been recorded outside of North America. Wyoming is on the southern portion of Bald Eagle's northern breeding range, although the entire state is part of the species' wintering range. Bald Eagle nests along major river drainages and lakes throughout Wyoming. The species has been documented in all 28 of Wyoming's latitude/longitude degree blocks, with breeding confirmed in 20 of the 28 degree blocks [9]. The northwestern and east central portions of Wyoming continue to have the highest concentrations of nesting Bald Eagles in the state. The most significant concentrations occur in Teton, Sublette, and Carbon counties, including a substantial number of nesting pairs in Grand Teton and Yellowstone National Parks [10-12]. Migration is variable and complex, and depends on the age of the individual, location of breeding territory, climate severity at the breeding site, and year-round food availability [6]. Adult Bald Eagles in some northern populations, including Wyoming, may not migrate at all; rather, they move locally to take advantage of available food sources or stay on territory where rivers remain open throughout the winter season [13, 14].

Habitat:
Bald Eagle typically nests in forested areas adjacent to rivers and large bodies of water, although a small number are found nesting along smaller drainages and lakes. For nesting, it selects mature and old-growth trees capable of supporting large nest structures in forest stands that have some habitat edge and are fairly close (typically < 2 km) to water with suitable foraging opportunities [6]. Distance from human developments and disturbance is an important factor in nest site selection [6]. In Wyoming, the number of nest sites is limited by the territorial behavior of Bald Eagle [15]. In Colorado and Wyoming, forest stands containing nest trees varied from old-growth or mature ponderosa pine to riparian corridors surrounded by rangeland [16]. Highly productive nesting areas in the Greater Yellowstone Ecosystem (GYE) have open water in winter; low severity of early spring weather, although this can be quite variable in terms of high productivity; limited human activity; and high river sinuosity with an abundance of islands, riffles, runs, and pools within the river [14, 15]. For perching and roosting, Bald Eagle prefers tall, mature coniferous or deciduous trees that provide a wide view of the surrounding terrain. Roosts are usually associated with aquatic foraging areas, although roost trees are not necessarily located as close to water as are nest trees [6].

Phenology:
Bald Eagle is diurnal and crepuscular. Adult Bald Eagles in Wyoming's GYE do not migrate. Bald Eagles in other parts of Wyoming generally migrate from late March through early April, and again from early September through October [17]. Although breeding phenology varies with latitude, nest building typically begins 1–3 months prior to egg laying [6]. In Wyoming, courtship typically occurs from January through early or mid-March, and fledging is completed by mid-July [18]. One brood is produced per year; however, a replacement clutch is possible if eggs are destroyed or removed during incubation [6].

Diet:
As an opportunistic forager, Bald Eagle selects a variety of foods across its range, which may be site-specific based on prey items available [19]. In most areas, Bald Eagle prefers fish, but also selects waterfowl and other birds, small and mid-sized mammals, and carrion [6]. Bald Eagles in the GYE are known to use over 100 different prey items, but 89% are fish [14]. It hunts live prey, scavenges on carrion, and pirates food [20].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: UNCOMMON
Using Breeding Bird Survey data, the Partner's in Flight Science Committee estimated the global population of Bald Eagle to be 250,000 birds [21]. Although a population estimate was not provided, about 0.5% of the global population is estimated to breed in Wyoming [22]. The statewide rank of UNCOMMON is based on the limited area of the state known to be occupied in any given season, and the relatively small coverage of suitable habitat within that area. Within suitable habitat in the occupied area, Bald Eagle also appears to be uncommon, occurring in relatively low densities and requiring intensive survey efforts to detect the species, with the exception of the GYE [9]. During the breeding season, Bald Eagle nests along all major river systems in Wyoming, with the largest number of nesting pairs occurring in the GYE along the Snake River drainage and its tributaries. The minimum number of nesting territories in the state is estimated at 101 [10-12]. Nesting data from 83 territories checked in western Wyoming in 2015 showed 74 occupied territories (89%) [12]. Of the 67 territories checked for productivity, 57 (85%) produced a total of 81 mature young, or 1.42 mature young per nest [12]. Bald Eagle has widespread distribution in North America [20].

Population Trends:
Historic: LARGE DECLINE
Recent: INCREASE
Bald Eagle populations have fluctuated over the past 200 years, and the species became rare in the mid- to late 1900s due to widespread use of pesticides (especially DDT) and human persecution [6]. Since 1980, as DDT levels in the environment dropped and human persecution decreased, Bald Eagle populations have rebounded. In the 1980s, the population of Bald Eagles in North America was estimated to be 80,000 individuals [19]. Since its ESA listing, Bald Eagle populations have been increasing in the contiguous 48 states; the number of nesting territories nearly tripled between 1980 and 1990 [23]. In 1999, the population was estimated to be 100,000 birds [6]. In Wyoming, the number of nesting pairs of Bald Eagles appears to have stabilized in the

Snake River drainage, but the nesting population is still increasing in the Green River Basin and likely at other locations in the state [10].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
In Wyoming, Bald Eagle is mainly restricted to major river drainages and lakes for nesting, although as the population has increased a few pairs are being found located along riparian stream corridors and smaller lakes and reservoirs. Although Bald Eagle has a long lifespan, it has a relatively low reproductive rate, producing only 1 brood per year [6], and exhibits a delayed age of first reproduction. Bald Eagle feeds at a high trophic level, making it more susceptible to negative effects from bioaccumulation [24].

Extrinsic Stressors:
SLIGHTLY STRESSED
Humans cause the most significant source of mortalities for Bald Eagle [6]. The negative impacts of human disturbance increase with increasing duration and frequency of the disturbance events [25]. Bald Eagle is particularly susceptible to human disturbance during the breeding season, and may abandon a nest if its disturbance threshold is exceeded [6]. In addition to disturbance by humans, major threats range-wide include habitat loss, biocide contamination, a decrease in prey availability, and illegal shooting [26], as well as vehicular collisions, electrocution, and wind farms. Bald Eagle can also be highly vulnerable to West Nile virus [27]. Organophosphorus and carbamate pesticides, heavy metals, and other environmental toxins threatened Bald Eagle survival and reproduction [6]. Lead poisoning can cause a significant amount of injury and death to Bald Eagle [24, 28]. In some areas, expansion of Bald Eagle breeding populations and carrying capacity may be limited by human development [29]. In Wyoming, nesting Bald Eagles continue to experience some site-specific risks from increasing energy development, rural development, recreational activities, and environmental contaminants [10-12]. Loss of older-aged cottonwood and conifer trees suitable for nesting near major rivers and lakes as a result of climate change and large-scale, more frequent forest fires, and changing hydrological conditions may also limit nesting habitat in the future [30].

KEY ACTIVITIES IN WYOMING

Bald Eagle has been federally protected under the “Bald and Golden Eagle Protection Act,” and subsequent amendments, since 1940. This act prohibits the “take” of Bald Eagles and Golden Eagles, which also includes parts, nests, and eggs of the species. This act also provides year-round protection for nest sites that may be affected by human activities [2]. The Wyoming Game and Fish Department (WGFD) initiated monitoring for Bald Eagle statewide in 1978, and continues to conduct annual nesting surveys for the species with most effort concentrated in western Wyoming. Currently, Wyoming participates in the National Post-delisting Monitoring Plan for Bald Eagle by contributing survey data to the monitoring effort [31]. WGFD nest survey objectives include monitoring Bald Eagle occupancy and productivity at nesting territories in the Snake River, Salt River and Green River Basin, south to Seedskadee National Wildlife Refuge [10-12]. Additional nesting and surveillance data are collected around the state by WGFD personnel. Data are also collected from Bald Eagle nest sites in Yellowstone National Park and by private consultant groups in other parts of Wyoming in association with energy development. The WGFD is actively involved in reviewing new federal regulations pertaining to Bald Eagle through participation in the Central Flyway Nongame Migratory Bird Technical Committee. The WGFD also provides information to the public, federal agencies, and other state agencies on the status of Bald Eagle nests, and provides recommendations on mitigation measures to conserve nest sites in Wyoming [10, 12]. Management guidelines have been developed for Bald Eagle nest sites for the GYE, which provide valuable information for avoiding disturbance to nesting eagles [32]. The United States Army Corp of Engineers provides support for Bald Eagle monitoring in the Jackson area to help schedule maintenance work along the diked portions of the Snake River where a concentration of nest sites are found [11, 12].

ECOLOGICAL INFORMATION NEEDS

Bald Eagle has been widely studied, and over 2,000 studies related to this species have been published [6]. Additional research is needed to assess the viability of Bald Eagle populations in landscapes altered by human developments, and to determine tolerance limits of Bald Eagle to human developments and activities [6]. Some productive Bald Eagles in Wyoming still experience site-specific risks due to increasing energy development, rural development, recreational activities, and environmental contaminants; thus, more information on specific tolerance levels and mitigation measures is needed [12]. Research is also needed to assess Bald Eagle ecology and habitat use in areas of Wyoming with intense energy development, such as the Powder River Basin, and Green River/New Fork areas south of Pinedale [15]. Necropsies on available fresh specimens are valuable for tracking disease and contaminant levels.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona and Susan M. Patla. Bald Eagle is classified as a Species of Greatest Conservation Need in Wyoming due to restricted population size and sensitivity to human disturbance, especially during the breeding season [15]. As such, WGFD management actions include annual monitoring to determine Bald Eagle nest occupancy and productivity, especially in areas of Wyoming that are experiencing large increases in energy and housing development and recreation along major river corridors. WGFD monitors Bald Eagle populations that nest in western Wyoming on the Snake and Green River drainages, and obtain other nesting data where available [12]. We have detected > 139 nest sites to-date, but believe potential habitat exists to support > 200 Bald Eagle territories statewide [12]. In 2015, we obtained occupancy data for 101 territories and productivity data for 67 nest sites, with Bald Eagle occupying a high proportion (i.e., ≥ 83%) of nesting territories monitored, and producing an average of 1.6 young per successful nest [12]. In addition, WGFD personnel continue to work cooperatively with landowners and personnel from other agencies and organizations to ensure optimum habitat for Bald Eagle is maintained across the state. In 2016, a genetic study of eagles nesting in the GYE was initiated by the Teton Raptor Center, Oklahoma State University, WGFD, and other partners to determine genetic connectivity, inbreeding coefficients, genetic health and contribution of the GYE population to overall Bald Eagle recovery.

CONTRIBUTORS

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Figure 1: Bald Eagle in Sublette County, Wyoming. (Photo courtesy of Elizabeth Boehm)

Figure 2: North American range of *Haliaeetus leucocephalus*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

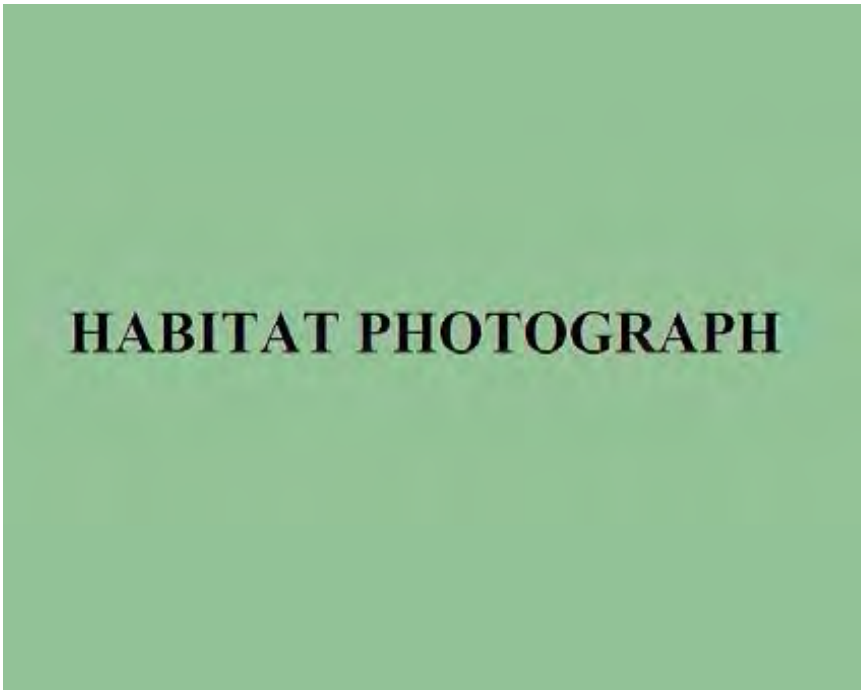

Figure 3: Photo not available.

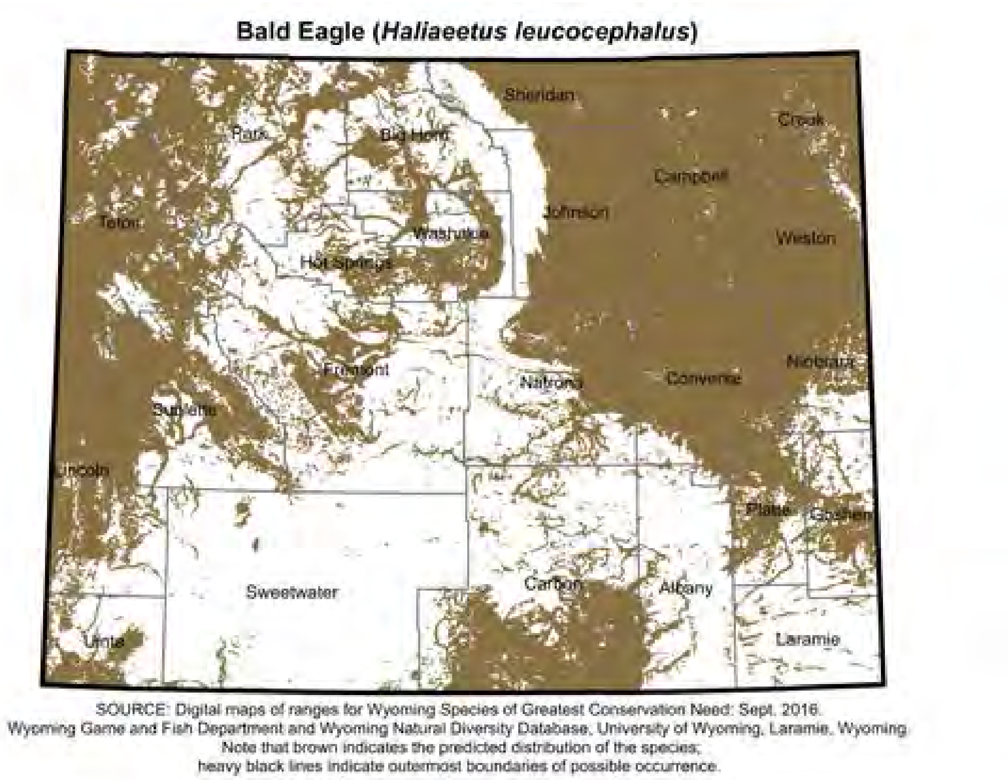

Figure 4: Range and predicted distribution of *Haliaeetus leucocephalus* in Wyoming.


Figure 5: Bald Eagle soaring over Seedskadee National Wildlife Refuge, Sweetwater County, Wyoming. (Photo courtesy of Tom Koerner, USFWS)

Bewick's Wren
Thryomanes bewickii

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS4 (Bc), Tier III
WYNDD: G5, S2
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 10

STATUS AND RANK COMMENTS
Bewick's Wren (*Thryomanes bewickii*) does not have any additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY
Taxonomy:
A member of the Troglodytidae Family, there are 15 recognized subspecies of Bewick's Wren, although two are now extinct [1]. Subspecies identification is based mainly on dorsal color, which can be complicated in study skins due to postmortem changes in color, where grays become more tannish and browns become more reddish [1]. The only subspecies that occurs in Wyoming is *T. b. eremophilus* [2].

Description:
Identification of Bewick's Wren is possible in the field, although the species varies considerably across its range in both size and color, with individuals in more northern latitudes having a larger size and those in more humid climates showing a darker plumage [1]. Bewick's Wren is medium-sized (length 13 cm, mass 11 g) with a very conspicuous, white supercilium or "eyebrow"; a relatively long tail that has barring on the middle feathers and white spots on the tips of the outer feathers; brown to grayish-brown upperparts; whitish throat and underparts; a gray wash on the sides and flanks; and grayish legs [1]. Males and females are similar. Feathers on the underparts of juveniles have dusky edges that often form scallops [1]. The only subspecies of Bewick's Wren to occur in Wyoming, *T. b. eremophilus*, is the grayest of all 15 subspecies. The most similar other subspecies is also the most geographically proximate to Wyoming: *T. b. cryptus* in eastern Colorado and points farther southeast. However, the dorsum of *T. b. eremophilus* is paler and grayer, and the central rectrices are a grayish-brown instead of brown [1]. The species most similar

to Bewick's Wren in Wyoming is House Wren (*Troglodytes aedon*), which is smaller, has a gray throat and underparts, and lacks the white supercilium and tail spots [1].

Distribution & Range:
Bewick's Wren ranges widely across western and south-central North America from southwestern British Columbia to southern Mexico, although distribution is discontinuous across that range [1]. The subspecies that occupies Wyoming extends from eastern California to extreme southern Wyoming and western Colorado, and south to central Mexico [1]. Bewick's Wren has been documented in 12 of Wyoming's 28 latitude/longitude degree blocks, with the majority of its range restricted to the southwestern-most counties [3, 4]. Within that range, breeding has been documented in 4 degree blocks and circumstantial evidence of nesting has been noted in another (Uinta, Sweetwater, and Carbon Counties) [3, 4]. Additional information is needed on observations from Albany, Laramie, and Sheridan Counties [3]. Bewick's Wren is a summer resident in Wyoming [4], and is assumed to migrate at least short distances south for the winter. It is a year-round resident in most of the rest of its range, including Mexico [1].

Habitat:
Across its range, Bewick's Wren occupies shrubby areas, thickets of brush and scrub in open areas, open woodlands, riparian woodlands, and chaparral [5]. On breeding grounds, Bewick's Wren prefers dense, scrubby vegetation for nest concealment, mixed with open woodlands [6]. In a comparison of habitat use in a Utah Juniper (*Juniperus osteosperma*) bird community in southwestern Wyoming, Bewick's Wren was found in areas of higher overstory juniper canopy cover than other avian species within the community [7]. The species also preferred woodlands with intermediate grass cover, tree height, seedling and sapling presence, and bare ground or rock cover [8]. In a study of avian community responses to juniper woodland structure and thinning treatments conducted on the Colorado Plateau, Bewick's Wren was found to be positively related to juniper density [9]. Habitat used during the winter is similar to that used on the breeding range [1].

Phenology:
Across most of its range Bewick's Wren is a year-round resident or short-distance migrant [1]. Migration does not appear to occur in southwestern British Columbia [10], but is assumed to occur in northerly interior population segments such as those in Wyoming, Kansas, and Missouri [1]. Overall, little information is available on Bewick's Wren migration. In Wyoming, the earliest date reported for spring migration is 17 April in Sweetwater County [3]. The species is known to migrate through western Colorado in mid-March [11]; thus, it may arrive in Wyoming in late March or early April [3]. Limited autumn reports of Bewick's Wren from Wyoming suggest it departs in September, but some individuals winter in Colorado and Utah. More information is needed on how many Wyoming birds leave, when they depart, and how far south they travel [3]. During mild winters, a few individuals may stay in Wyoming [12]. During the breeding season, Bewick's Wren initiates nest building soon after males arrive on their territory [1]. The species is an opportunistic cavity nester, using a variety of available sites [1]. Clutch size is typically 5–7 eggs (range 3–8), with 1 egg laid per day until the clutch is complete [1, 13]. Second clutches have been confirmed in Kansas for Bewick's Wrens with early first clutches [1]. Incubation is 14–16 days, and young fledge 16 days after hatching [1]. Bewick's Wren is an uncommon cowbird (*Molothrus* spp.) host [14], but reports of brood parasitism indicate that individuals may either desert the nest [15] or remove the parasitic egg [16]. House Wren is known to compete for nest sites and even destroy eggs of Bewick's Wren [1].

Diet:
Bewick's Wren consumes a variety of adult and larval Arthropods of various families (e.g., insects, spiders, beetles, bees, grasshoppers, crickets, and flies), as well as butterflies and moths (*Lepidoptera*) [1, 14]. Young are fed mostly caterpillars (*Lepidoptera*), plus a variety of spiders (*Araneae*), grasshoppers (*Orthoptera*), insect pupae, and small arthropods [16, 17]. Prey are taken by hopping about and gleaning items from the ground and from the leaves, branches, and trunks of low vegetation, brush, and trees; as well as by probing crevices of branches and trunks and flipping and probing under dead leaves [1]. Fruit and other plant material is eaten infrequently, and likely mostly in winter [1].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD BUT PATCHY
Wyoming: UNCOMMON
Using North American Breeding Bird Survey (BBS) data, the Partners in Flight Science Committee estimated the global population of Bewick's Wren to be 5.6 million birds [18]. Approximately 0.10% of the global population, or an estimated 6,000 birds, breed in Wyoming [19]. The statewide rank of UNCOMMON is based on the limited area of the state known to be occupied in any given season, and the relatively small coverage of suitable habitat within that area. Within suitable habitat in the occupied area, Bewick's Wren also appears to be uncommon, occurring in relatively low densities and requiring intensive survey efforts to detect the species [4]. Currently, there are not enough data from the Integrated Monitoring in Bird Conservation Regions (IMBCR) survey efforts to reliably estimate Wyoming densities or occupancy rates [20, 21].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Population trends are not available from the BBS for Bewick's Wren in Wyoming due to a limited distribution in the state and low detection rates during monitoring surveys. Substantial population declines are known from the eastern portion of Bewick's Wren range, and some increases have been documented in the southwestern U.S. [1].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
In Wyoming, Bewick's Wren has a moderate level of intrinsic vulnerability. This stems primarily from its apparently low density and somewhat strong specialization to a relatively rare set of habitats in the state [3, 7, 22]. Also, although apparently robust to some human activities, Bewick's Wren is primarily insectivorous which may place it at some risk of prey reduction and toxin bioaccumulation via pesticide application, although the degree to which this occurs in Bewick's Wren Wyoming range may be limited.

Extrinsic Stressors:
SLIGHTLY STRESSED
Stressors to Bewick's Wren populations in Wyoming are most likely associated with land use practices in preferred breeding habitat, specifically mature juniper woodlands. Juniper woodlands are extremely limited in Wyoming and are generally concentrated in the southwestern reaches of the state. These areas may be subjected to heavy livestock grazing, oil and gas

development, recreational uses, invasive species, altered fire regimes, and cowbird nest parasitism, as well as juniper thinning and removal treatments [9, 22]. While local, state, and federal land use agreements may limit adverse impacts to these areas and provide specific guidelines for alterations, particular efforts should be made to maintain multi-aged juniper woodlands with a multi-layered native understory plant community [22]. Finally, because this taxon is a cavity nester, maintaining a network of spreading, older-growth trees is crucial for long-term productivity [7]. Pesticide application also has the potential to reduce prey populations and contaminate birds themselves.

KEY ACTIVITIES IN WYOMING

Little work has been done specific to Bewick's Wren in Wyoming since it was first noted in the state in 1982 [12, 23]. Bewick's Wren is classified as a Species of Greatest Conservation Need (SGCN) by the Wyoming Game and Fish Department (WGFD), and a Wyoming Partners in Flight Level III Priority Species due to restricted habitat and a lack of information on breeding status and population trends in the state [22]. Bewick's Wren is not adequately monitored by current national or regional avian monitoring efforts in Wyoming, including the IMBCR program initiated in 2009 [21] and the BBS program conducted on 108 established routes since 1968 [20]. Observations of this species are reported to the WGFD and vetted through the Wyoming Bird Records Committee (WBRC). Bewick's Wren is a species for which the WBRC requests documentation on first latitude/longitude degree block sightings and all nesting observations. In 2016 and 2017, the WGFD will conduct a project focused on addressing data deficiencies for Utah juniper obligate species, including Bewick's Wren, in southwestern Wyoming. This project will address a number of objectives, including evaluating species distribution and richness, estimating relative abundance and occupancy rates, and quantifying and evaluating habitat characteristics.

ECOLOGICAL INFORMATION NEEDS

In Wyoming, assessment of the status of Bewick's Wren is hampered by a lack of basic ecological and population data. Additional information is needed on distribution and habitat use, and the timing and frequency of migration. Estimates of abundance and occupancy rates are needed to assess status, monitor populations, and evaluate trends. Research is needed on the effects of habitat alterations and the impact of brood parasitism. Traditional state-wide survey efforts do not tend to detect Bewick's Wren, suggesting targeted, species-specific monitoring efforts are needed. Furthermore, the distribution of juniper forests in Wyoming is far more vast than the distribution of Bewick's Wren, and thus a better understanding of habitat use and requirements at this northernmost range boundary is needed. Additional information is also needed to determine the extent of the species' occupation of other parts of Wyoming where observations have been documented, including Fremont, Natrona, Sheridan and Albany Counties [3]. A better understanding of the spatial pattern, and timing, of arthropod productivity in southwestern Wyoming would provide important information on how to manage landscapes for the benefit of Bewick's Wren and other insectivorous birds.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Bewick's Wren is classified as a SGCN in Wyoming due to unknown population status and trends in the state; a need for robust information on breeding status; limited distribution of required breeding habitat; loss, degradation, and fragmentation of Utah Juniper habitat due to industrial developments; and incompatible management practices. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [20] and IMBCR [21]. While these monitoring programs provide robust estimates of occupancy, density, or population trends for many avian species in Wyoming, survey efforts do not tend to detect Bewick's Wrens at adequate levels, suggesting targeted, species-specific monitoring efforts are needed. Best management practices to benefit Bewick's Wren are similar to those for sympatric Utah Juniper obligate species and include implementing a sufficient monitoring technique; maintaining mature stands of Utah Juniper habitat where Bewick's Wren nests, including herbaceous vegetation and shrubs for foraging; implementing prescribed and natural fire management to maintain savannah-like stands of juniper woodlands in areas occupied by Bewick's Wren; and coordinating Utah Juniper management to provide a mosaic of juniper woodland conditions [22].

CONTRIBUTORS

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Figure 1: Adult Bewick's Wren in Sweetwater County, Wyoming. (Photo courtesy of Shawn Billerman)

Figure 2: North American range of *Thryomanes bewickii*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

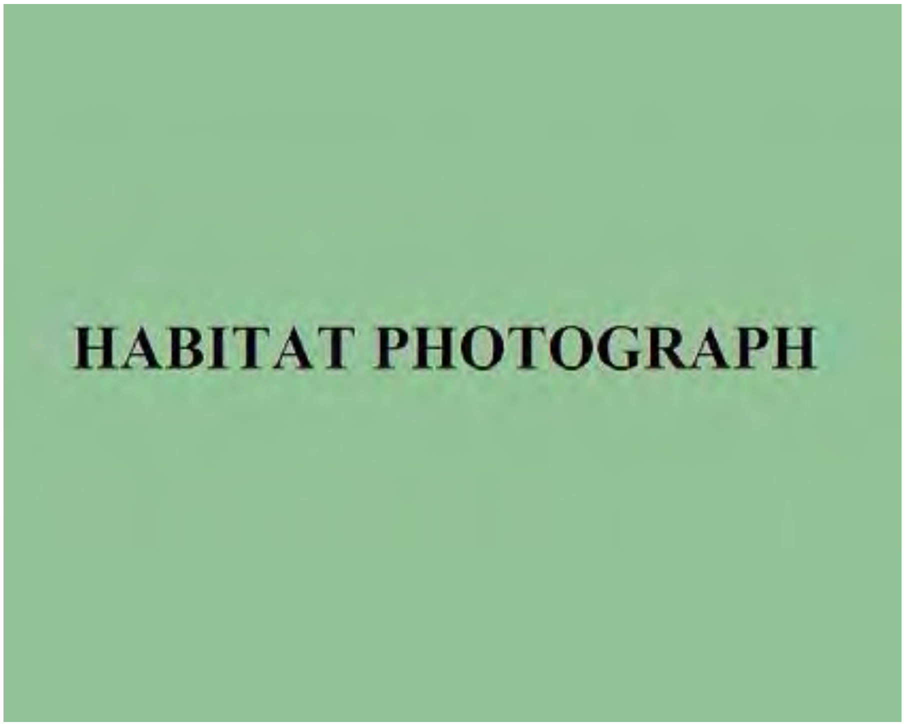

Figure 3: Photo not available.

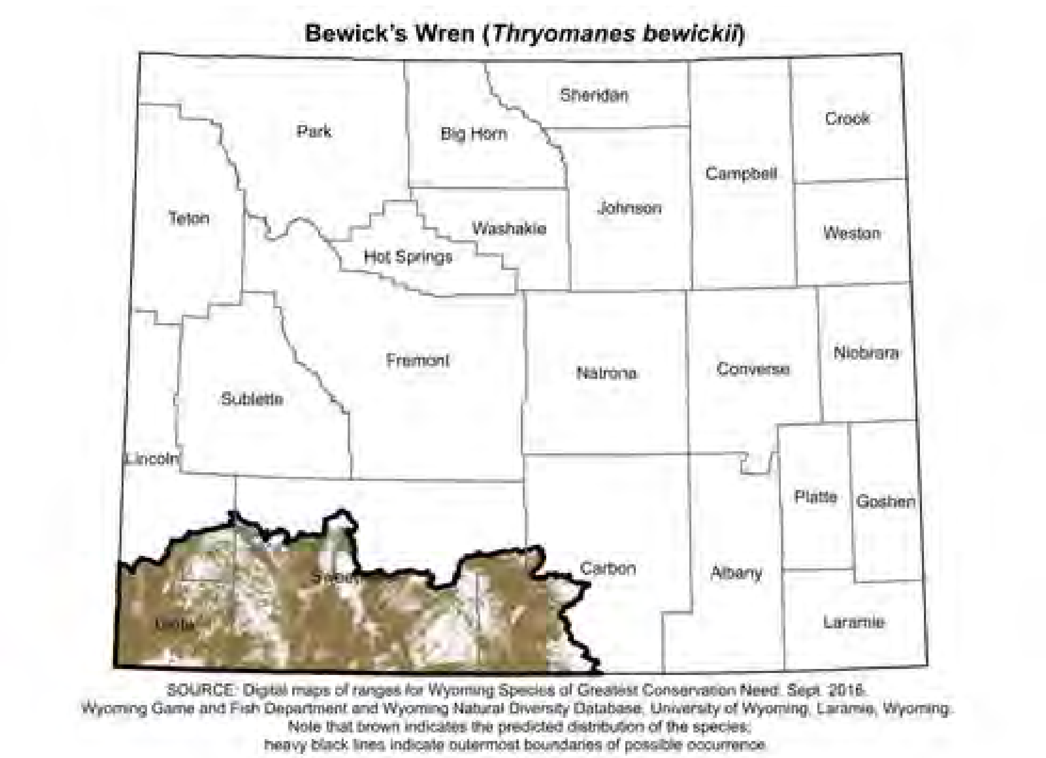

Figure 4: Range and predicted distribution of *Thryomanes bewickii* in Wyoming.

Black-backed Woodpecker
Picoides arcticus

REGULATORY STATUS
USFWS: Petitioned for Listing; Migratory Bird
USFS R2: Sensitive
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: No special status
WGFD: NSSU (U), Tier II
WYNDD: G5, S2
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 10

STATUS AND RANK COMMENTS
The subpopulation of Black-backed Woodpecker (*Picoides arcticus*) that occurs in the Black Hills has been assigned a state conservation rank of T1B and a Wyoming Contribution rank of VERY HIGH by the Wyoming Natural Diversity Database. This isolated population of Black-backed Woodpecker in the Black Hills of South Dakota and Wyoming, along with the isolated population in Oregon and California, was petitioned for listing as Threatened or Endangered under the Federal Endangered Species Act (ESA) in 2012 [1]. In 2013, the United States Fish and Wildlife Service (USFWS) issued a positive 90-day finding [2] and initiated a 12-month review, which remains in-progress. It is important to note that Black-backed Woodpecker in portions of Wyoming other than the Black Hills, such as the western mountains (see Distribution and Range, below), are not under consideration for ESA listing at this time.

NATURAL HISTORY
Taxonomy:
There are currently no recognized subspecies of Black-backed Woodpecker [3, 4]. Recent genetic evidence suggests subspecies designation may be warranted for the population in the Black Hills of Wyoming and South Dakota [5].

Description:
Identification of Black-backed Woodpecker is possible in the field. It is a mid-sized black-and-white woodpecker, similar in size and shape to Hairy Woodpecker (*Picoides villosus*) [6, 7]. Males and females differ in plumage. In both sexes, adults have a solid black head, back, wings, and tail; a solid white chin, throat, breast, and belly; and heavy barring on the sides and flanks. Males have a solid yellow cap, which is absent in females [6]. Juveniles are similar in appearance to adults, but are duller overall, have a reduced or absent yellow crown patch, and slightly buffy underparts [3, 7]. The species has only three toes on each foot, two directed forward, and one

directed backward, while most other species of woodpeckers have four toes [3]. It is most easily confused with American Three-toed Woodpecker (*P. dorsalis*) in its range. Black-backed Woodpecker can be identified by the all black back, while the back of the American Three-toed Woodpecker is white. Additionally, the American Three-toed Woodpecker has a narrow white eyebrow extending from the eye down to the back, which is lacking in the Black-backed Woodpecker [6, 7]. Downy Woodpeckers (*P. pubescens*) and Hairy Woodpeckers (*P. villosus*) are also similar looking species, but both of these species have large white patches on their backs, lack barring on their sides, and males have red patches on the back of their heads [6].

Distribution & Range:
Black-backed Woodpecker is distributed across the boreal region of northern North America, and extends south into the Cascades, Sierra Nevada, and the northern Rocky Mountain region into northwestern Wyoming. There is a disjunct population in eastern Wyoming and western South Dakota in the Black Hills. The species is non-migratory, though irruptions may occur in winter to the south of its normal range [3].

Habitat:
The Black-backed Woodpecker is restricted to mature, fire regulated, boreal and coniferous forests, which include the combination of decadent trees, snags, and fallen logs the species requires [8]. The species composition of these forests varies across Black-backed Woodpecker range. In Wyoming, habitat includes mature forests dominated by spruce (*Picea* spp.), Douglas Fir (*Pseudotsuga menziesii*), Ponderosa Pine (*Pinus ponderosa*), and Lodgepole Pine (*Pinus contorta*) [3]. Generally, the species is considered uncommon to rare in these habitats. However, local increases may occur in response to beetle outbreaks and fires [8]. These beetle-killed and burned trees, as well as decadent trees, snags, and dead wood, provide abundant wood-boring beetle larva, which the woodpecker depends upon [8]. In the Black Hills of Wyoming, the species is largely restricted to burned habitats [9, 10]. Elsewhere in its range, the species is strongly tied to unaltered areas burned within the previous four years [11-20].

Phenology:
The Black-backed Woodpecker is resident in its habitat. In winter, the species is infrequently found south of its normal range. Excavation of the nest cavity typically occurs in April and May. Egg laying is thought to occur between late April and early July. In Oregon, incubation was observed between late May and early June. Fledging was observed in Idaho at about 24 days of age, and departure from the nest occurred between early June and early July, while in Oregon young left the nest as early as mid-June [3].

Diet:
The Black-backed Woodpecker feeds primarily upon larvae of wood-boring beetles in the families Cerambycidae and Buprestidae, engraver beetles, and mountain pine beetles (*Dendroctonus ponderosae*) [3]. The woodpecker also consumes spiders, ants, wood-boring caterpillars, other insects, fruit, and mast [9].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE

Black-backed Woodpecker has a statewide abundance rank of RARE and also appears to be rare within suitable environments in the occupied area [21]. In 2013, Partners in Flight estimated the Wyoming population of Black-backed Woodpecker to be around 3,000 individuals, or about 0.40% of the global population [22]; however, this abundance estimate is based primarily on Breeding Bird Survey (BBS) data and should be viewed with caution due to the low detection rate of this species in the state. From 1968–2015, annual Wyoming BBS detections of Black-backed Woodpecker ranged from 0 to 3, with none recorded in most years [23]. Just 4 Black-backed Woodpeckers were detected during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [24].

Population Trends:
Historic: STABLE
Recent: STABLE to MODERATE DECLINE
Robust population trends are not available for Black-backed Woodpecker in Wyoming because the species is infrequently detected during monitoring surveys. Survey-wide trend data from the North American BBS suggest that Black-backed Woodpecker numbers increased annually from 1966–2013 and from 2003–2013, but these estimates have low credibility and are not statistically significant [25].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
The Black-backed Woodpecker is a fire-dependent species, utilizing the abundance of wood-boring beetles on fire-killed or fire-damaged trees for foraging, and the trees for cavity excavation [8]. The species creates new cavities for each breeding season [3].

Extrinsic Stressors:
MODERATELY STRESSED
The Black-backed Woodpecker relies on fire killed forests and trees for breeding and foraging habitat. Fire suppression threatens the long term persistence of this species across its range, including in Wyoming [3, 11, 13-15, 17, 26-28]. Additionally, salvage logging in burned and beetle-killed areas threatens this species by removing dead trees that could be used for cavities and foraging [8, 12, 14, 16, 19, 29-33].

KEY ACTIVITIES IN WYOMING

Annual BBS occasionally detect the Black-backed Woodpecker in Wyoming. These data are too limited to produce abundance estimates and population trends [25]. Similarly, the IMBCR program (formerly the Monitoring Wyoming Birds program) reports few detections of the species in the state [24]. Research focusing on demography and habitat use by Black-backed Woodpecker in burned and beetle killed forests has been conducted in the Black Hills region [34, 35]. In 2015, a graduate project was initiated at the University of Missouri, in conjunction with the United States Forest Service, to obtain Black-backed Woodpecker population estimates in the Black Hills of Wyoming and South Dakota. In 2016, call-playback surveys were conducted along 20 transects in Wyoming (totaling 200 survey locations), which resulted in 32 total detections of Black-backed Woodpecker in the state [36].

ECOLOGICAL INFORMATION NEEDS

Increased knowledge of differential habitat use, if any, between the edges of burn habitats and the interior of burn habitats is needed [8]. Basic demography is largely unknown [3]. Knowledge on the over-wintering bonds of families is needed [8]. Knowledge on the dispersal of the species after using beetle-killed forests, and fire-killed forests, is needed [8]. Abundance estimates and population trends across the species range and in Wyoming are needed.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Zachary J. Walker. Black-backed Woodpecker was petitioned for listing under the ESA in 2012 [1]. In 2013, the USFWS service issued a positive 90-day finding for this species and has begun analysis for a 12-month review [2]. Black-backed Woodpecker is classified as a Species of Greatest Conservation Need in Wyoming due to insufficient/limited information on breeding, distribution, and population status and trend. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming including the BBS and IMBCR programs. Because of the low detection rate of the aforementioned efforts, species specific surveys should be considered. Currently funded research on Black-backed Woodpecker, within the Black Hills, should be evaluated to develop a survey and management scheme. Best management practices or key management recommendations to benefit Black-backed Woodpecker include maintenance of mature conifer forest that contains an element of disturbance [37]. Management efforts should be made to retain nesting snags and allow natural fire regimes. Salvage logging after a fire should be conducted in a patchwork fashion, leaving some areas intact for Black-backed Woodpecker and other post-fire dependent species.

CONTRIBUTORS

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Figure 1: Adult male (left) and female (right) Black-backed Woodpeckers in New Hampshire. (Photos courtesy of Glen Tepke, http://www.pbase.com/gtepke/profile)

Figure 2: North American range of *Picoides arcticus*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Ideal Black-backed Woodpecker habitat. Burned forest from the 2009 Arnica Fire, in Yellowstone National Park, 1 year post-burn. (Photo courtesy of William Romme)

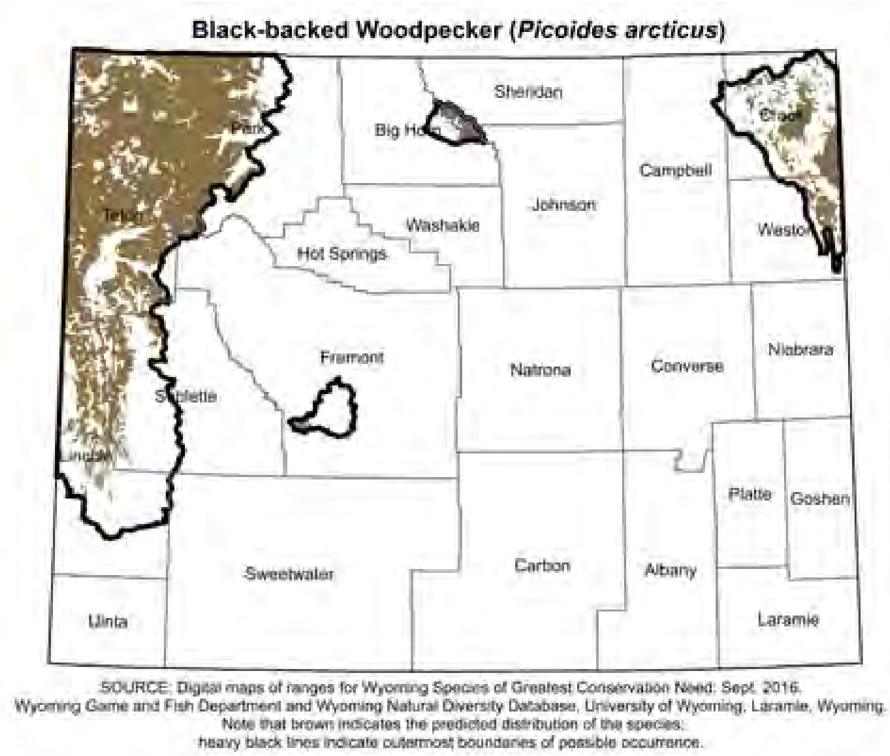

Figure 4: Range and predicted distribution of *Picoides arcticus* in Wyoming.

Black-billed Cuckoo

Coccyzus erythropthalmus

REGULATORY STATUS

USFWS: Migratory Bird
USFS R2: No special status
UWFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: Bird of Conservation Concern
WGFD: NSS4 (Bc), Tier II
WYNDD: G5, S2S3
    Wyoming contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 13

STATUS AND RANK COMMENTS

The Wyoming Natural Diversity Database has assigned Black-billed Cuckoo (*Coccyzus erythropthalmus*) a state conservation rank ranging from S2 (Imperiled) to S3 (Vulnerable) because of uncertainty about the abundance and amount of suitable habitat for this species in Wyoming.

NATURAL HISTORY

Taxonomy:

There are no recognized subspecies of Black-billed Cuckoo [1]. Although Yellow-billed Cuckoo (*C. americanus*) is also found in Wyoming, the 2 species do not hybridize. The species most closely related to the Black-billed Cuckoo is the Gray-capped Cuckoo (*C. lansbergi*) of South America [2].

Description:

Black-billed Cuckoo (28–31 cm long, 45–55 g) is a long-tailed, slender passerine that is identifiable in the field [2]. Underparts are a dull grayish white, with the upperparts and top half of the head a grayish-brown with olive tones. Tail is 15 cm, plain, grayish brown on top, and darker underneath. Bill is dark below and above, curved, 24 mm long, with a hooked tip on the upper mandible. Breeding adults have bright red eye ring, but it may be yellow on the wintering grounds (far south of Wyoming). Females are slightly larger than males. Otherwise, adults/juveniles and males/females appear similar. Black-billed Cuckoo is zygodactylous (two toes point forward, two point backwards). The most similar species in Wyoming is Yellow-billed Cuckoo, which can be differentiated by its yellow lower mandible, yellowish eye ring, and prominent rufous patch on the inner web of its primaries. Juveniles can be confused between the two species. The best way to differentiate between the two species is by the size of the undertail white spots, which are smaller in Black-billed Cuckoo.

Distribution & Range:
Black-billed Cuckoo breeds from New England west to the Rocky Mountain front, as far north as central Alberta and south to Tennessee [2]. Wyoming forms a portion of the far eastern extent of breeding range. The species has been observed in 23 of Wyoming's 28 latitude/longitude degree blocks, with most detections in the eastern two-thirds of the state [3]. Confirmed or suspected breeding has been documented in 11 of those 23 degree blocks. Black-billed Cuckoo is a summer resident in Wyoming, migrating annually through the southeastern U.S. and Mexico to winter range in South America. It is thought to winter in portions of Colombia, Venezuela, Peru, Bolivia, and Ecuador [2, 4, 5].

Habitat:
During the breeding season, Black-billed Cuckoo prefers habitats composed of trees, forest edges, and thickets, typically near water [2]. In Wyoming, it is most often found in riparian corridors composed of mature cottonwood (*Populus* spp.) with dense understories [6]. Black-billed Cuckoo is not found above 2,134 m in elevation. Plant use varies by region, but species used by Black-billed Cuckoo include: cottonwood, aspen and poplar (*Populus* spp.), birch (*Betula* spp.), hawthorn (*Crataegus* spp.), willow (*Salix* spp.), maple (*Acer* spp.), hickory (*Carya* spp.), oak (*Quercus* spp.), oak-chestnut (*Castanea* spp.), pine (*Pinus* spp.), hemlock (*Tsuga* spp.), alder (*Alnus* spp.) and to a lesser extent fir (*Abies* spp.) and spruce (*Picea* spp.) [7-14]. Habitat use is similar to Yellow-billed Cuckoo, but Black-billed Cuckoo typically inhabits higher elevations and extensive woodlands more often [12, 14]. During migration it uses thickets, groves, meadow and forest edges, and wooded areas, especially near streams and ponds [2, 15, 16]. Black-billed Cuckoo winters in scrub and woodland habitats in South America [2, 4, 17].

Phenology:
Black-billed Cuckoo is a late migrant, arriving in Wyoming in early June [6]. There is limited fall migration information, with only one modern sighting near Cheyenne in late August 1987. Most migratory travel occurs at night [18], and the species may be at least somewhat nocturnal during the breeding season as well. Little information is known about Black-billed Cuckoo pair formation and nesting, but they likely occur in late May to early June, and during the month of June, respectively [2, 19, 20]. Although the relationship between food supply and breeding is poorly understood, it is suggested that timing of first clutch might be influenced by the timing of cicada, grasshopper, and caterpillar outbreaks [2, 21-24]. Nesting dates in South Dakota ranged from 30 May–23 August [25]. Eggs are typically laid every second day, with average clutch size 2 to 3 eggs [7, 26, 27]. Chicks often hatch in the early morning after a 10 to 11 day incubation period [27]. Chicks are altricial at hatching, leave the nest at day 6 or 7, and are unable to fly until 3 weeks [2, 27]. Black-billed Cuckoo likely produces only one clutch per year, but little information on this is available [23], especially in Wyoming. Black-billed Cuckoo occasionally acts as an intraspecific and interspecific brood parasite – i.e., it reproduces by laying eggs in other birds' nests and relies on their parental care to fledge cuckoo chicks. This reproductive strategy appears to be used infrequently, but the rate has not been quantified anywhere in the species' range [2].

Diet:
Black-billed Cuckoo primarily consumes large insects, including caterpillars (especially during outbreaks), katydids, cicadas, crickets, grasshoppers, and butterflies [21, 24, 28, 29]. It will also consume, to a lesser extent, eggs of other bird species [30], small mollusks, fish, aquatic larvae, fruits, and seeds [26]. A pellet of caterpillar hair and cuckoo stomach lining will be regurgitated when the mass obstructs digestion [2, 31].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
Using North American Breeding Bird Survey (BBS) data, the Partners in Flight Science Committee estimated the global population of Black-billed Cuckoo to be 870,000 birds [32]. Extrapolation suggests approximately 0.30% of the global population, or around 3,000 birds, could breed in Wyoming [33], but this estimate is likely high and should be viewed with caution. The statewide rank of RARE is based on the rather small area of the state known to be occupied in any given season, and the small coverage of suitable habitat with that area. Within suitable habitat in the occupied area, Black-billed Cuckoo appears to be uncommon, occurring in relatively low densities and requiring intensive survey efforts to detect the species [3].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Robust population trends are not available for Black-billed Cuckoo in Wyoming due to limited distribution in the state and low detection rates during monitoring surveys. Black-billed Cuckoo population trend data from the BBS in Wyoming are available from 1968–2013 and suggest a substantial decline of -7.15 annually (N = 18 routes, 95% CI: -12.21 to -2.56) [34]. However, these results fall within a credibility category containing data with 'important deficiencies' and should be viewed with caution. Low relative abundance and number of routes with Black-billed Cuckoo detections likely contribute to this classification [34].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Large insects are the main food source of Black-billed Cuckoo, and long-term population viability might depend on periodic insect irruptions [2]. This high position on the trophic chain, coupled with a relatively high degree of habitat specialization in Wyoming, suggests MODERATE VULNERABILITY for the species.

Extrinsic Stressors:
SLIGHTLY STRESSED
Black-billed Cuckoo is susceptible to pesticides (via reductions in insect prey as well as bioaccumulation of pesticide toxins in cuckoos themselves), collisions with anthropogenic infrastructure, and habitat degradation. Use of pesticides to control caterpillars might especially affect cuckoo populations [2]. Caterpillars are a substantial prey item for cuckoos, and hydrocarbon pesticides have been shown to accumulate in adipose tissue of Black-billed Cuckoo [35]. A nocturnal migrant, Black-billed Cuckoo can be fatally injured by collisions with buildings and television towers [36]. Although as-yet unstudied, the proliferation of wind turbines in Wyoming and the region may be increasing this source of mortality. Additionally, habitat patch size influences cuckoo presence, with birds occurring only in patches of suitable habitat > 4,555 square meters in South Dakota [37] and only in "larger" aspen groves in Saskatchewan [38].

KEY ACTIVITIES IN WYOMING

Black-billed Cuckoo is listed as a Species of Greatest Conservation Need (SGCN) in Wyoming by the Wyoming Game and Fish Department (WGFD), and as a Level II Priority Species requiring monitoring action in the Wyoming Bird Conservation Plan [39]. The species is not adequately monitored by current national or regional avian monitoring efforts in Wyoming, including the IMBCR program initiated in 2009 (0 detections since initiation) [40] or the BBS program conducted on 108 established routes since 1968 [34]. No systematic survey of Black-billed Cuckoo has been conducted in Wyoming, and there are no new or on-going research or monitoring projects designed specifically for this species in the state. Observations of this species are reported to the WGFD and vetted through the Wyoming Bird Records Committee (WBRC). Black-billed Cuckoo is a species for which the WBRC requests documentation on first latitude/longitude degree block sightings and all nesting observations.

ECOLOGICAL INFORMATION NEEDS

Information on Black-billed Cuckoo population size, habitat associations, and statewide distribution, especially during the breeding season, would assist resource managers in integrating Black-billed Cuckoo into management plans and actions [6]. Also, a better understanding of the spatial pattern, and timing, of arthropod productivity in eastern Wyoming woodlands would provide important information on how to manage landscapes for the benefit of Black-billed Cuckoo.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Black-billed Cuckoo is classified as a SGCN in Wyoming due to insufficient information on breeding, distribution, and population status and trends. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the North American BBS [34] and the multi-partner IMBCR [40]. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, survey efforts do not adequately detect Black-billed Cuckoo, suggesting that targeted, species-specific monitoring efforts are needed. Best management practices or key management recommendations to benefit Black-billed Cuckoo include maintaining dense shrubs and diverse vegetation heights in plains/basin riparian habitats, and limiting use of insecticides in riparian areas to ensure a food source exists for this and other insectivorous species [39].

CONTRIBUTORS

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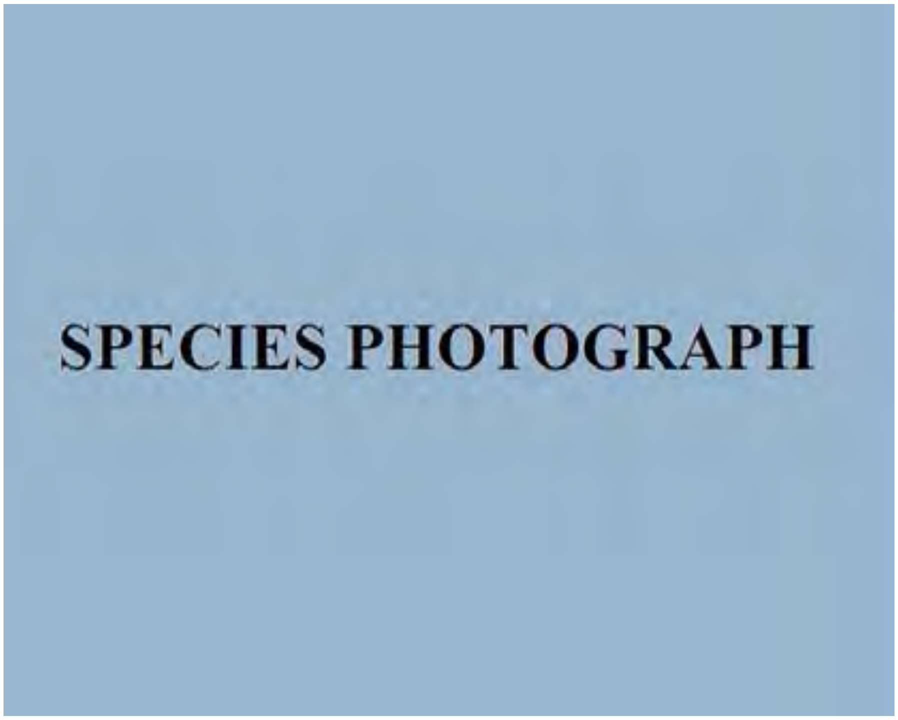

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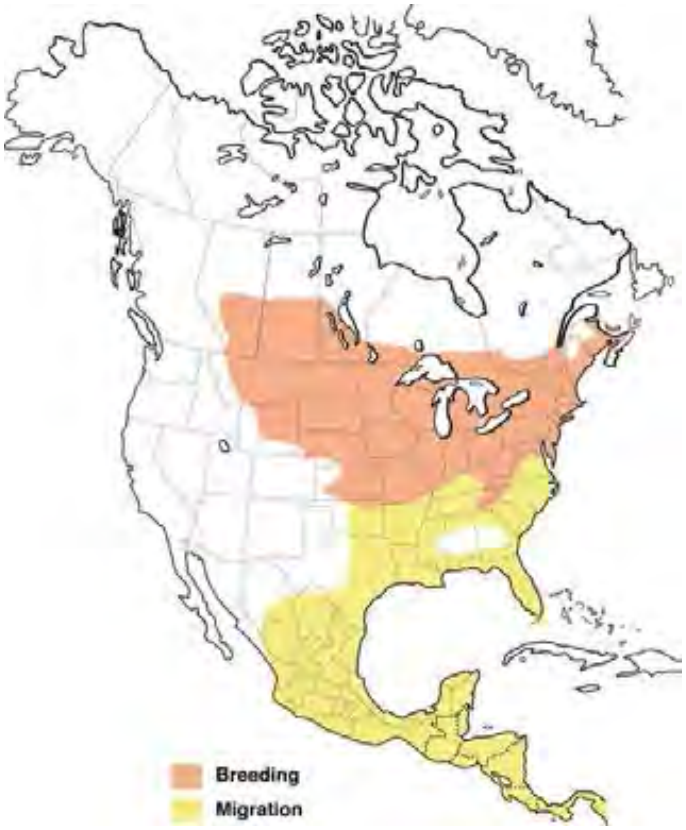
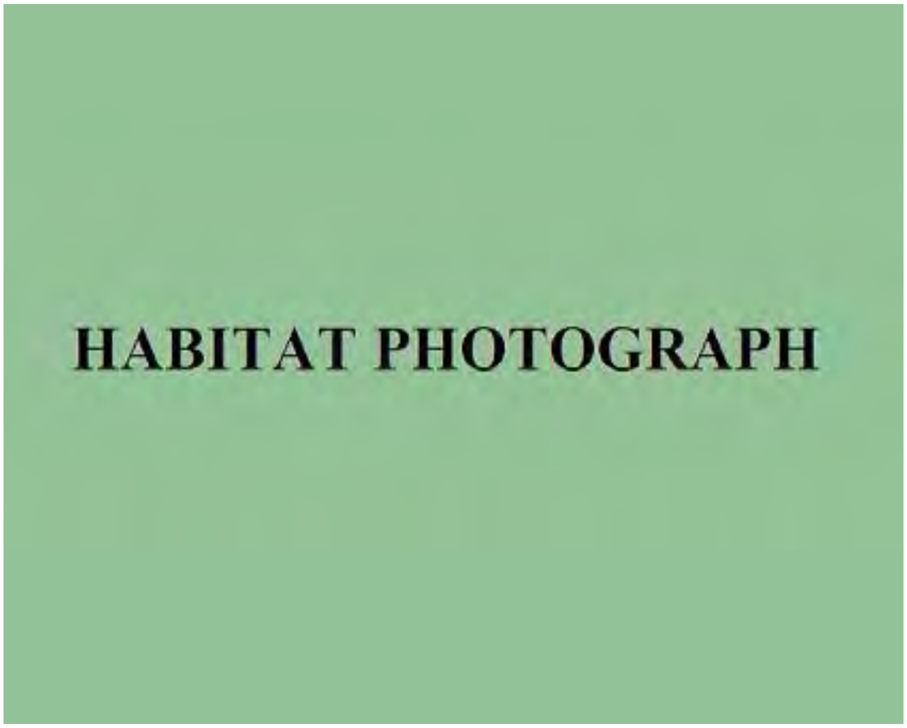


Figure 2: North American range of *Coccyzus erythropthalmus*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)



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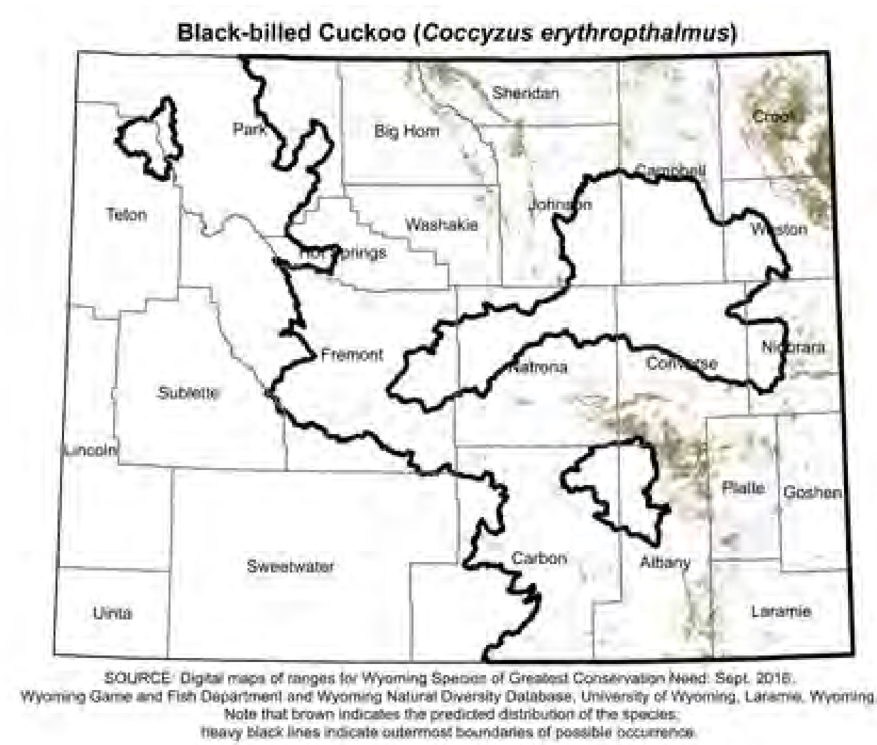

Figure 4: Range and predicted distribution of *Coccyzus erythropthalmus* in Wyoming.

Black-chinned Hummingbird

Archilochus alexandri

REGULATORY STATUS

USFWS: Migratory Bird
USFS R2: No special status
UWFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: No special status
WGFD: NSSU (U), Tier II
WYNDD: G5, S2
  Wyoming contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 11

STATUS AND RANK COMMENTS

Black-chinned Hummingbird (*Archilochus alexandri*) does not have any additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:

No subspecies of Black-chinned Hummingbird are recognized. However, molecular genetic research is being conducted to assess the possibility amongst known populations [1].

Description:

Identification of Black-chinned Hummingbird is possible in the field. The species is a slender and small member of the *Trochiladae* Family. Black-chinned Hummingbird males are easier to identify in the field than females; however, where its range overlaps with Ruby-throated Hummingbird (*A. colubris)*, distinguishing between males can be challenging, especially in poor light conditions [2]. Male upperparts are a flat metallic bronze-green; the chin and upper throat are black; and the lower throat is a diagnostic metallic violet-purple. Underparts are primarily a flat grayish-white or brownish-gray. Females are more difficult to identify in the field, as they closely resemble female Anna's (*Calypte anna*) and Ruby-throated Hummingbirds [2]. Slight differences in bill length, body proportions, and feather color are typically diagnostic. Female upperparts are also a dull, metallic bronze-green. Underparts are generally a flat white with occasional dusky markings on the throat region. The three pairs of outer tail feathers are white-tipped and black subterminally. Both males and females have black, slightly decurved bills, and dark brown or black irises. Legs and feet are black to dark brown in both sexes. There is no coloration difference in nonbreeding birds; however, Black-chinned Hummingbird molts annually and the duration is about 7 to 8 months [3]. Research indicates that female length and weight measurements tend to be greater than males; juvenile weight tends to be greater than that of adults of the same gender [2, 4, 5].

Distribution & Range:
Wyoming forms a limited portion of the eastern edge of the Black-chinned Hummingbird's breeding range [2]. Observations are largely concentrated in the western and central portions of Wyoming, and many may be associated with migrants versus breeders [6]. Black-chinned Hummingbird has been documented in 13 of Wyoming's 28 latitude/longitude degree blocks, with circumstantial evidence of breeding occurring only in degree block 23 (Green River area) [7]. Only 3 out of 28 latitude/longitude degree blocks include confirmed observations as accepted by the Wyoming Bird Records Committee (WBRC) [8]. This species winters outside of Wyoming, primarily in Mexico and southern Texas [2] and distribution in Wyoming during migration is poorly understood.

Habitat:
Limited information is known about preferred Black-chinned Hummingbird habitat in Wyoming; however, it is believed the species utilizes habitats similar to those used in other western states [6]. Black-chinned Hummingbird tends to be found in canyons and deciduous riparian forests and shrublands, as well as piñon-juniper (*Pinus* spp.-*Juniperus* spp.) woodlands, xeric desert washes and irrigated orchards [9, 10]. The species is believed to forage in open brush, meadows, and fields [11]. Black-chinned Hummingbird has also adapted readily to urban areas with mature trees, nectar-producing vegetation, and residential feeders [2]. WBRC accepted records primarily include observations with cottonwood (*Populus* spp.) riparian and canyon habitats, as well as residential hummingbird feeders.

Phenology:
Black-chinned Hummingbird has been documented in Wyoming as early as 15 May, although observations tend to be more common in June and July. Wyoming breeding records are very limited and are restricted to the southwestern region of the state [2, 7]. The species lays a clutch usually consisting of 2 eggs, infrequently 3 [12]. Typically, each egg is laid 1 day apart. Incubation duration is usually 12–14 days, followed by a 21 day nestling period. Females will feed fledglings for about a week after they leave the nest. There are no sound data on whether the species re-nests following failure [2].

Diet:
Black-chinned Hummingbird feeds primarily on flower nectar and small insects. Where nectar sources are limited, it will ingest larger quantities of protein-rich insects. The species will also consume sugar water provided at hummingbird feeders [2].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
Using North American Breeding Bird Survey (BBS) data, the Partners in Flight Science Committee estimated the global population of Black-chinned Hummingbird to be 5 million birds [13]. Approximately 0.10% of the global population, or an estimated 5,000 birds, breed in Wyoming [14]. However, this abundance estimate should be viewed with caution, given the very low detection rate of this species in the state. The statewide rank of UNCOMMON is based on

the limited area of the state known to be occupied in any given season, and the relatively small coverage of suitable habitat within that area. Within suitable habitat in the occupied area, Black-chinned Hummingbird also appears to be uncommon, occurring in relatively low densities and requiring intensive survey efforts to detect the species [7]. From 2009–2015, the Integrated Monitoring in Bird Conservation Regions (IMBCR) program did not detect any Black-chinned Hummingbirds on survey routes in Wyoming [15].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Population trends are not available for Black-chinned Hummingbird in Wyoming due to a limited distribution in the state and low detection rates during monitoring surveys. Currently, there are no robust BBS trend data for Black-chinned Hummingbird in Wyoming due to an extremely limited observation sample size (*N* = 5 routes; 1968–2013) [16]. However, 1966–2013 trend analysis for Black-chinned Hummingbird in the western BBS region, United States, and survey-wide indicate a slight annual population increase of 1.01, 1.15, and 1.17%, respectively [16]. More specifically and in proximity to Wyoming, trend analyses for Idaho, Montana, and Utah indicate a slight annual population increase through 2013 (5.65, 9.50, and 2.91%, respectively); however, only the trends for Idaho and Utah are statistically significant. Colorado 1968–2013 trend data indicate a potential slight decrease of 0.44% annually; however, the data are not statistically significant. All BBS data presented in this account have been determined to fall within a credibility category containing data with 'deficiencies' or 'important deficiencies'. Low relative abundance and number of routes with Black-chinned Hummingbird detections likely contribute to this classification [16].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
In Wyoming, Black-chinned Hummingbird has moderate intrinsic vulnerability to extrinsic stressors, which stems from its peripheral breeding range status, low density, and low fecundity [6, 17]. While Black-chinned Hummingbird is known to produce 2 broods per year, the productivity averages around 1.1 young fledged per female per season [18]. Additionally, the taxon's preferred breeding habitat is generally restricted to mesic riparian habitats [2].

Extrinsic Stressors:
SLIGHTLY STRESSED
Extrinsic stressors to Black-chinned Hummingbird populations in Wyoming are most likely associated with land use practices in preferred habitat, primarily riparian forest and shrubland. Riparian lands constitute a small percentage of Wyoming's landscape [19] and their importance to avian migration, nesting, and foraging is well documented [20]. While local, state, and federal measures may limit certain impacts in these areas, the cumulative effects of development (e.g., agriculture, ranching, energy extraction, urbanization, recreation), invasive species, and hydrologic regime change (e.g., impoundments, irrigation withdrawals, channel alterations) contribute to the degradation of riparian lands in Wyoming [19]. Additionally, canyon and cliff habitats are also vulnerable to human disturbances (e.g., mining, roads, recreation) in Wyoming, and efforts to minimize impacts in these areas will likely benefit Black-chinned Hummingbird populations. Despite various potential stressors, it is possible that Black-chinned Hummingbird benefits from the presence of maintained sugar water feeders and landscape plantings with preferred nectar sources in residential areas [2].

KEY ACTIVITIES IN WYOMING

Black-chinned Hummingbird is listed as a Species of Greatest Conservation Need (SGCN) in Wyoming by the Wyoming Game and Fish Department (WGFD), and as a Level II Priority Species requiring monitoring action in the Wyoming Bird Conservation Plan [20]. Existing statewide monitoring efforts for landbirds may occasionally detect Black-chinned Hummingbird, but these programs are not specifically designed to capture hummingbird observations. The annual BBS program is conducted on routes statewide, but only five Black-chinned Hummingbirds have been reported since the survey was initiated in 1968 [16]. No Black-chinned Hummingbirds have been detected during IMBCR surveys through 2015 [15]. Additionally, efforts associated with the United States Geological Survey's bird banding stations in Wyoming through 2015 produced only five Black-chinned Hummingbird records since 1960 [21]. No additional, targeted, systematic survey of Black-chinned Hummingbird has been conducted in Wyoming. Observations of this species are reported to the WGFD and vetted through the WBRC. Black-chinned Hummingbird is a species for which the WBRC requests documentation on first latitude/longitude degree block sightings and all nesting observations. Since 1991, five observations of the species from Sheridan, Uinta, Fremont, Natrona, and Washakie counties have been accepted by the WBRC.

ECOLOGICAL INFORMATION NEEDS

Knowledge of Black-chinned Hummingbird distribution during the breeding and migration seasons in Wyoming is poorly understood [6]. Better estimates of abundance and population trends are needed for this species in the state.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Black-chinned Hummingbird is classified as a SGCN in Wyoming due to unknown population status and trends in the state. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [16] and IMBCR [15]. While these monitoring programs provide robust estimates of occupancy, density, or population trends for many avian species in Wyoming, survey efforts do not tend to detect Black-chinned Hummingbird at adequate levels, suggesting targeted, species-specific monitoring efforts are needed. Best management practices to benefit Black-chinned Hummingbird include adequate monitoring, maintaining large continuous riparian corridors comprised of a multilayered native vegetation structure, and minimizing and/or avoiding disturbance to canyon habitats [20].

CONTRIBUTORS

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Figure 1: Adult male (left) and female (right) Black-chinned Hummingbirds at a feeder in Durango, Colorado. (Photos courtesy of Bill Schmoker)

Figure 2: North American range of *Archilochus alexandri*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

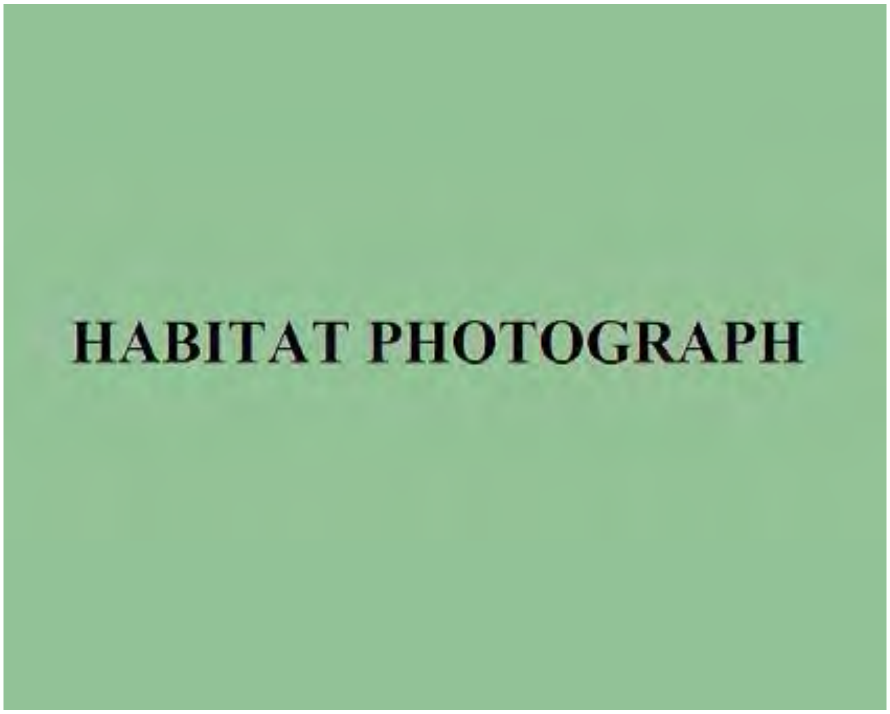

Figure 3: Photo not available.

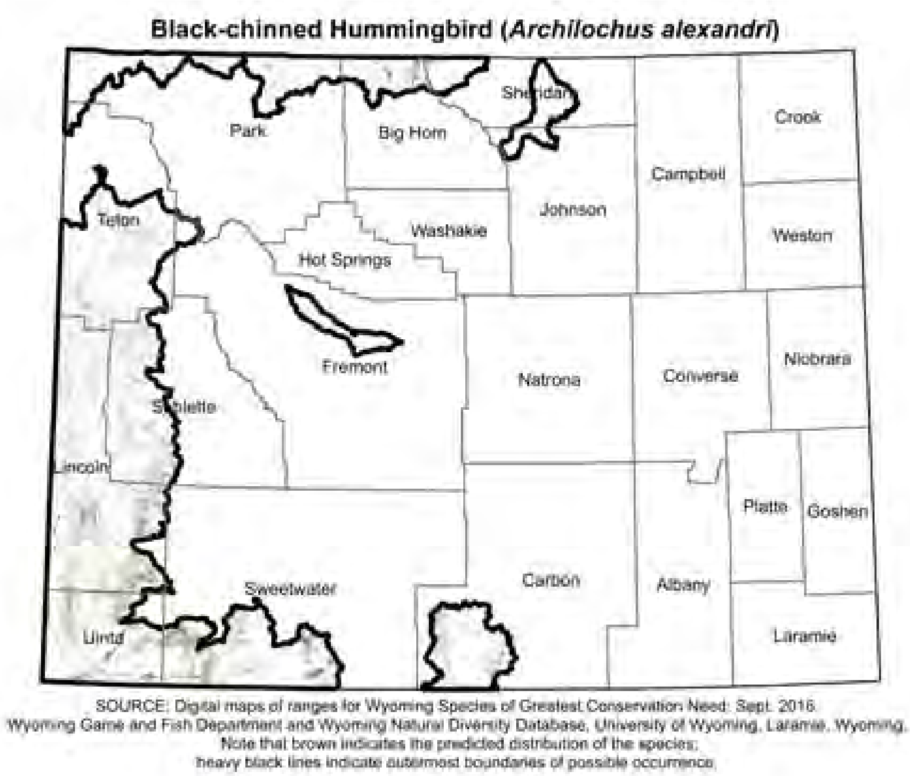

Figure 4: Range and predicted distribution of *Archilochus alexandri* in Wyoming.

Figure 5: Adult male Black-chinned Hummingbird showing its distinctive purple iridescent gorget at a feeder in Durango, Colorado. (Photo courtesy of Bill Schmoker)

Black-crowned Night-Heron

Nycticorax nycticorax

REGULATORY STATUS

USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G5, S2S3
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: Not ranked

STATUS AND RANK COMMENTS

The Wyoming Natural Diversity Database has assigned Black-crowned Night-Heron (*Nycticorax nycticorax*) a state conservation rank ranging from S2 (Imperiled) to S3 (Vulnerable) because of uncertainty about the abundance, proportion of range occupied, and population trends for this species in Wyoming.

NATURAL HISTORY

Taxonomy:

Worldwide, there are currently four recognized subspecies of Black-crowned Night-Heron with slight differences in body size and coloration. *N. n. hoactli* is the only subspecies found in North America, and therefore also Wyoming [1, 2].

Description:

Identification of Black-crowned Night-Heron is possible in the field. It is a medium heron; adults weigh approximately 883 g, range in length from 58–66 cm, and have a wingspan of approximately 112 cm [1, 3]. The sexes are similar in appearance, but males are slightly larger [1]. Black-crowned Night-Heron has a stocky build, large head, and shorter neck and legs than most other heron species [1, 3]. Breeding adults have a black crown that does not extend below the eye; white throat and cheeks; black nape with several long, thin, white feather plumes that extend down the solid black back; gray wings and tail; light gray to white underparts; a large, thick black bill; and bright red eyes [1, 3]. The legs are typically yellow but develop a pink or red hue during the breeding season. Adults are unlikely to be confused with any other species in their Wyoming range. Juvenile Black-crowned Night-Herons may be confused with American Bittern (*Botaurus lentiginosus*), but juvenile night-herons have red eyes, a short neck, white spots on their wings, and pale spots or streaks on their underparts instead of bold, vertical stripes [1, 3].

Distribution & Range:
In North America, Black-crowned Night-Heron is distributed across most of the United States and Mexico, and can also be found in the Prairie Potholes Region of south central Canada [1]. Black-crowned Night-Heron migrates through Wyoming in the spring and fall and is a summer resident [4, 5]. Southern and far northwestern Wyoming are on the edge of the species' core breeding distribution [1], with nearly all breeding records occurring in the southern half of the state at elevations below 2,134 m (7,000 ft) [4, 5]. Although the species has been observed at waterbodies across the state, confirmed breeding has been documented in just 10 of the 28 latitude/longitude degree blocks [4].

Habitat:
Black-crowned Night-Heron is associated with a wide range of aquatic, wetland, and riparian habitats across its breeding and wintering ranges [1]. In Wyoming, Black-crowned Night Heron may be observed at a variety of waterbodies, but breeding colonies are typically associated with larger marshes and lakes that support stands of bulrushes and cattails [4, 5]. This species will uses numerous substrates for nesting across its breeding distribution (e.g., living and dead trees, willows, shrubs, vines, reeds, anthropogenic structures, rocks, the ground) [1], but most nests in Wyoming are in emergent aquatic reeds, island trees and shrubs, or on the ground of islands [4, 5]. Nests are constructed primarily of twigs and sticks, but may be mixed or lined with local roots, grass, or reeds [1].

Phenology:
In Wyoming, spring arrival of migrating and breeding Black-crowned Night-Herons occurs the second week of April [5], but little is known about the specific nesting and breeding habits of this colonial nesting species in the state. Dates of nest initiation, egg laying, hatching, and fledging vary widely by geographic location [1]. Clutch size increases with latitude, but typically ranges from 3–5 eggs [1]. Eggs hatch after being incubated by both sexes for 23–26 days. If disturbed, chicks can leave the nest just 10 days after hatching, but typically do not leave until they are 29–34 days old. After vacating the nest, young remain in the surrounding vegetation until they are approximately 6 weeks old and able to fly [1]. Black-crowned Night-Heron is a single-brood species, but will renest following loss of the first clutch [1]. Fall migration from Wyoming to wintering grounds begins in mid-September, with most migrants and residents leaving the state by October [5].

Diet:
Black-crowned Night-Heron forages in productive shallow-water habitat primarily at night and during dawn and dusk [1]. This species feeds opportunistically on a wide variety of terrestrial and aquatic prey including freshwater and marine fish, prawns and crayfish, shellfish, leaches, aquatic and terrestrial insects and worms, amphibians, lizards, snakes, turtles, small mammals and birds, eggs, carrion, plant materials, and even garbage from dumps and landfills [1]. Black-crowned Night-Heron has been documented using both passive and active bait-fishing techniques to catch fish [6].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE

There are no robust estimates of abundance available for Black-crowned Night-Heron in Wyoming. The species has a statewide abundance rank of RARE and appears to be uncommon within suitable environments in the occupied area [4]. Colonial nesting waterbird surveys conducted from 2002–2006 by the Wyoming Game and Fish Department (WGFD) recorded a range of 29 to 78 individuals annually across all surveyed sites [7-11]. From 1968–2015, annual Wyoming Breeding Bird Survey (BBS) detections of Black-crowned Night-Heron ranged from 0 to 10, with none recorded in most years [12]. Black-crowned Night-Heron was not detected during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [13]. While surveys conducted as part of the BBS and IMBCR programs may occasional detect this species, neither is specifically designed to capture heron observations.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Robust population trends are not available for Black-crowned Night-Heron in Wyoming because the species is infrequently detected during monitoring efforts. North American BBS survey-wide trend data have deficiencies, and should be viewed with caution, but suggest that Black-crowned Night-Heron numbers decreased annually by 0.62% from 1966–2013 and increased annually by 2.29% from 2003–2013 [14]. Neither trend estimate was statistically significant.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Black-crowned Night-Heron has moderate intrinsic vulnerability in Wyoming due to low abundance, a dependence on a narrow range of habitats types, and colonial nesting behaviors that can expose large numbers of breeding individuals to disturbance. Like other wading birds, Black-crowned Night-Heron forages in productive shallow-water environments, which are relatively uncommon and unstable in the state. Natural or anthropogenic disturbance to breeding colonies could potentially have a large negative impact on local populations of Black-crowned Night-Heron.

Extrinsic Stressors:
MODERATELY STRESSED
Black-crowned Night-Heron is moderately stressed by extrinsic stressors in Wyoming, where already limited natural aquatic habitat is potentially vulnerable to climate change and drought, invasive plant species, and development for infrastructure, energy, and agriculture [15, 16]. Black-crowned Night-Heron has demonstrated sensitivity to drought and has already lost nesting habitat to prolonged drought conditions in Wyoming [5, 17]. However, this species will use constructed wetlands and anthropogenic structures for foraging and nesting [18-20], which may support the idea that man-made aquatic habitats could help alleviate the loss or contraction of natural habitats in Wyoming [15]. Black-crowned Night-Heron nestlings are sensitive to disturbance from aquatic and terrestrial recreation near breeding colonies [21]. Finally, this species is at risk for bioaccumulation of heavy metals and other environmental contaminants from feeding in polluted aquatic habitats [5, 17, 22-26].

KEY ACTIVITIES IN WYOMING

Black-crowned Night-Heron is classified as a Species of Greatest Conservation Need (SGCN) by the WGFD. Current statewide bird monitoring programs are designed for monitoring breeding songbird populations and are unlikely to provide useful information on Black-crowned Night-

Heron. These monitoring programs include the BBS program conducted on 108 established routes since 1968 [14], and the multi-agency IMBCR program initiated in 2009 [13]. Since 1984, WGFD has conducted annual or periodic monitoring at the most important and productive sites for colonial waterbird SGCN to determine species presence and distribution, and to estimate number of nesting pairs. The most recent effort was the culmination of a multi-year cooperative agreement between the WGFD and the United States Fish and Wildlife Service to conduct an intensive survey of all historic, known, potential, and new colonial waterbird breeding sites statewide as part of a western range-wide effort to track population size, trends, and locations of breeding colonial waterbirds in the western United States [27, 28]. In 2014, an online Atlas of western colonial waterbird nesting sites was produced with data collected and submitted by participating states [29]. Every three to five years, WGFD personnel visit known colonial waterbird nesting sites outside of Yellowstone National Park to evaluate water level conditions, determine species present at each site, and estimate the number of nesting pairs of colonial waterbirds. There are currently no research projects designed specifically for Black-crowned Night-Heron in Wyoming.

ECOLOGICAL INFORMATION NEEDS

Black-crowned Night-Heron would benefit from research to determine its detailed distribution, the location and habitat characteristics of current breeding colonies, and the annual abundance of migrating and breeding adults in Wyoming. Very little is known about the specific breeding habits of this species in the state, with the exception of approximate arrival and departure dates, and nothing is known about nest success or fledgling survival at the few known breeding locations. Due to the scarcity and inherent vulnerability of aquatic habitat in Wyoming, it would be valuable to identify current and future anthropogenic and natural stressors to ensure the persistence of breeding and foraging habitat for Black-crowned Night-Heron.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Zachary J. Walker. Black-crowned Night-Heron is classified as a Species of Greatest Conservation Need due to limited distribution of breeding sites, and breeding site instability. Colonial water bird surveys are conducted within the state, but existing data are not robust enough to support estimates of occupancy, density, or population trend. Targeted, species-specific survey methods may be warranted for this species. Management priorities in the short-term should focus on addressing data deficiencies. Best management practices to benefit Black-crowned Night-Heron include protection of suitable breeding locations, minimize nesting disturbance, and maintenance of stable water levels throughout the nesting season.

CONTRIBUTORS

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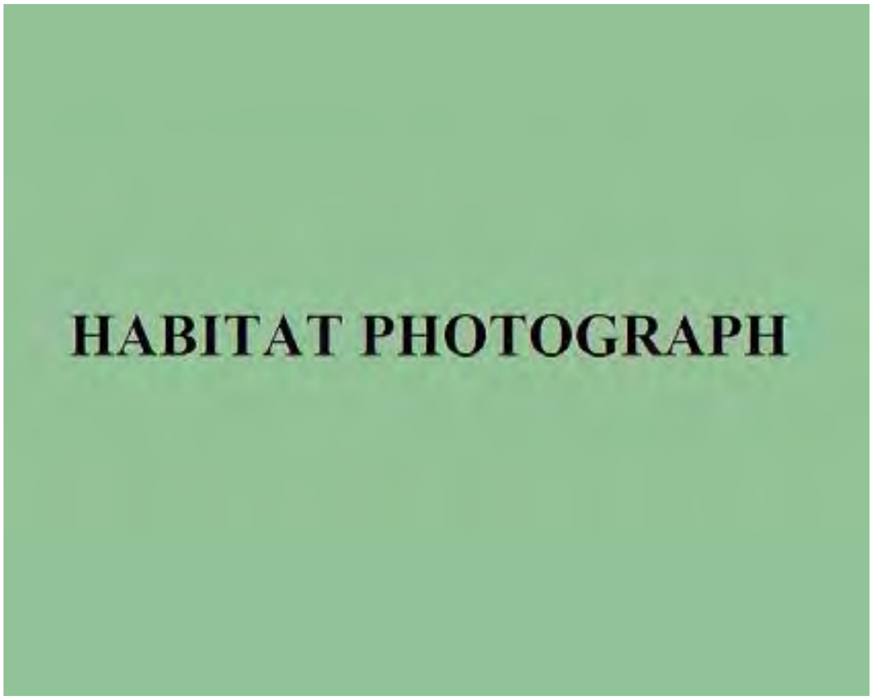
Figure 1: Adult Black-crowned Night-Heron in Albany County, Wyoming. (Photo courtesy of Shawn Billerman)

Figure 2: North American range of *Nycticorax nycticorax*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)



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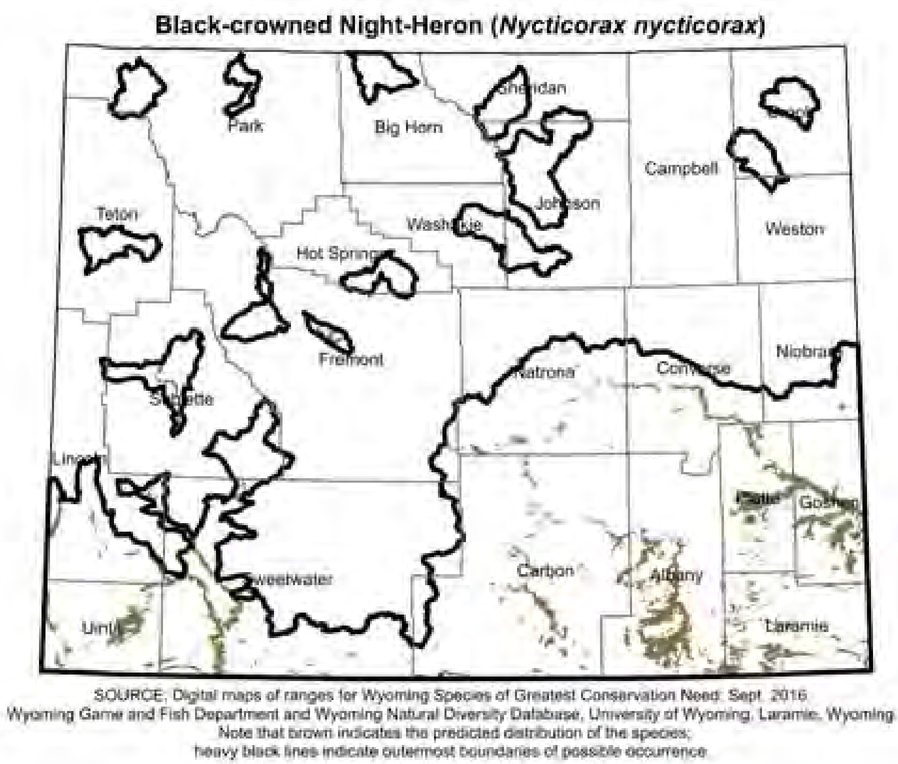

Figure 4: Range and predicted distribution of *Nycticorax nycticorax* in Wyoming.

Black Rosy-Finch
Leucosticte atrata

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: Bird of Conservation Concern
WGFD: NSSU (U), Tier II
WYNDD: G4, S1B/S2N
    Wyoming Contribution: VERY HIGH
IUCN: Least Concern
PIF Continental Concern Score: 16

STATUS AND RANK COMMENTS
Black Rosy-Finch (*Leucosticte atrata*) has been assigned different S-ranks by the Wyoming Natural Diversity Database for the breeding and non-breeding seasons. This is because the species' habitat is not as restrictive during the non-breeding season, which makes the species less intrinsically vulnerable.

NATURAL HISTORY
Taxonomy:
There are no recognized subspecies of Black Rosy-Finch. In 1983, the three American rosy-finch species: Black Rosy-Finch, Brown-capped Rosy-Finch (*L. australis*), and Grey-crowned Rosy-Finch (*L. tephrocotis*), were combined with Asian Rosy-Finch (*L. arctoa*) into one species. In 1993, the American Ornithologist Union (AOU) reinstated original species status designations due to a lack of evidence supporting the merge [1]. Recent genetic evidence suggests that the three North American Rosy-Finches may only constitute one species [2]. However, the most recent AOU ruling rejected merging the three American rosy-finches into one species [3].

Description:
Identification of Black Rosy-Finch is possible in the field. The Black Rosy-Finch is approximately 16 cm in length, similar in size and overall shape to large sparrows, but stockier. The species has a mid-sized conical bill, and a relatively short, notched tail. Adult males and females differ in plumage. The male is uniformly dark brownish-black on the back, breast, neck, and face below the eye. The feathers of the belly, rump, upper- and under-tail coverts, and the bend of the wing (shoulder) are broadly tipped with pink. The forecrown is black, with a silver-gray band around the hindcrown. The bill is yellow during the breeding season, and gray to black during the winter. Females look similar to the male, but the body is a lighter grayish-brown, and the back is more streaked. The pink on the feathers is reduced or absent. The gray on the

hindcrown is often absent by midsummer. Juveniles look similar to females, but are lighter in coloring. The species is similar in appearance to Brown-capped Rosy-Finch and Gray-crowned Rosy-Finch but Black Rosy-Finch is darker overall [4, 5].

Distribution & Range:
Black Rosy-Finch is a localized, high altitude breeder in the mountains of Wyoming, Montana, Idaho, Oregon, Nevada, and Utah. In winter, the species may descend to lower elevations adjacent to breeding areas. Occasionally, the species may wander farther, regularly occurring in Colorado, northern New Mexico and southern Wyoming and has been documented in the Black Hills of South Dakota [5-7].

Habitat:
Black Rosy-Finch breeds in alpine tundra habitats. The species nests on cliff and rock faces, and forages on tundra, fellfields, rock slides, snowfields, and glaciers within 4 km of the nest site. In Wyoming, suitable habitat is found in the Gallatin, Teton, Gros Ventre, Wind River, and Absaroka ranges, and the Beartooth and Bighorn Mountains [5]. In the winter, Black Rosy-Finches use alpine tundra and open slopes just below tree line. The species often descends into intermountain valleys when snow covers higher slopes, and can also be found in human landscapes especially where bird feeders provide food [5].

Phenology:
Migratory patterns and timing of Black Rosy-Finch are largely unknown. Generally, the species leaves wintering grounds in mid-March to mid-April and arrives in breeding areas by late April. Post breeding migration to lower elevations usually occurs in October. Knowledge of the nesting cycle is limited but observations suggest nest building begins between early June and mid-July, egg laying occurs between late June and late July, followed by incubation between mid-June and early August, nestlings hatch from early July to late August, and young fledge from late July to late August [5].

Diet:
The species eats seeds in winter, including those offered at bird feeding stations. During the breeding season, the species eats seeds and insects [5].

CONSERVATION CONCERNS

Abundance:
Continental: REGIONAL ENDEMIC
Wyoming: RARE
No population estimates are available for the Black Rosy-Finch in Wyoming. In 2013, Partners in Flight estimated the global population at 20,000 birds [8]. Wyoming supports a large portion of this population [5].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Population trends of Black Rosy-Finch are largely unknown. The Christmas Bird Count (CBC) is the only long term monitoring program to provide frequent detections of the species. In Wyoming, these counts have shown a slight increase in the number of birds detected over the past 20 years. This is similar to national trends, which suggest a slight increase over this time

period [9]. However, apparent trends should be viewed with caution due to the nomadic nature of the species in winter [5].

Intrinsic Vulnerability:
HIGH VULNERABILITY
Black Rosy-Finch is highly vulnerable to extrinsic stressors. Specifically, during the breeding season, the species is restricted to high alpine slopes, nesting on cliff and rock faces above tree line. This habitat only occurs in limited locations in Wyoming, and elsewhere across its range [5]. The species is less vulnerable in the winter, using a variety of landscapes at lower elevations for foraging.

Extrinsic Stressors:
SLIGHLTY STRESSED
The remoteness and inaccessibility of breeding habitat protects Black Rosy-Finch from most threats. Breeding habitat may become reduced in size and quality due to global climate change [10]. Potential human impacts on the species are poorly understood and largely conjectural. For example, blasting operations for mining could both destroy or create breeding habitat [5]. Livestock grazing may have a negative impact by reducing food availability and by attracting Brown-headed Cowbirds (*Molothurs ater*), which parasitize the nests of many passerine birds leading to reduced nest success [5, 11]. In winter, the species tends to occur in larger concentrations at lower elevations, which may lead to increased mortality through window and automobile collisions, predation by domestic cats, and potential disease transmission [5].

KEY ACTIVITIES IN WYOMING

A graduate research project initiated in fall 2015 at the University of Wyoming will investigate abundance and distribution of Black Rosy-Finch in western Wyoming. The goals of this study are to develop a predictive distribution map and evaluate potential impacts of reduced snowfields at breeding sites. Preliminary field work funded through the Meg and Bert Raynes Wildlife Fund in summer 2015 resulted in the documentation of three new breeding sites in western Wyoming [12]. The Integrated Monitoring in Bird Conservation Regions program has detected the species during a limited number of point counts [13-15]. The species is regularly detected during CBCs in Wyoming. However, due to the nomadic nature of the species and the inconsistent survey effort, results from these surveys should be considered carefully [5].

ECOLOGICAL INFORMATION NEEDS

A clear understanding of the genetic relationships between the three rosy-finch species in North America is lacking. Genetic studies by Drovetski (2009) and McDonald (2002) remain inconclusive but suggest that American rosy-finch species are closely related [2, 16]. Little is known in regard to breeding biology of the species, specifically, when and where pair bonds form; timing of breeding as it relates to latitude; nesting and annual reproductive success; and nest site fidelity. Factors that negatively affect the species during the breeding season and in winter are unknown. One recent study indicated that stocking fish in high alpine lakes affected rosy-finch productivity [17]. Robust abundance and population trend estimates are lacking. Specific wintering locations for birds that nest in Wyoming are unknown.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Susan M. Patla. Black Rosy-Finch is one of the least studied bird species in the western United States, including Wyoming where the majority of the population appears to nest. Baseline data are needed on distribution and abundance. A recent graduate study funded through a State Wildlife Grant should provide valuable information for future management strategies and actions. Information needs include: determining the importance of persistent snowfields during the nesting season for productivity, creating and testing a map of potential nesting habitat to determine distribution and abundance, identifying the mechanisms of how future climate changes may affect rosy-finches throughout the year, identifying migration and wintering sites for Wyoming's nesting population, and setting up a long-term monitoring protocol to determine future population trends.

CONTRIBUTORS

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Figure 1: Male (top) and female (bottom) Black Rosy-Finches near Lake Hattie, Albany County, Wyoming. (Photos courtesy of Shawn Billerman)

Figure 2: North American range of *Leucosticte atrata*. The species breeds at high elevation sites and migrates to lower elevations for the winter months. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Black Rosy-Finch habitat in Bighorn National Forest, Wyoming, near Lake Angeline in the Cloud Peak Wilderness. (Photo courtesy of Jesse Agee)

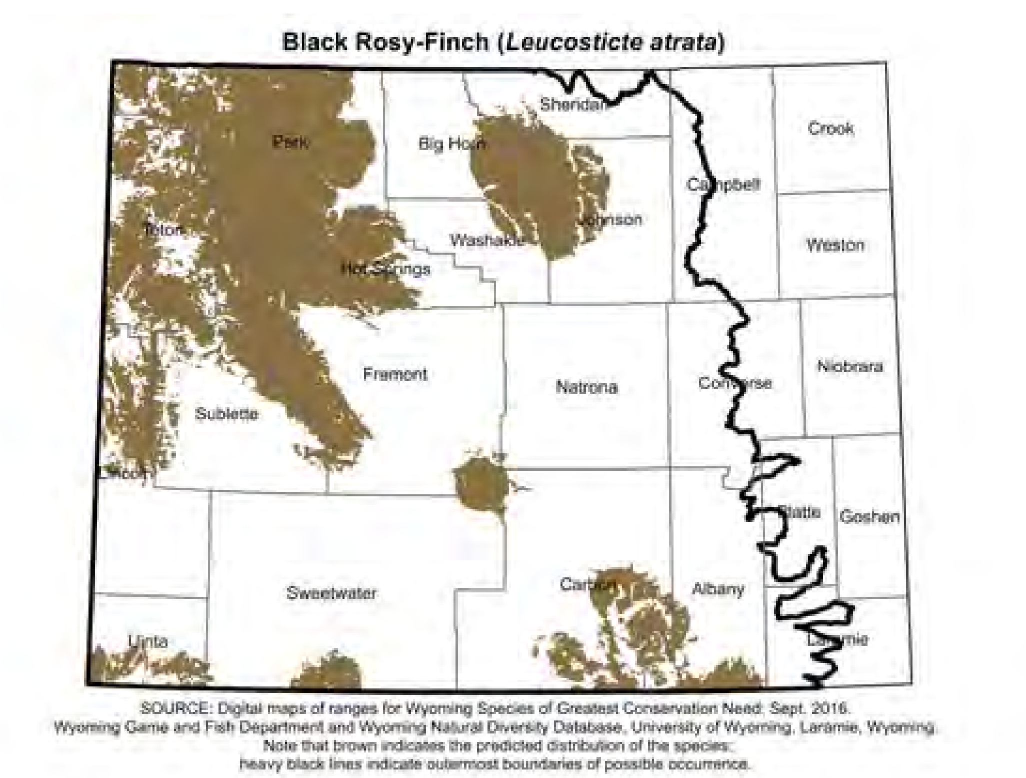

Figure 4: Range and predicted distribution of *Leucosticte atrata* in Wyoming.

Black Tern

Chlidonias niger

REGULATORY STATUS

USFWS: Migratory Bird
USFS R2: Sensitive
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G4, S1
    Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: Not ranked

STATUS AND RANK COMMENTS

Black Tern (*Chlidonias niger*) has no additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:

There are two recognized and geographically distinct subspecies of Black Tern, but only *C. n. surinamensis* is found in Wyoming [1, 2]. This New World subspecies breeds across southern Canada and the northern United States, and winters in Mexico and northern and northwestern South America [1].

Description:

Identification of Black Tern is possible in the field. It is a small marsh tern; adults weigh between 50–60 g, range in length from 23–26 cm, and have a wingspan of approximately 61 cm [1, 3]. The sexes are similar in appearance, with only slight differences in color saturation and males averaging 1–5% larger than females [1, 4]. In the breeding season, Black Tern has a solid black head and underbody (with the exception of a white undertail), dark gray wings, back and tail, dark brown eyes, reddish black legs and feet, and a small black bill [1, 3]. In the non-breeding season, the wings and back remain dark gray, but the underbody fades to white and the black head is reduced to a black hind-crown [1, 3]. Two other species of tern are considered Wyoming summer residents and are known to breed in the state: Caspian Tern (*Hydroprogne caspia*) and Forster's Tern (*Sterna forsteri*) [5, 6]. Black Tern is easily distinguished from both Caspian Tern and Forster's Tern during the breeding season by its distinctive black head and underbody [3].

Distribution & Range:

Black Tern is a localized breeder from central Canada to as far south as southern Colorado in the western United States and the Great Lakes in the east, but the core of their range is in the Prairie

Potholes Region (PPR) [1]. Wyoming lies within the southern edge of its breeding range. Black Tern migrates through the state in the spring and fall and is a summer resident [5, 6]. Although this species has been observed at waterbodies across the state, confirmed or suspected breeding has been documented in just 7 of the 28 latitude/longitude degree blocks [6].

Habitat:
Black Tern breeds in productive freshwater habitats with emergent and floating aquatic vegetation, including ponds, lakes, marshes, wetlands and occasionally peripheral marsh habitat along rivers and islands [1]. This species is more likely to occur in hemi-marsh stage wetlands (roughly 50% open water and 50% interior emergent vegetation) that are part of larger wetland complexes with little to no anthropogenic activity or disturbance [7, 8]. Black Tern has been shown to differentially select habitats for breeding and foraging based on local wetland characteristics, with breeding terns selecting for wetlands with more emergent vegetation and foraging terns selecting for larger wetlands with areas of open water [9]. Structure is more important than the species of emergent vegetation, with breeding terns often selecting short-dense or tall-sparse vegetation for nesting sites [10]. Black Tern favors areas of calm freshwater with 25–75% emergent vegetation to serve as a floating substrate for nesting, although non-floating substrates may also be used depending on habitat [1]. Nests are usually formed from piled dead emergent vegetation, and are typically just 2–5 cm above the surface of the water [1].

Phenology:
In Wyoming, spring arrival of migrating and breeding Black Terns typically begins the second week of May, with peak migration occurring from late May to early June [5]. Very little is known about the specific nesting and breeding habits of this species in Wyoming. Clutches are typically initiated in early June, and usually contain 2 or 3 eggs [1]. Eggs hatch from late June to early July, and young fledge from mid- to late July [1]. Black Tern is considered a single-brood species, but will often renest following loss of the first clutch [1]. Fall migration from Wyoming starts in August, with all migrants and residents leaving by the end of September [5].

Diet:
Black Tern feeds primarily on insects and small freshwater fish during the breeding season, and insects and small marine fish during the non-breeding season [1].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
There are no robust estimates of abundance available for Black Tern in Wyoming. The statewide abundance rank of VERY RARE is based on the rather small area of the state known to be occupied in any given season, and the small coverage of suitable habitat within that area. However, within suitable habitats in the occupied area, Black Tern appears to be uncommon, occurring at relatively low density and requiring intensive survey efforts to detect [6]. Detections of Black Tern in Wyoming are limited. Colonial nesting waterbird surveys conducted from 2002–2006 by the Wyoming Game and Fish Department (WGFD) recorded a range of 12 to 100+ individuals annually across all surveyed sites [11-15]. From 1968–2015, annual Wyoming Breeding Bird Survey (BBS) detections of Black Tern ranged from 0 to 6, with none recorded in most years [16]. Just 1 Black Tern was detected during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [17]. While surveys conducted

as part of the BBS and IMBCR programs may occasionally detect this species, neither is specifically designed to capture tern observations.

Population Trends:
Historic: LARGE DECLINE
Recent: STABLE
Robust population trends are not available for Black Tern in Wyoming due to low detection rates during monitoring efforts, and uncertainty exists even in larger scale estimates. However, Black Tern is believed to have a decreasing population trend across much of its North American and global distribution [1]. Survey-wide trend data from the North American BBS indicate that Black Tern numbers experienced a statistically significant annual decline of 2.33% from 1966–2013 and a non-significant annual increase of 3.35% from 2003–2013; however, these data have deficiencies and should be viewed with caution [18]. In the PPR, Black Tern numbers declined annually by 1.18% from 1966–2013 and increased annually by 2.55% from 2003–2013, but neither trend estimate was statistically significant [18].

Intrinsic Vulnerability:
HIGH VULNERABILITY
Black Tern has high intrinsic vulnerability in Wyoming due to selective habitat requirements which limit its distribution and abundance in the state, and colonial nesting and nest-building behaviors that potentially leave the species susceptible to disturbance. Large, productive wetland complexes are uncommon in Wyoming, which is one of the most arid states in the country [5, 19, 20]. Natural or anthropogenic disturbance to breeding colonies can potentially affect large numbers of nesting individuals and negatively impact local populations of Black Tern. In addition, Black Tern nests are often insubstantial and constructed on floating vegetation just a few centimeters above the surface of the water [1]. These characteristics can leave nests highly vulnerable to damage or loss from surface disturbance and fluctuating water levels [21], which commonly occur on waterbodies in Wyoming.

Extrinsic Stressors:
MODERATELY STRESSED
Black Tern is moderately stressed by extrinsic stressors in Wyoming, where already limited natural wetland habitat is potentially vulnerable to climate change and drought, invasive plant species, and development for infrastructure, energy, and agriculture [19, 20]. Natural wetlands in Wyoming are declining in size and number, with less than 2% of the total state area classified as wetland habitat [19, 20]. Drought can render previously productive migration, breeding, and foraging sites unsuitable through the contraction or complete loss of wetland habitat and changes to the structure and availability of emergent aquatic vegetation [8, 22, 23]. One study found that under modeled drier conditions in the United States portion of the PPR, Black Tern lost close to 100% of its current range [22]. Large-scale conversion of wetlands for development leads to fragmentation and direct loss of Black Tern habitat, while anthropogenic activity on adjacent lands can lead to avoidance and changes to water quality and availability, vegetation structure, and food availability [1, 7, 24].

KEY ACTIVITIES IN WYOMING
Black Tern is classified as a Species of Greatest Conservation Need (SGCN) by the WGFD, and as a Level I Priority Bird Species requiring conservation action in the Wyoming Bird Conservation Plan [25]. Current statewide bird monitoring programs are designed for monitoring

breeding songbird populations and are unlikely to provide useful information on Black Tern. These monitoring programs include the BBS program conducted on 108 established routes since 1968 [18], and the multi-agency IMBCR program initiated in 2009 [17]. Since 1984, WGFD has conducted annual or periodic monitoring at the most important and productive sites for colonial waterbird SGCN to determine species presence and distribution, and to estimate number of nesting pairs. The most recent effort was the culmination of a multi-year cooperative agreement between the WGFD and the United States Fish and Wildlife Service (USFWS) to conduct an intensive survey of all historic, known, potential, and new colonial waterbird breeding sites statewide as part of a western range-wide effort to track population size, trends, and locations of breeding colonial waterbirds in the western United States [26, 27]. In 2014, an online Atlas of western colonial waterbird nesting sites was produced with data collected and submitted by participating states [28]. Every three to five years, WGFD personnel visit known colonial waterbird nesting sites outside of Yellowstone National Park to evaluate water level conditions, determine species present at each site, and estimate the number of nesting pairs of colonial waterbirds. There are currently no research projects designed specifically for Black Tern in Wyoming.

ECOLOGICAL INFORMATION NEEDS

In Wyoming, Black Tern would benefit from research to determine its detailed distribution, the location and habitat characteristics of current nesting sites, and the annual abundance of migrating and breeding adults. Beyond approximate arrival and departure dates, very little is known about the pathways of migrants, or the specific breeding habits of this species in Wyoming. Nothing is known about nest success or fledgling survival at the few known breeding locations. It would be valuable to examine how current and future land use practices and the potential impacts of climate change could affect the availability and quality of already limited Black Tern habitat in Wyoming, as these stressors could influence the future persistence of this species in the state.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. The colonial nature of Black Terns and other waterbirds makes these species particularly vulnerable across their range to loss or degradation of nesting sites, stochastic weather events such as drought and flooding, changing land use practices, pollution, and climate change. In Wyoming, Black Tern is classified as a SGCN due to limited suitable aquatic or wetland breeding habitat, sensitivity to human disturbance during the breeding season, and susceptibility of nests to fluctuating water levels [19]. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [18] and IMBCR [17] programs. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, colonial waterbirds are one of the species groups that warrant a targeted, species-specific survey method approach to obtain these data. WGFD conducted inventories of nesting colonial waterbirds, including Black Tern, from 1984–1986 [29, 30]. In 1990, WGFD summarized all information presently known on colonial nesting waterbirds in Wyoming [31]. Since 1984, WGFD has conducted annual or periodic monitoring at the most important and productive sites for colonial waterbird Species of Greatest Conservation Need. Results have shown Black Tern nesting at five sites in Wyoming; Cokeville Meadows National Wildlife Refuge near Cokeville, and four sites within the Laramie Plains Basin near Laramie [6]. Due to their sensitivity to human disturbance during the nesting season, the survey technique used for colonial waterbirds is minimally invasive and provides only an estimate of the number of breeding pairs and coarse habitat associations of each waterbird species present in the colony. Actual nests, eggs, or young are not located or counted to prevent colony disruption and reduce predation risk. From 2009–2012, WGFD and USFWS cooperated to conduct a rigorous survey of all historic, known, potential, and new colonial waterbird breeding sites statewide as part of a western range-wide effort to track population size, trends, and locations of breeding colonial waterbirds in the western United States [26, 27]. A total of 90 sites were evaluated in Wyoming; 86 potential colonial waterbird nesting sites and 4 known nesting sites. A lack of adequate emergent vegetation to provide secure nesting areas for colonial waterbirds was noted at most potential sites visited. An online Atlas of western colonial waterbird nesting sites was produced with data collected and submitted by participating states [28]. Best management practices to benefit Black Tern include maintaining large, high quality wetland complexes; keeping water levels stable during the nesting season; installing artificial nest platforms where needed; protecting any colony site used by Black Tern; keeping human disturbance to a minimum during the breeding season, and monitoring colony sites every three years to determine Black Tern presence and estimate number of nesting pairs [19, 25].

CONTRIBUTORS

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Figure 1: Black Tern with breeding plumage in Lacreek National Wildlife Refuge, South Dakota. (Photo courtesy of Tom Koerner, USFWS)

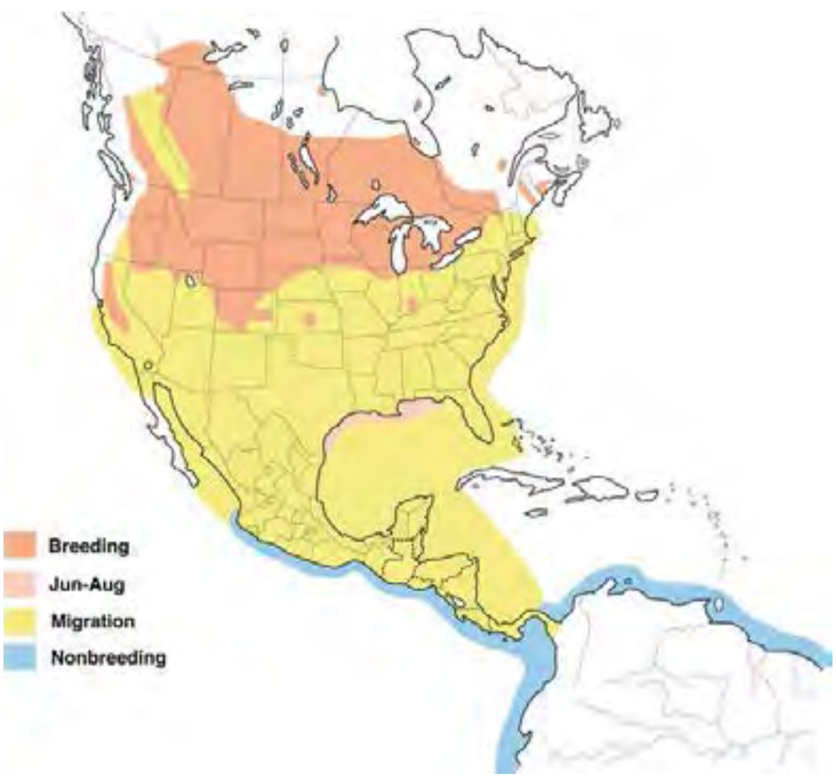

Figure 2: North American range of *Chlidonias niger*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

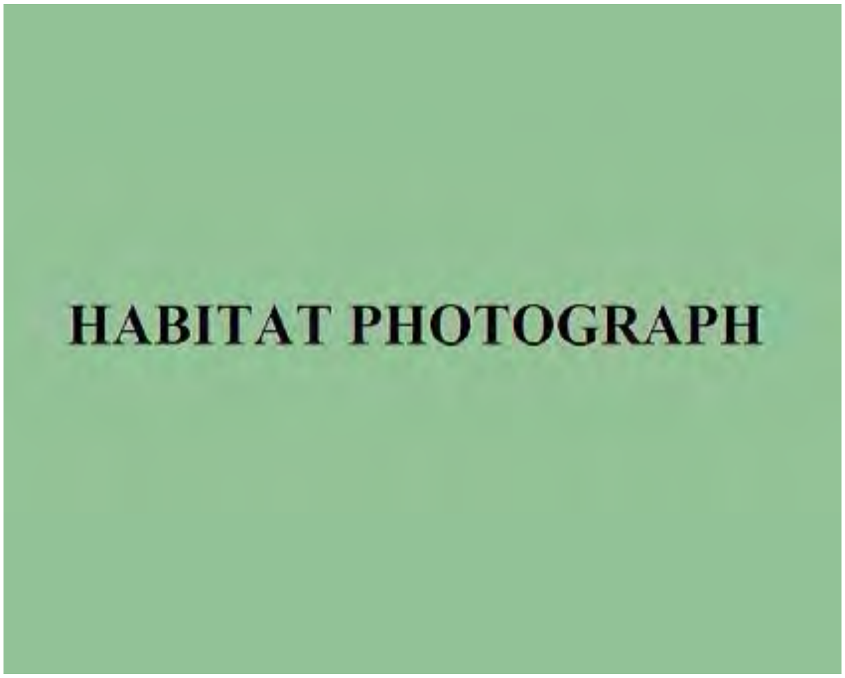

Figure 3: Photo not available.

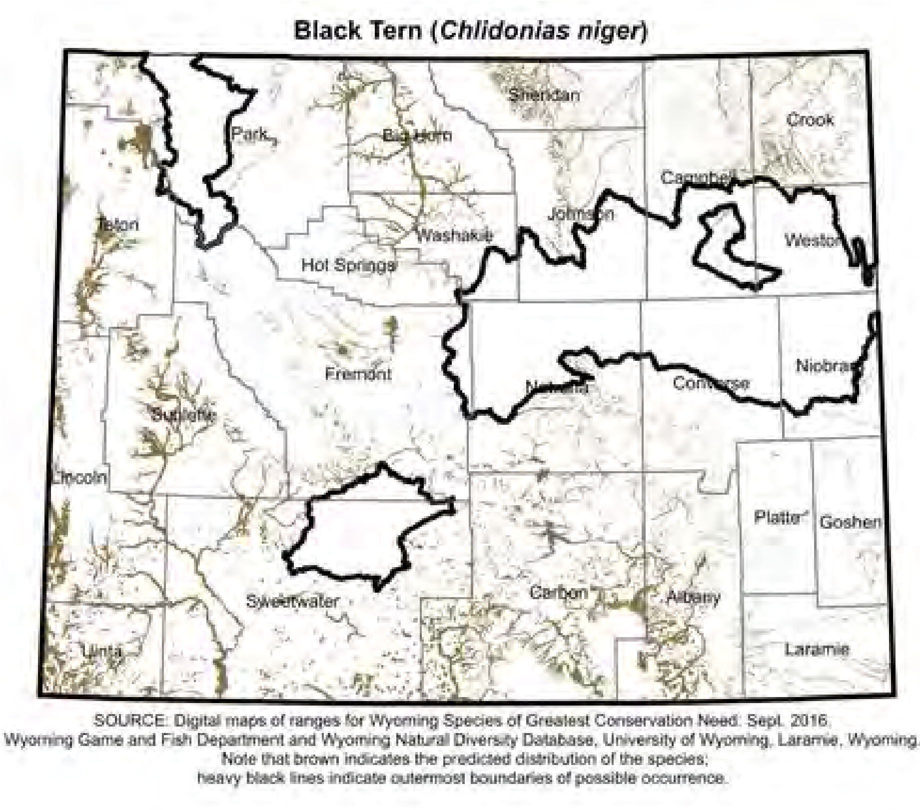

Figure 4: Range and predicted distribution of *Chlidonias niger* in Wyoming.

Figure 5: Black Tern nest with eggs in Malheur National Wildlife Refuge, Oregon. (Photo courtesy of Lauren B. Harter)

Black-throated Gray Warbler

Setophaga nigrescens

REGULATORY STATUS

USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS4 (Bc), Tier II
WYNDD: G5, S2
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 11

STATUS AND RANK COMMENTS

Black-throated Gray Warbler (*Setophaga nigrescens*) does not have any additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:

There are no subspecies recognized for Black-throated Gray Warbler [1-3], although Unitt (2004) recommends a range wide analysis of plumage variation [4], despite previous studies detecting only average differences among populations [2, 3, 5]. Originally, the Black-throated Gray Warbler was placed in the *Dendroica* genus, but recent genetic studies reclassified it into the *Setophaga* genus [6]. Thus, literature prior to 2010 lists the species in the *Dendroica* genus.

Description:

Black-throated Gray Warbler is an average-sized wood-warbler (11–13 cm, 7–10 g) [7]. It is identifiable by its black, white, and gray plumage with a yellow spot on the lores (might be difficult to see). On adult males, upperparts are gray with black streaks on the back, underparts are white with black streaks on the flanks, there are two white wing-bars and white on the tail, and the head and throat are black with white superciliary and submustachial areas. Adult females are similar, but are duller, have a white chin, and white mixed into the black throat patch. Juveniles are similar to adult females, but have a mostly white throat patch and are duller overall. There is little seasonal variation in plumage, but there might be a brownish coloration in the early fall [8]. The two warblers in Wyoming that could be confused with Black-throated Gray Warbler are Blackpoll Warbler (*S. striata*) and Black-and-white Warbler (*Mniotilta varia*). Blackpoll Warbler is only black and white in alternate plumage, and can be distinguished from Black-throated Gray Warbler by its white cheek and less distinctive facial pattern. Black-and-white Warbler can be differentiated by its black and white striped upperparts and ventral streaks, which are not restricted to the flanks.

Distribution & Range:
Black-throated Gray Warbler has been documented in 16 of Wyoming's 28 latitude/longitude degree blocks, with confirmed or circumstantial evidence of breeding occurring in 8 of those 16 degree blocks [9]. Only 5 of the 16 degree blocks in which sightings have occurred include confirmed observations as accepted by the Wyoming Bird Records Committee (WBRC) [10]. Black-throated Gray Warbler is found in central and southwest Wyoming, and is a summer resident. The species' breeding range extends from British Columbia south to the northern Baja Peninsula, east to New Mexico, and north to central Wyoming. Black-throated Gray Warbler winters in central and western Mexico [7].

Habitat:
During the breeding season in southwestern Wyoming, Black-throated Gray Warbler prefers north- and east-facing slopes, woodland with Pinyon Pine (*Pinus edulis*), and breast-height understory vegetation [11]. Black-throated Gray Warbler prefers to breed in juniper woodland habitats [12]. Migration habitats are similar to breeding season habitats. In Colorado, Black-throated Gray Warbler uses piñon-juniper, scrub oak (*Quercus* spp.), cottonwood (*Populus* spp.), willow (*Salix* spp.), tamarisk (*Tamarix* spp.), and alder (*Alnus* spp.) habitats [13]. Winter habitat in Mexico and the southwestern United States is similar to breeding season habitat [7].

Phenology:
Migrants east of the continental divide in Wyoming arrive in early May, but timing of arrival in juniper habitats in the southwest is unknown [12]. Migrants arrive in Colorado between mid-April and late May, with a peak in early May [14, 15]. Timing of fall departure is uncertain due to few records in Wyoming [12]. In Colorado, departures range between early August and early October, with a peak of late August to mid-September [14]. There is no information on timing of pair formation or nest building [7]. Pairs usually produce only one brood, but are capable of a second brood [16, 17]. Eggs considered "fresh" were observed from mid-May to late June in Oregon and Washington [16]. Clutch size averages 4 eggs, with a range of 3–5 [18]. Timing of egg laying commencement and time between each egg laid is unclear, with substantially different times reported [16, 19]. There is no information on incubation period or hatching [7]. Chicks are altricial at hatching [7].

Diet:
Insects comprise the majority of food consumed by Black-throated Gray Warbler [7]. The only confirmed foods consumed are "small (2–4 cm) green caterpillars" [16, 20] and cordgrass (*Spartina* spp.) seeds [21].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
Using North American Breeding Bird Survey (BBS) data, the Partners in Flight (PIF) Science Committee estimated the global population of Black-throated Gray Warbler to be 2.4 million birds [22]. There is no estimate provided for the percentage of the global population that occurs in Wyoming. In northeast Utah, birds/km transect were estimated at 0.1 (±0.1), 1.8 (±1.2), and 0.4

in sagebrush-greasewood, juniper woodland, and riparian habitats, respectively [23]. The statewide rank of RARE is based on the rather small area of the state known to be occupied in any given season, and the small coverage of suitable habitat within that area. Within suitable habitat in the occupied area, Black-throated Gray Warbler appears to be uncommon, occurring in relatively low densities and requiring intense survey efforts to detect the species [9]. Black-throated Gray Warbler density (number of birds per square km) and population size estimates for Wyoming are available from the Integrated Monitoring in Bird Conservation Regions (IMBCR) program for the years 2010, 2013, and 2015, although detections are limited so data must be interpreted with caution [24].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Little data are available for Black-throated Gray Warbler in Wyoming. Currently, there are no BBS trend data for Black-throated Gray Warbler in Wyoming due to a limited distribution in the state and low detection rates during monitoring surveys. However, 1968–2013 BBS trend and survey-wide analysis indicate a statistically insignificant annual decrease of 1.49% (N = 390 routes, 95% CI: -3.49 to 0.72), an annual decrease of 1.49% (N = 388 routes, 95% CI: -3.49 to -0.72) in the western BBS region, and an annual decrease of 2.23% (N = 35 routes; 95% CI: -4.48 to -0.03) in Colorado [25].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
In Wyoming, Black-throated Gray Warbler has moderate intrinsic vulnerability to extrinsic stressors. The species' primary vulnerabilities stem from its peripheral breeding range status and low density [9, 12]. Additionally, one of the taxon's preferred breeding habitats is mature juniper woodlands, which is limited in Wyoming [11, 26].

Extrinsic Stressors:
SLIGHTLY STRESSED
Extrinsic stressors to Black-throated Gray Warbler include nest parasitism and habitat alteration. Stressors in Wyoming are most likely associated with land use practices in preferred breeding habitat, specifically mature juniper woodlands, which are extremely limited in Wyoming and are generally concentrated in the southwestern reaches of the state. These areas may be subjected to heavy livestock grazing, oil and gas development, recreational uses, invasive species, altered fire regimes, and cowbird (*Molothrus* spp.) nest parasitism, as well as juniper thinning and removal treatments [26, 27]. Drought and climate change could also alter preferred habitat. While local, state, and federal land use agreements may limit adverse impacts to these areas and provide specific guidelines for alterations, particular efforts should be made to maintain multi-aged juniper woodlands with a multi-layered native understory plant community [26]. Brown-headed Cowbird (*M. ater*) has been shown to parasitize nests of Black-throated Gray Warbler across its range [28-31]. Additionally, habitat alteration, such as removal of overstory trees to enhance pastureland, might affect habitat use [32]. Fragmentation, alteration, and loss of habitat might have cumulative effects on Black-throated Gray Warbler populations, but there is little information available to assess these effects on either the local or regional level [7].

KEY ACTIVITIES IN WYOMING

Little work has been done specific to Black-throated Gray Warbler in Wyoming since the first nesting record was documented in the state in 1982 [33]. Black-throated Gray Warbler is classified as a Species of Greatest Conservation Need (SGCN) by the Wyoming Game and Fish Department (WGFD), and a Wyoming PIF Level III Priority Species due to restricted habitat distribution and limited information on the breeding status and population trends in the state [26]. Black-throated Gray Warbler is not adequately monitored by current national or regional avian monitoring efforts in Wyoming, including the BBS program conducted on 108 established routes since 1968 [25] and the IMBCR program initiated in 2009 (3 detections since initiation) [24]. Observations of this species are reported to the WGFD and vetted through the WBRC. Black-throated Gray Warbler is a species for which the WBRC requests documentation on first latitude/longitude degree block sightings and all nesting observations. In 2016 and 2017, the WGFD will conduct a project focused on addressing data deficiencies for Utah Juniper obligate species in southwestern Wyoming, including Black-throated Gray Warbler. This project will address a number of objectives, including evaluating species distribution and richness, estimating relative abundance and occupancy rates, and quantifying and evaluating habitat characteristics.

ECOLOGICAL INFORMATION NEEDS

In Wyoming, assessment of the status of Black-throated Gray Warbler is hampered by a lack of ecological and population data. Additional information is needed on distribution and habitat use, and estimates of abundance and occupancy rates are needed to assess status, monitor populations, and evaluate trends. Research is needed on the effects of habitat alterations and the impact of brood parasitism on Black-throated Gray Warbler, and to determine distinctive geographic variation in disjunct populations. Additional information is also needed to determine the extent of this species' status and distribution in other parts of Wyoming where observations have been documented, especially Big Horn, Fremont, Hot Springs, Carbon, Natrona, and Washakie Counties [9, 12]. The effects of incompatible forest management practices, habitat loss and degradation, drought, and climate change are needed.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Black-throated Gray Warbler is classified as a SGCN in Wyoming due to unknown population status and trends in the state; a need for robust information on breeding status; limited distribution of required breeding habitat; loss, degradation, and fragmentation of Utah Juniper habitat due to industrial developments; and incompatible management practices. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [25] and IMBCR [24]. While these monitoring programs provide robust estimates of occupancy, density, or population trends for many avian species in Wyoming, survey efforts do not tend to detect Black-throated Gray Warbler at adequate levels, suggesting targeted, species-specific monitoring efforts are needed. Best management practices to benefit Black-throated Gray Warbler are similar to those for sympatric Utah Juniper obligate species. These include implementing a sufficient monitoring technique; maintaining mature stands of juniper and piñon-juniper habitats where Black-throated Gray Warbler occurs, including small-scale openings of habitat and overstory trees; avoiding or minimizing insecticide use in woodland habitats to maintain a food source for Black-throated Gray Warbler (and other insectivores); and excluding grazing until after July 31st in areas where Black-throated Gray Warbler occurs to reduce brood parasitism by Brown-headed Cowbird [26].

CONTRIBUTORS

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Figure 1: Adult male Black-throated Gray Warbler (note black throat) in Moffat County, Colorado. (Photo courtesy of Bill Schmoker)

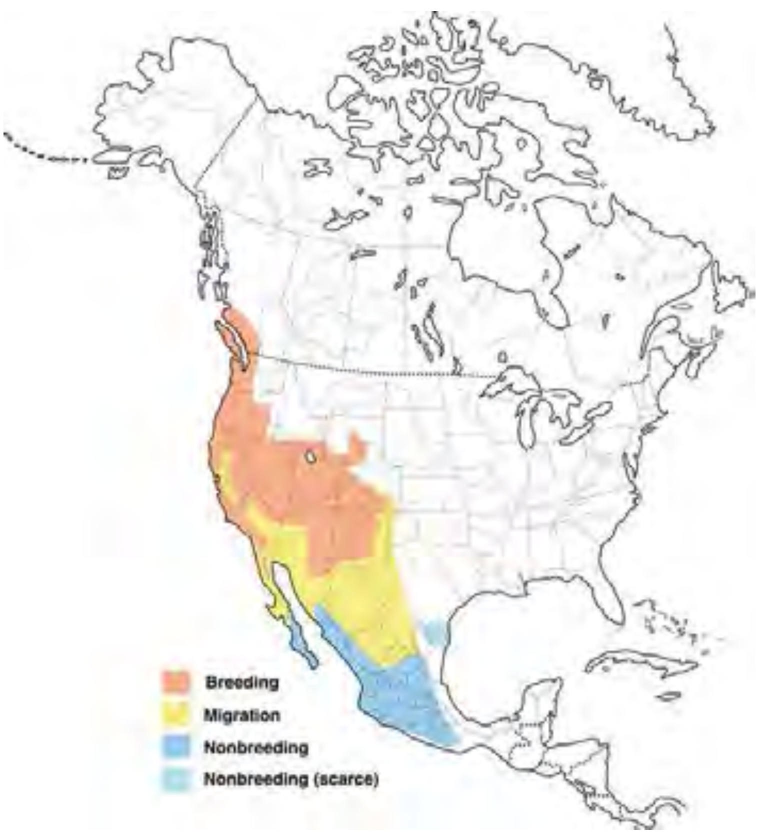

Figure 2: North American range of *Setophaga nigrescens*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

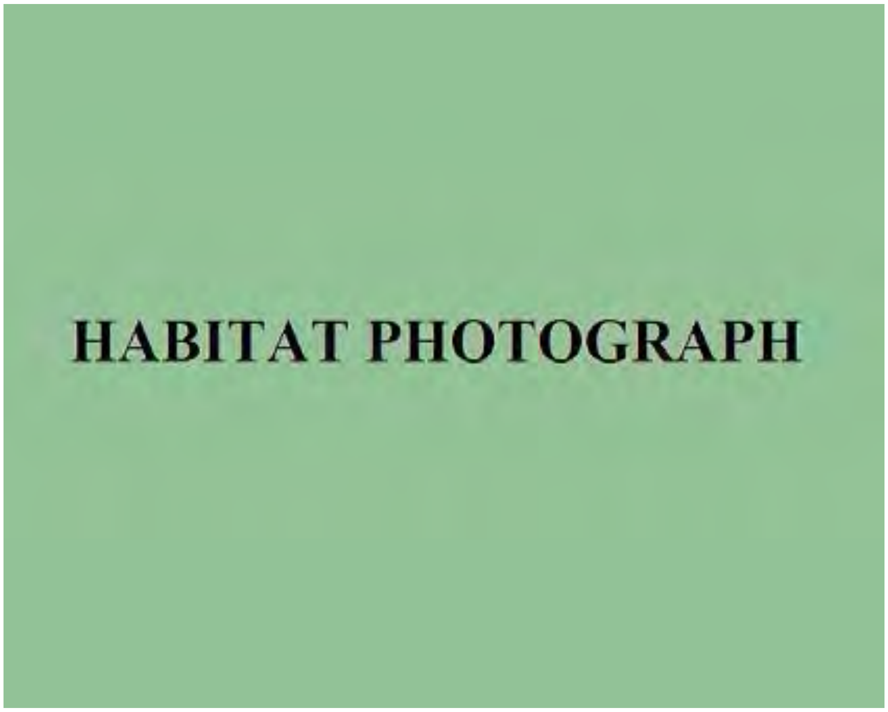

Figure 3: Photo not available.

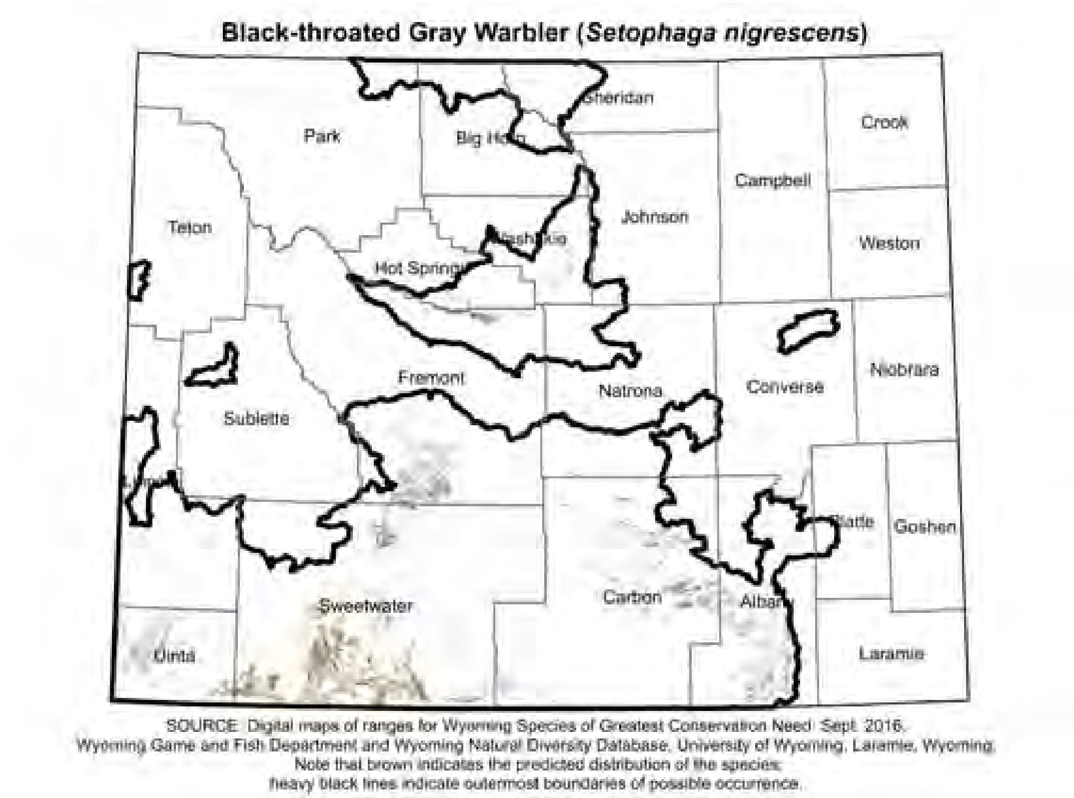

Figure 4: Range and predicted distribution of *Setophaga nigrescens* in Wyoming.

Blue-gray Gnatcatcher

Polioptila caerulea

REGULATORY STATUS

USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS4 (Bc), Tier III
WYNDD: G5, S3S4
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 7

STATUS AND RANK COMMENTS

The Wyoming Natural Diversity Database has assigned Blue-gray Gnatcatcher (*Polioptila caerulea*) a state conservation rank ranging from S3 (Vulnerable) to S4 (Apparently Secure) because of uncertainty about the abundance and population trends for this species in Wyoming.

NATURAL HISTORY

Taxonomy:

Blue-gray Gnatcatcher has seven identified subspecies [1]. Nine subspecies have been described, but two are thought to need additional validation [1, 2]. The western subspecies, *P. c. obscura*, occurs within Wyoming [2].

Description:

Identification of Blue-gray Gnatcatcher is possible in the field. Blue-gray Gnatcatcher is bluish-gray in dorsal coloration, with a white belly and prominent white eye-ring. Sexes are similar in plumage. Males can be distinguished from females while in alternate plumage, exhibiting a black forehead and supercilium [1]. Juveniles are similar to adults, but are grayish in coloration. Blue-gray Gnatcatcher has a long, black tail with white outside feathers that comprises about 45% of its total body length [1]. Overall adult body length is approximately 12 cm, with a mass of approximately 6 g [1, 3, 4]. Within its Wyoming breeding distribution, Blue-gray Gnatcatcher is similar in appearance to Plumbeous Vireo (*Vireo plumbeus*), Gray Vireo (*V. vicinior*), and several species of *Empidonax* flycatcher; however, Blue-gray Gnatcatcher can be distinguished from all by its bi-colored tail and lack of white wing bars [5].

Distribution & Range:

The breeding range of Blue-gray Gnatcatcher occurs throughout the eastern and southwestern portions of the United States. This species is considered a permanent resident within northern Central America. Northern breeding populations winter along the Pacific Coast of Central

America to Honduras, southern Florida, and Cuba [1]. This species is mostly absent in the northwestern United States and Great Plains. However, Blue-gray Gnatcatcher has begun to expand its range northward [1, 6, 7]. It is estimated that this species has shifted its range approximately 300 km to the north [1]. Blue-gray Gnatcatcher is thought to have expanded into Wyoming in the mid-20th Century [2, 7], and is considered most abundant in the southwestern portion of the state [2, 8]. Blue-gray Gnatcatcher has been documented in 21 of Wyoming's 28 latitude/longitude degree blocks [8]. Confirmed breeding observations have been documented in 4 degree blocks, and circumstantial evidence of breeding has been noted in 2 additional degree blocks [8].

Habitat:
Blue-gray Gnatcatcher can be found in a variety of habitats. It may occur in shrublands, mature forests, and riparian zones [1]. Blue-gray Gnatcatcher is typically absent from needle-bearing conifer habitats [1]. Throughout its range, Blue-gray Gnatcatcher prefers gap edge habitats [1]. In the southwestern United States, Blue-gray Gnatcatcher is typically found in pinyon-juniper (*Pinus* spp.-*Juniperus* spp.) woodlands and adjoining chaparral habitats [3]. Within Wyoming, Blue-gray Gnatcatcher is found primarily in juniper and deciduous riparian habitats [2]. Blue-gray Gnatcatcher has been documented in southwestern Wyoming in select high density shrub ecotones, preferring shrubs within the family Rosaceae [9]. The cup-shaped nest is built by both sexes and takes around a week to build. Nests are constructed out of plant fiber, spider webbing, and lichen [1].

Phenology:
Blue-gray Gnatcatcher is primarily diurnal. Migrating patterns and movements of subpopulations are unclear. Northern individuals may leap over populations in Central America, and the degree of subpopulation mixing remains unknown [1]. Blue-gray Gnatcatcher arrives within the state during the first week of May [2]. Both males and females appear to migrate at the same time, with both sexes arriving simultaneously [1]. The earliest accepted observation of this species in Wyoming is 14 April [2]. Birds begin to leave the state in mid-August and are typically gone by October. The latest accepted observation of this species in the state is 18 December [2]. Pairing typically occurs within a day of appearance at breeding areas [1, 10]. Blue-gray Gnatcatcher has been documented to re-nest and produce a second brood. Nests are typically only used in a single nesting attempt, and may be recycled to construct new nest structures [1, 11]. A banded Blue-gray Gnatcatcher female was documented to recycle nesting materials for 6 consecutive nests up to 500 ft away [10]. Clutch size is typically 4–5 eggs [4]. Incubation is typically 15 days, with fledging occurring around 10–15 days [1]. Brood parasitism by cowbirds (*Molothrus* spp.) has been documented for this species and can be a limiting factor [10].

Diet:
Blue-gray Gnatcatcher is an invertivore. This species feeds in dense vegetation, gleaning small insects and spiders. Blue-gray Gnatcatcher has also been known to sally and hawk prey [1]. It is thought that tail movement may have a functional role while foraging [3].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE to UNCOMMON

Using North American Breeding Bird Survey (BBS) data, the Partners in Flight Science Committee estimated the global population of Blue-gray Gnatcatcher to be 160 million birds [12]. Approximately 0.04% of the global population, or around 60,000 birds, is estimated to breed in Wyoming [13]; however, this abundance estimate should be viewed with caution given the low detection rate of this species in the state. The statewide rank of RARE to UNCOMMON is based on the limited area of the state known to be occupied in any given season, and the relatively small coverage of suitable habitat within that area. Within suitable habitat in the occupied area, Blue-gray Gnatcatcher appears to be uncommon, occurring in relatively low densities and requiring intensive survey efforts to detect the species [8]. Blue-gray Gnatcatcher density (number of birds per square km) and population size estimates for Wyoming are available from the Integrated Monitoring in Bird Conservation Regions (IMBCR) program for the years 2009–2015, although detections are limited so data must be interpreted with caution [14].

Population Trends:
Historic: INCREASE
Recent: UNKNOWN
Population trends are not available for Blue-gray Gnatcatcher in Wyoming due to a limited distribution in the state and low detection rates during monitoring surveys. Currently, there are no robust North American BBS trend data for Blue-gray Gnatcatcher in Wyoming due to an extremely limited observation sample size (N = 11 routes; 1968–2013) and data that fall within a credibility category containing important deficiencies [15]. Low relative abundance and number of routes with Blue-gray Gnatcatcher detections likely contribute to this classification [15]. However, 1966–2013 BBS trend analysis for this species survey-wide indicates a slight annual population increase of 0.39% (N = 2,178 routes; 95% CI: 0.08–0.70).

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Blue-gray Gnatcatcher occurs in shrublands, mature forests, and riparian zones. Pinyon-juniper habitats have shown increased occupancy of this species, and it is surmised that mountain mahogany (*Cercocarpus* spp.) may be important to this species in Wyoming [9]. The preference for ecotones may make this species more accessible to cowbird nest parasitism. Blue-gray Gnatcatcher is one of the smallest regular hosts for Brown-headed Cowbird (*M. ater*) and is not able to eject or puncture cowbird eggs [1].

Extrinsic Stressors:
MODERATELY STRESSED
Extrinsic stressors for the Blue-gray Gnatcatcher are largely unknown. There is evidence that increased urbanization and nest parasitism by cowbirds have impacted populations [1, 11]. Blue-gray Gnatcatcher has been found to avoid urban situations [1]. Areas inhabited by this species in the state have increased energy development potential. Increased infrastructure associated with development may impact the persistence of this species within Wyoming. However, direct impacts of energy development on this species are unknown.

KEY ACTIVITIES IN WYOMING

Blue-gray Gnatcatcher is classified as a Species of Greatest Conservation Need (SGCN) by the Wyoming Game and Fish Department. This species is not adequately monitored by current national or regional avian monitoring efforts in Wyoming, including the IMBCR program initiated in 2009 (87 detections since initiation) [14] or the BBS program conducted on 108 established routes since 1968 [15]. No systematic surveys of Blue-gray Gnatcatcher has been conducted in Wyoming. A study to address data deficiencies of bird and mammal juniper obligates in southwestern Wyoming, including Blue-gray Gnatcatcher, was funded for calendar years 2016 and 2017. This project will address a number of objectives, including evaluating species distribution and richness, estimating relative abundance and occupancy rates, and quantifying and evaluating habitat characteristics.

ECOLOGICAL INFORMATION NEEDS

The range and status of the Blue-gray Gnatcatcher remain unclear in Wyoming. More information is needed to determine breeding range and population extent within the state. More information is needed regarding impacts of land management activities on breeding and survival, impacts of herbicides and pesticides, and climate change.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Blue-gray Gnatcatcher is classified as a SGCN in Wyoming due to unknown population status and trends in the state; a need for robust information on breeding status; limited distribution of required breeding habitat; loss, degradation, and fragmentation of Utah Juniper (*J. osteosperma*) habitat due to industrial developments; and incompatible management practices. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [15] and IMBCR [14]. While these monitoring programs provide robust estimates of occupancy, density, or population trends for many avian species in Wyoming, survey efforts do not tend to detect Blue-gray Gnatcatcher at adequate levels, suggesting targeted, species-specific monitoring efforts are needed. Management priorities for the species in the short-term will focus on addressing data deficiencies. Information should be gathered on species presence, distribution, population status, and the impact of potential threats. Any information gathered will ultimately be used to develop management and conservation recommendations for this species. Best management practices to benefit Blue-gray Gnatcatcher are similar to those for sympatric Utah Juniper obligate species in Wyoming and include implementing a sufficient monitoring technique, maintaining mature stands of Utah Juniper habitat where Blue-gray Gnatcatcher nests, and coordinating Utah Juniper management to provide a mosaic of juniper woodland conditions [16].

CONTRIBUTORS

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Figure 1: Adult male Blue-gray Gnatcatcher in Laramie County, Wyoming. (Photo courtesy of Pete Arnold)

Figure 2: North American range of *Polioptila caerulea*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

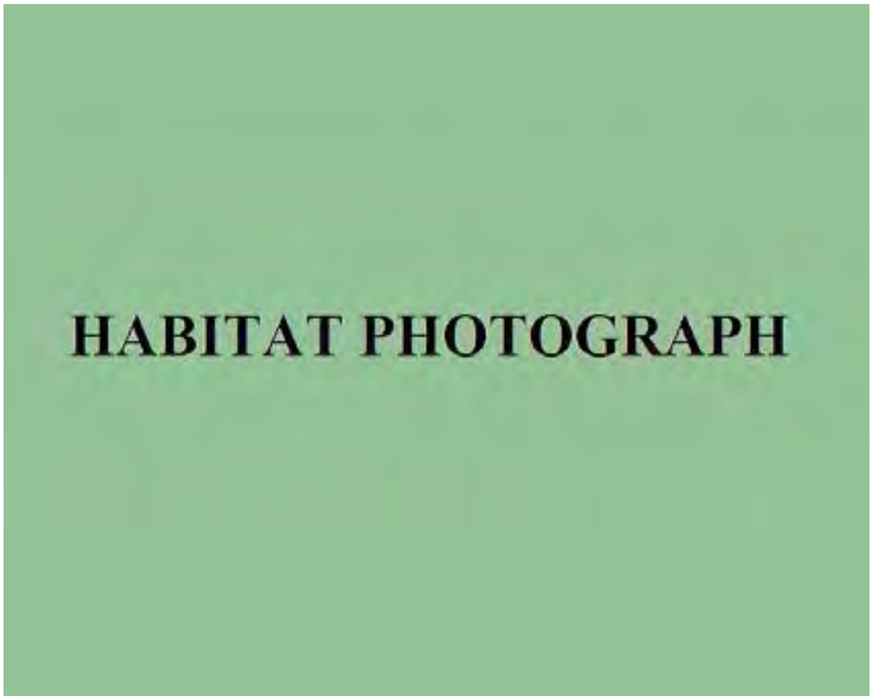

Figure 3: Photo not available.

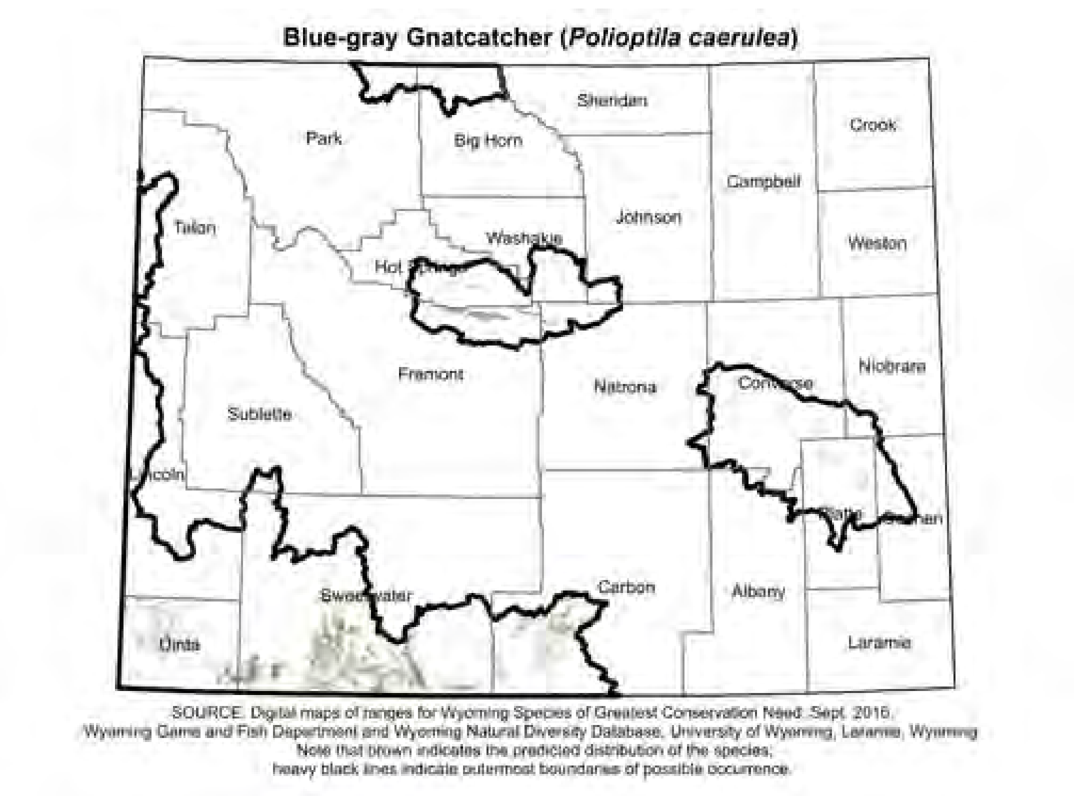

Figure 4: Range and predicted distribution of *Polioptila caerulea* in Wyoming.

Blue Grosbeak

Passerina caerulea

REGULATORY STATUS

USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS4 (Bc), Tier III
WYNDD: G5, S1
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 8

STATUS AND RANK COMMENTS

Blue Grosbeak (*Passerina caerulea*) does not have any additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:

Six subspecies of Blue Grosbeak are recognized, but only *P. c. caerulea*, *P. c. interfusa*, and *P. c. salicaria* are known to breed in the United States [1, 2]. In Wyoming, *P. c. interfusa* is the only known subspecies [1]; it breeds in the southwest United States and northwest Mexico, and typically winters in western Mexico. Regional differences in body measurements and coloration have largely contributed to designating subspecies [2, 3]. Recent molecular phylogeny indicates that the Blue Grosbeak is closely related to Lazuli Bunting (*P. amoena*) [4]. Previously, there had been disagreement about whether Blue Grosbeak belongs in the genus *Guiraca* or *Passerina* [5-7].

Description:

Blue Grosbeak is a large bunting in the Cardinalidae family. It is readily identifiable in the field during breeding season. Male Blue Grosbeaks are an overall vibrant blue with a large head, tiny black mask anterior to the eyes, and two reddish-brown wing-bars [8]. The back feathers may display black or brown edges, subject to age and wear [3]. Females also have two reddish-brown wing-bars, but the plumage is uniformly brown with occasional blue feathers on the upperparts. Both females and males have heavy beaks, with a silver lower mandible and a black upper [9, 10]. Legs are black in both sexes [2]. Weight and body measurements tend to be about the same, regardless of gender [8]. Subadult females tend to look like adult females, while subadult males are a lighter brown with different amounts of blue. At first glance, Indigo Bunting (*P. cyanea*) and Lazuli Bunting share basic similarities with Blue Grosbeak for females and males, and female Blue Grosbeaks can also be confused with female Brown-headed Cowbirds (*Molothrus ater*).

However, differences in overall size, wing coverts, and especially bill volume all contribute to Blue Grosbeak identification [2].

Distribution & Range:
Wyoming forms an extremely limited portion of the western edge of Blue Grosbeak's established central North American breeding range [2]. The species has been documented in 19 of Wyoming's 28 latitude/longitude degree blocks, with confirmed breeding occurring in 7 degree blocks [11]. Only 2 of the 19 degree blocks in which sightings have occurred include confirmed observations as accepted by the Wyoming Bird Records Committee; one is located in the far western portion of the state, while the other is in the far northeastern corner [12]. While rare in the state, Blue Grosbeak is known to be locally abundant within the North Platte River corridor from Torrington to Guernsey, Wyoming [1]. This species winters outside of Wyoming in Mexico, Central America, and the Greater Antilles islands. Blue Grosbeaks that summer in Wyoming are believed to winter in western Mexico, as far southeast as the Valley of Mexico, and Baja California Sur [13]. No information about distribution in Wyoming during migration is available.

Habitat:
In Wyoming, Blue Grosbeak generally prefers cottonwood (*Populus* spp.)-dominated riparian areas that include a shrubby layer, but the species can also be found in shrub-dominated water edges and even urban and rural developed areas [1, 11]. In North America, the species can be found in a variety of landscapes, including human-influenced areas such as old fields, utility-line corridors, post-logging slash areas, and fallow fields reverting to woodland [2, 8]. In less altered landscapes, the species can be found in an array of habitats on a regional basis. For instance, in Arkansas Blue Grosbeak prefers upland areas in proximity to the Mississippi River and, generally, areas with low canopy cover and shrub concentration [14, 15], while in southern California the species favors vegetated areas adjacent to water and grassy habitats [16].

Phenology:
Blue Grosbeak arrives in Wyoming in mid-May, although there is a 5 May report [1]. Pairs are present by early June, with some individuals possibly still migrating. The species lays a clutch consisting of 3–5 eggs (typically 4), laid at an approximate rate of 1 per day. Chicks hatch after a 12–13 day incubation period [2]. While there is little known about nestling period length, there are reports of young leaving the nest 9–10 days after hatching [17, 18]. While there are no documented records in Wyoming, a second brood is characteristic and Blue Grosbeak is known to re-nest after failure [1, 2]. Brown-headed Cowbird (*M. ater*) and Bronzed Cowbird (*M. aeneus*) are known to parasitize Blue Grosbeak nests, although the female Blue Grosbeak will, at times, eject the egg from the nest or bury it within the nest [19]. Blue Grosbeaks in Wyoming tend to depart for wintering grounds by mid-September, although there is a report of an active nest on 23 September [1].

Diet:
Blue Grosbeak feeds primarily on insects, snails, and the seeds of wild and planted grasses. Its bill is able to manage seeds as large as corn and insects such as mantids (Mantidae) and sphinx moth (Sphingidae) caterpillars [18, 20]. Food capture techniques may include gleaning, fly-catching, and plucking vegetation from the air and ground [20-23]. When feeding nestlings, the prey's appendages are removed prior to being delivered [2].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
Using North American Breeding Bird Survey (BBS) data, the Partners in Flight Science Committee estimated the global population of Blue Grosbeak to be 24 million birds [24]. Approximately 0.1% of the global population, or an estimated 30,000 birds, breeds in Wyoming [25]; however, this abundance estimate should be viewed with caution given the low detection rate of this species in the state. The statewide rank of RARE is based on the rather small area of the state known to be occupied in any given season, and the small coverage of suitable habitat within that area. Within suitable habitat in the occupied area, Blue Grosbeak also appears to be rare, as it occupies only a small percentage of preferred habitat within its range and may not be readily detected during surveys expected to indicate its presence [11]. Blue Grosbeak density (number of birds per square km) and population size estimates for Wyoming are available from the Integrated Monitoring in Bird Conservation Regions (IMBCR) program for the years 2009, 2010, 2014, and 2015, although sample sizes are extremely small so data must be interpreted with caution [26].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Population trends are not available for Blue Grosbeak in Wyoming due to a limited distribution in the state and low detection rates during monitoring surveys. Currently, there are no robust North American BBS trend data for Blue Grosbeak in Wyoming due to a lack of observations of this species during surveys since initiation in 1968 [27]. Regional BBS data, however, indicate a stable population in the west [27].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
In Wyoming, Blue Grosbeak has moderate intrinsic vulnerability to extrinsic stressors, which stems from its peripheral breeding range status (despite confirmed breeding records throughout the state) and low density [1]. Additionally, the taxon's preferred breeding habitat in Wyoming is generally restricted to low elevation riparian habitats and reservoirs [1, 2].

Extrinsic Stressors:
SLIGHTLY STRESSED
Stressors to Blue Grosbeak populations in Wyoming are most likely associated with land use practices in vegetated multi-story riparian corridors, as well as reservoir shores with established shrub shorelines. Riparian lands constitute a small percentage of Wyoming's landscape [28] and their importance to avian migration, nesting, and foraging is well documented [29]. While local, state, and federal measures may limit certain impacts in these areas, the cumulative effects of development (e.g., agriculture, ranching, energy, urbanization, recreation), invasive species, and hydrologic regime change (e.g., impoundments, irrigation withdrawals, channel alterations) contribute to the degradation of riparian lands in Wyoming [28]. Despite various stressors, it is possible that the Blue Grosbeak benefits from the presence of shelterbelts and shrub plantings associated with rural and residential development, as well as human disturbed areas such as transmission corridors, old fields, and slash openings left post-logging [1, 2].

KEY ACTIVITIES IN WYOMING

The Wyoming Game and Fish Department classifies Blue Grosbeak as a Species of Greatest Conservation Need (SGCN). No systematic survey of Blue Grosbeak has been conducted in Wyoming, and existing data are not robust enough to support estimates of occupancy, density, or population trend. There are no new or on-going research or monitoring projects designed specifically for this species in the state.

ECOLOGICAL INFORMATION NEEDS

In Wyoming, Blue Grosbeak would benefit from research to determine its nesting and population status in the state. Beyond approximate arrival and departure dates, very little is known about the specific breeding habits of this species in Wyoming. It would be valuable to examine how current and future land use practices and the potential impacts of climate change could affect the availability and quality of already limited riparian habitat in Wyoming, as these stressors could influence the future persistence of this species in the state.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Blue Grosbeak is classified as a SGCN in Wyoming due to insufficient information on breeding, distribution, and population status and trends. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [27] and the multi-partner IMBCR [26]. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, a targeted, species-specific survey method may be warranted to obtain these data for Blue Grosbeak.

CONTRIBUTORS

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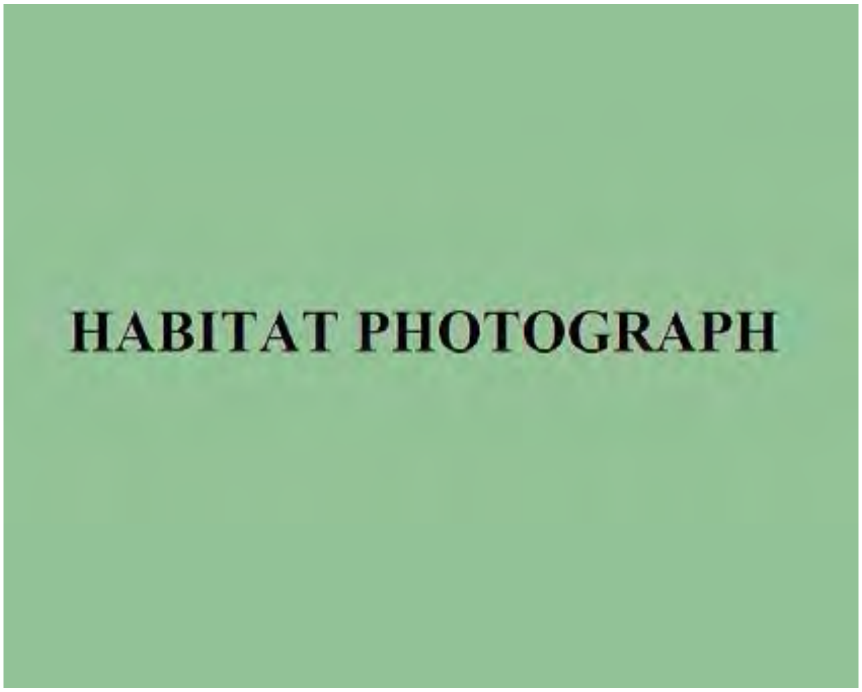
Figure 1: Adult Blue Grosbeaks: male (top) in Jefferson County, Colorado and female (bottom) in Socorro County, New Mexico. (Photos courtesy of Bill Schmoker)

Figure 2: North American range of *Passerina caerulea*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)



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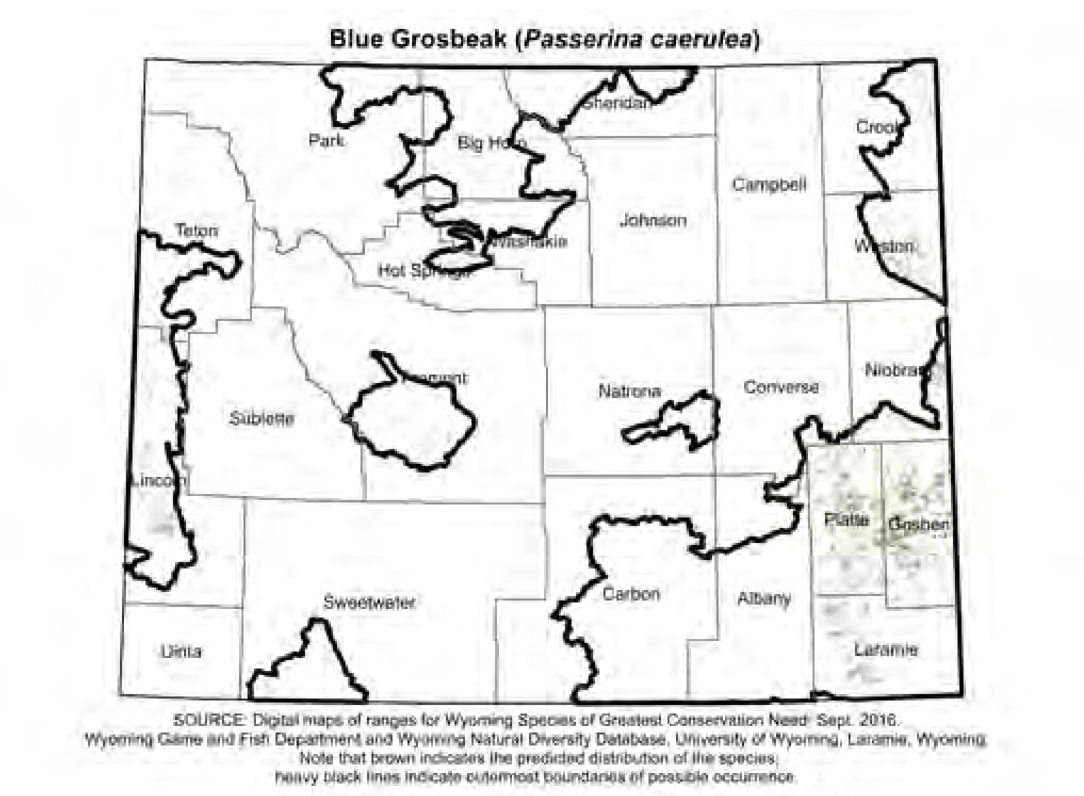

Figure 4: Range and predicted distribution of *Passerina caerulea* in Wyoming.

Bobolink

Dolichonyx oryzivorus

REGULATORY STATUS

USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS4 (Bc), Tier II
WYNDD: G5, S2S3
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 13

STATUS AND RANK COMMENTS

The Wyoming Natural Diversity Database has assigned Bobolink (*Dolichonyx oryzivorus*) a state conservation rank ranging from S2 (Imperiled) to S3 (Vulnerable) because of uncertainty about the actual abundance of the species in Wyoming.

NATURAL HISTORY

Taxonomy:

There are currently no recognized subspecies of Bobolink [1, 2].

Description:

Identification of Bobolink is possible in the field. Adults weigh roughly 43 g (males average larger than females), range in length from 15.2–20.5 cm, and have a wingspan of about 29.2 cm [1, 3]. Males and females have strikingly different plumage during the breeding season. Males have solid black underparts; silvery-white wing patches, lower back, and upper tail; a conspicuous, buffy yellow nape; and a black bill [1, 3]. In contrast, females have yellowish underparts; upperparts streaked with brown; faint streaking on the flanks; a buffy stripe along the top of the crown with wider, brown stripes on each side; a dark stripe behind the eyes; and a pinkish bill [1, 3]. The tail feathers of both males and females are pointed [1]. After the breeding season, males molt into non-breeding plumage prior to migration and look nearly identical to females [1]. Juveniles are similar in appearance to adult females but they lack streaking on the flanks [4]. Female, juvenile, and non-breeding male Bobolinks appear similar to many sparrow species, but can be distinguished by their larger size and pointed tail feathers [1]. Male Lark Buntings (*Calamospiza melanocorys*) are superficially similar to male Bobolinks during the breeding season, but the former are easily distinguished by a black nape and upperparts [3].

Distribution & Range:
During the breeding season, Bobolink is found across the northern half of the United States and portions of southern Canada. The species' distribution is patchy in the southwestern periphery of its range, which includes Wyoming. Bobolink migrates through the state in the spring and fall and is a summer resident [5, 6]. Bobolink has been documented in 26 of Wyoming's 28 latitude/longitude degree blocks, with confirmed or circumstantial evidence of breeding occurring in 11 degree blocks [6]. Most breeding observations are patchily distributed across the state and come from Crook County, Sheridan and Johnson Counties along the eastern edge of the Bighorn Mountains, and a small population on the National Elk Refuge in Teton County [5]. Bobolink migrates approximately 10,000 km to South America, where it winters in Bolivia, Paraguay, and Argentina following a prolonged stopover in Venezuela [1].

Habitat:
Bobolink is associated with tall grass and mixed-grass prairie ecosystems, and the species will also utilize hayfields and irrigated and non-irrigated meadows [1]. In Wyoming, Bobolink breeds in mixed prairie shrublands, grasslands, and irrigated meadows [5, 6]. Across the species' range, Bobolink prefers grassland habitat with tall and dense horizontal cover for nesting [7-9]. The species nests on the ground, with females constructing cup nests out of grasses, sedges, and forbs [1]. Herbaceous vegetation provides cover for the nest, food in the form of seeds, and substrate for preferred invertebrate prey [1].

Phenology:
In Wyoming, spring arrival of migrating and breeding Bobolinks occurs in early to late May [5]. As a polygynous species, males may breed with multiple females within their territory [1]. Nesting phenology has not been studied in Wyoming, but in Wisconsin eggs are laid in mid- to late May. Incubation lasts roughly 11–13 days, and fledging occurs at 10 or 11 days of age. Fledglings may be fed by adults for up to 28 days. Bobolink is typically a single-brood species, but may renest following loss of the first clutch [1]. In Wyoming, most Bobolinks have left the state for wintering grounds by the end of August [5].

Diet:
During the breeding season, Bobolink consumes the adults and larvae of insects, spiders, and snails, as well as the seeds of forbs. Diet during migration and the non-breeding season consists primarily of grains and forb seeds, although some insects may also be consumed. Nestlings and fledglings are fed invertebrates [1].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
In 2013, Partners in Flight estimated that Bobolink had a global population of approximately 8 million individuals and a Wyoming population of about 30,000 [10]; however, this abundance estimate is based primarily on Breeding Bird Survey (BBS) data and should be viewed with caution due to the low detection rate of this species in the state. The statewide abundance rank of RARE is based on the limited area of the state known to be occupied in any given season and the relatively small coverage of suitable habitat within that area. Bobolink appears to be uncommon even within suitable habitat in the occupied area, occurring at relatively low density and requiring intensive surveys efforts to detect [6]. From 1968–2015, annual Wyoming BBS

detections of Bobolink ranged from 0 to 91 (average = 14), with 9 recorded in 2015 [11]. Just 1 Bobolink has been detected during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [12].

Population Trends:
Historic: MODERATE DECLINE
Recent: UNKNOWN
Robust population trends are not available for Bobolink in Wyoming because the species is infrequently detected during monitoring efforts. Historic population declines occurred across the species' distribution due to conversion of native grassland habitats for agricultural use [1]. Survey-wide trend data from the North American BBS indicate that Bobolink numbers experienced statistically significant annual declines of 2.04% from 1966–2013 and 1.19% from 2003–2013 [13].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Bobolink has moderate intrinsic vulnerability in Wyoming because it appears to occur at relatively low density and has ground nesting behaviors that may leave the species susceptible to nest loss. Bobolink prefers undisturbed tall or mixed grass prairie habitat during the nesting cycle, with greater abundance and higher breeding success observed in large, unfragmented tracts of preferred habitat [1, 14-16]. This species nests on the ground among vegetation, which exposes it to natural and anthropogenic ground disturbance, especially in agricultural landscapes. Bobolink has high fidelity to breeding sites [1, 17], which may leave returning individuals vulnerable to the sudden loss or conversion of breeding habitat.

Extrinsic Stressors:
MODERATELY STRESSED
Prairie grassland habitats in the state are vulnerable to development for energy, infrastructure, and agriculture; invasive plant species such as Cheatgrass (*Bromus tectorum*) and Canada Thistle (*Cirsium arvense*); anthropogenic disturbance from off-road recreational activities; altered fire and grazing regimes; and drought and climate change [6]. Habitat loss and conversion represent significant threats to Bobolink; specifically, the loss of tall and mixed grass prairie and conversion of meadows and hayfields to other agricultural crops can reduce available breeding habitat for the species [1]. Early summer mowing of cultivated fields can destroy existing nests and eggs, kill nestlings and fledglings, and reduce future habitat quality for those that survive the disturbance [1, 5, 18, 19]. Bobolink responses to grazing are mixed across its distribution, but heavy grazing may reduce habitat quality for this species [1]. Studies in other parts of its distribution have found lower Bobolink density in grazed versus ungrazed habitat [20] and lower abundance in heavily grazed habitat compared to ungrazed or moderately grazed habitat [21, 22]. Several recent studies have suggested that Bobolink is tolerant of, and may even prefer, habitats with introduced and non-native grasses [23, 24]. It is unknown how Bobolink is affected by potential extrinsic stressors in Wyoming.

KEY ACTIVITIES IN WYOMING

Bobolink is classified as a Species of Greatest Conservation Need (SGCN) by the Wyoming Game and Fish Department, and as a Level II Priority Bird Species requiring monitoring in the Wyoming Bird Conservation Plan [25]. Current statewide activities for monitoring annual detections and population trends for Bobolink in Wyoming include the BBS program conducted on 108 established routes since 1968 [13], and the multi-agency IMBCR program initiated in 2009

[12]. BBS routes across the state detect the species annually, but not at a high enough frequency to produce viable population or trend estimates [13]. There are currently no research projects designed specifically for Bobolink in Wyoming. Observations of this species are reported to the Wyoming Game and Fish Department and vetted through the Wyoming Bird Records Committee (WBRC). Bobolink is a species for which the WBRC requests documentation on first latitude/longitude degree block sightings and all nesting observations [26].

Ecological Information Needs

In Wyoming, Bobolink would benefit from research to determine its actual abundance, detailed distribution, and breeding phenology. Additional research is needed to examine if current harvesting practices in the state are potentially impacting the reproductive success of breeding Bobolinks that nest in cultivated fields in Wyoming.

Management in Wyoming

This section authored solely by WGFD; Andrea C. Orabona. Bobolink is classified as a SGCN in Wyoming due to insufficient information on breeding, distribution, population status and trends, and impacts of habitat loss and degradation on grassland habitats [27]. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [13] and the multi-partner IMBCR [12]. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, survey efforts do not tend to detect Bobolink at adequate levels, suggesting targeted, species-specific monitoring efforts are needed. Best management practices to benefit Bobolink include managing for large expanses of grassland habitats that have dense grass, a heavy cover of forbs, and thick litter depth; limiting high intensity fire regimes and livestock grazing; rotating livestock grazing; delaying spring mowing; avoiding nighttime and annual mowing; using a flush bar on mowers; implementing mowing and prescribed in the fall to avoid the nesting season; and minimizing insecticide use to maintain a food source for Bobolinks [25]. Key recommendations for Bobolink include limiting habitat conversions of large expanses of existing grasslands; minimizing conflicts during the breeding season with energy extraction and development, recreation, and landowners; and reducing disturbance (e.g., haying, burning, moderate to heavy grazing) during the breeding season [25, 27].

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Figure 1: Adult male Bobolink in breeding plumage in Boulder County, Colorado. (Photo courtesy of Bill Schmoker)

Figure 2: North American range of *Dolichonyx oryzivorus*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Mixed grass prairie habitat. Potential habitat for Bobolink in Thunder Basin National Grassland, Wyoming. (Photo courtesy of Michael T. Wickens)

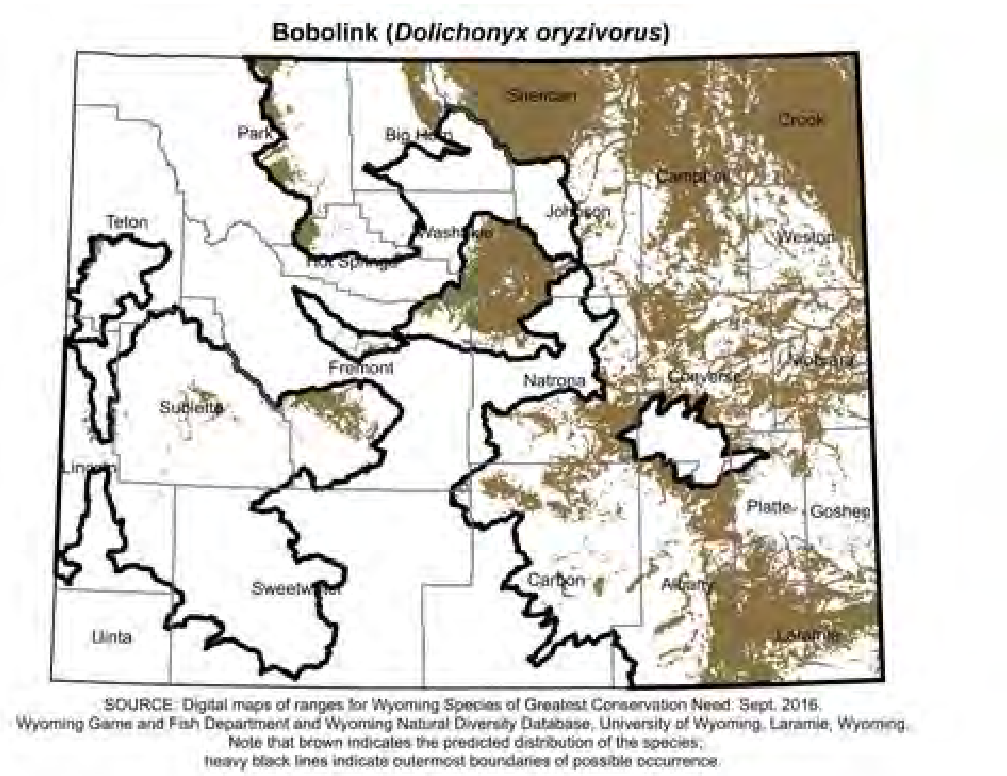

Figure 4: Range and predicted distribution of *Dolichonyx oryzivorus* in Wyoming.

Boreal Owl
Aegolius funereus

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: Sensitive
USFS R4: Sensitive
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G5, S2
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 10

STATUS AND RANK COMMENTS
Boreal Owl (*Aegolius funereus*) has no additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY
Taxonomy:
There are seven recognized subspecies of Boreal Owl. The only subspecies found in North America is *A. f. richardsoni*. The remaining subspecies are found across Europe and Asia, where the species is known as Tengmalm's Owl [1].

Description:
Identification of Boreal Owl is possible in the field. Boreal Owl is a small owl that stands 21 to 28 cm tall. Males and females are identical in plumage. The species has a conspicuous grayish-white facial disc, which is framed by a brown-black border and white, raised supercilium. The eyes are yellow, the crown has numerous small, white spots, and the bill is a buff-white color [1]. Underparts are a creamy white with broad streaks that are brown to russet, and the back is brown with large white spots and blotches. The wings and tail have rows of white spots. Juvenile birds have a uniformly brown head and upperparts from June to September [2]. Within its Wyoming distribution, Boreal Owl is most similar in size and shape to Northern Saw-whet Owl (*A. acadicus*), Northern Pygmy-Owl (*Glaucidium gnoma*), Flammulated Owl (*Otus flammeolus*), Western Screech-Owl (*Megascops kennicottii*), and Eastern Screech Owl (*M. asio*). Boreal Owl lacks ear tufts, which distinguishes it from screech-owls. Unlike Boreal Owl, Flammulated Owl has dark eyes and a tawny facial disk, and Northern Saw-whet Owl has a black bill and a forehead streaked with white. Northern Pygmy-Owl has a longer tail than Boreal Owl, and two distinctive black patches on the back of the head [3].

Distribution & Range:
Boreal Owl is distributed across the boreal regions of Alaska, Canada, and Eurasia. In North America, the distribution extends south and includes the Rocky Mountains, Blue Mountains, and Cascade ranges. In Wyoming, the species has been documented in the Bighorn, Absaroka, Teton, Wind River, Wyoming, Sierra Madre, and Snowy Ranges [4-10].

Habitat:
Throughout its range, Boreal Owl is associated with mature and old-growth forests. In the Rocky Mountains, the species occurs in old-growth and mature subalpine forests dominated by Subalpine Fir (*Abies lasiocarpa*) and Engelmann Spruce (*Picea engelmannii*) [1, 5, 11-15]. Mixed spruce-fir/mature Lodgepole Pine (*Pinus contorta*) forests also are used in Wyoming [16]. Boreal Owl will use mixed-forest and Quaking Aspen (*Populus tremuloides*) forest in other parts of its range [1, 17]. The species requires tree cavities for nesting [1]. The elevation range of Boreal Owl varies with latitude. In Wyoming, the species occurs above 2,000 m during the breeding season [5, 11]. Habitat use during dispersal and irruption events is poorly understood [1].

Phenology:
Boreal Owl is generally non-migratory but irruptions outside its normal range do occur, normally between October and April [1]. Nesting phenology is not fully understood in Wyoming. In northwestern Wyoming, territorial singing occurs in March and April [18]. In Colorado and Idaho, egg laying occurs between mid-April and early June [1], while in Alberta it is estimated to be in March and early April [19]. Incubation lasts for 29 to 32 days, and nestlings remain in the nest for 28 to 36 days [1]. In Alberta, fledging occurs from late May to early June [19]. After fledging, young are fed by adults for at least two weeks, with full independence achieved three to six weeks after leaving the nest cavity [1].

Diet:
The primary food items of Boreal Owl are small mammals, particularly Red-backed Vole (*Myodes* spp.) and voles in the genus *Microtus* [4, 13, 20, 21]. Occasionally, larger small mammals are taken, as well as amphibians, birds, and insects [1, 4, 19, 22].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
Currently, no population estimates exist for the state. The statewide abundance rank of VERY RARE is based on the rather small area of the state known to be occupied in any given season and limited suitable habitat within that area. However, within suitable habitat in the occupied area, Boreal Owl appears to be uncommon, occurring in relatively low densities and requiring intensive survey efforts to detect the species [10]. Detections of Boreal Owl in Wyoming are limited.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Population trends of Boreal Owl in Wyoming are unknown.

Intrinsic Vulnerability:
MODERATE VULNERABILITY

In Wyoming, Boreal Owl is restricted to mature and old-growth forests in higher elevations. The presence of this habitat is the limiting factor for persistence of the species in the state [23]. Abundance in some areas may be limited by the availability of nest cavities [4, 24].

<u>Extrinsic Stressors</u>:
MODERATELY STRESSED
Long-term studies in Europe found that prey availability influences Boreal Owl breeding success both directly [25, 26] and indirectly [27]. Logging of mature and old-growth forest removes suitable nesting and foraging habitat [1]. Insect infestations such as the recent Mountain Pine Beetle (*Dendroctonus ponderosae*) epidemic, disease, and wildfires threaten the species by reducing the amount of mature forest. Habitat shifts due to climate change also could affect Boreal Owl in parts of the species' range [28].

KEY ACTIVITIES IN WYOMING

The Wyoming Game and Fish Department (WGFD) and the United States Forest Service conduct winter call back surveys for different owl species, including Boreal Owl. The WGFD conducted surveys in the Wyoming Range in 2009 and 2010, and Boreal Owl was the most frequently detected owl species [7, 8]. Similar surveys were conducted by both agencies in the Shoshone National Forest in 1998, 1999, and from 2008 to 2010 [9], and in the Bridger-Teton National Forest in 2001, 2008, and 2009 [16]. Surveys emphasized use of mature Engelmann Spruce and Subalpine Fir, as well as mixed spruce-fir/mature Lodgepole Pine by Boreal Owl in Wyoming [9, 16]. Winter call surveys are also conducted in Bighorn National Forest [29]. Continued surveys are planned in these national forests, and it is expected that each route will be surveyed on a regular basis [30]. Recent owl surveys along the base of the Teton Range south of Jackson reported Boreal Owl as the second most common species detected in 2013 [31].

ECOLOGICAL INFORMATION NEEDS

Boreal Owl would benefit from research to determine the full extent of its distribution in Wyoming, and the effect of habitat type on breeding productivity [32]. Demographic rates of Boreal Owl are poorly understood, especially in the Rocky Mountains where population viability is unknown [32]. The response of the species to land management activities, incompatible recreational activities, and human disturbance, particularly during the breeding season, is unknown [16, 23].

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Boreal Owl is classified as a Species of Greatest Conservation Need in Wyoming due to restricted or declining population size or distribution and ongoing severe limiting factors that include the elimination of coniferous forest habitat from beetle kill, logging, and climate change [33]. Results of past surveys have revealed Boreal Owl distribution in the state. An adequate amount of snowpack is needed during March and April to facilitate conducting the current call-playback survey technique via snow machine; thus, survey efforts have been inconsistent over time due to unfavorable snow conditions. This species would benefit from a survey method that can be more consistently applied to better ascertain occupancy, distribution, and site-specific habitat characteristic associations. Best management practices to benefit Boreal Owl include maintaining large stands of mature and old growth forests and stands of mature aspen in areas where the species occurs; retaining large-diameter snags and all trees with existing cavities; retaining mature and decadent trees for future snag creation; avoiding the removal and fragmentation of mature and old growth conifer forests through logging, human developments, and ongoing human disturbance; avoiding clearcutting, except where needed for aspen regeneration; and, where tree removal must occur, using forest management practices, such as uneven-aged management and small patch cuts with long rotations, to maintain suitable Boreal Owl habitat [34].

CONTRIBUTORS

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Figure 1: Adult Boreal Owl in Larimer County, Colorado. (Photo courtesy of Bill Schmoker)

Figure 2: North American range of *Aegolius funereus*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Boreal Owl habitat, spruce-fir forest in Yellowstone National Park. (Photo courtesy of Michael T. Wickens)

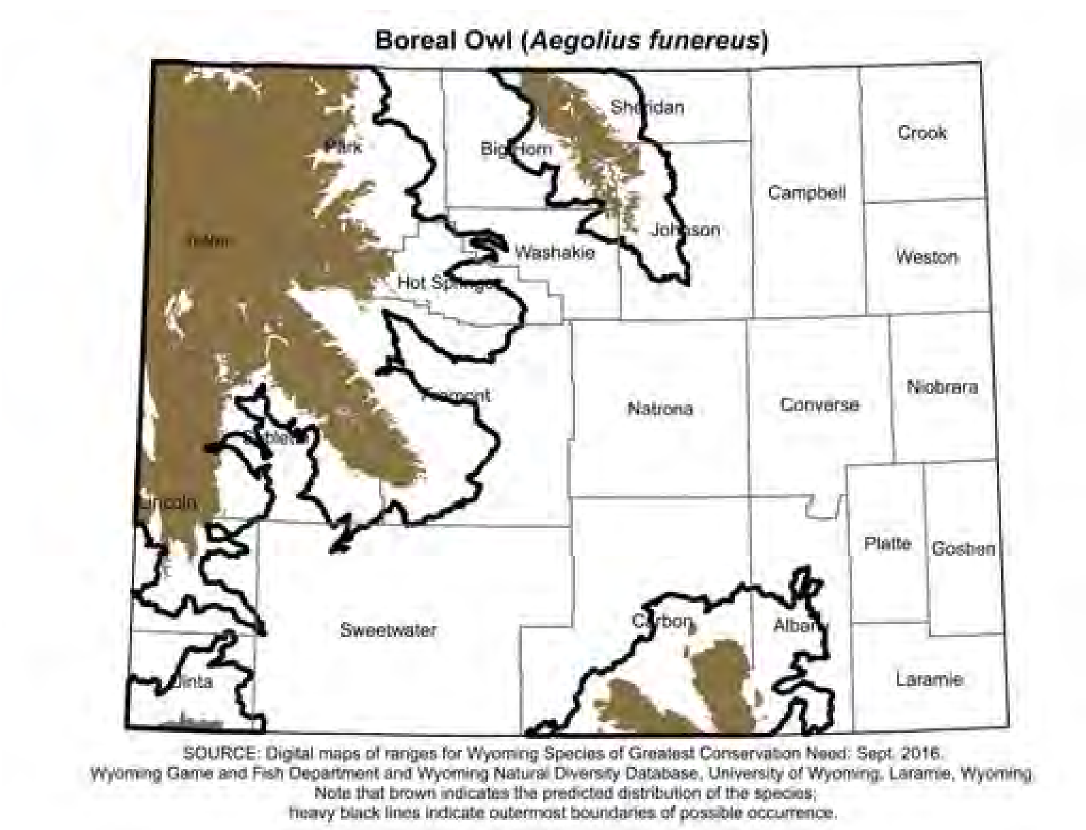

Figure 4: Range and predicted distribution of *Aegolius funereus* in Wyoming.

Brewer's Sparrow
Spizella breweri

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: Sensitive
USFS R4: No Special Status
Wyoming BLM: Sensitive
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: Bird of Conservation Concern
WGFD: NSS4 (Bc), Tier II
WYNDD: G5, S5
Wyoming Contribution: MEDIUM
IUCN: Least Concern
PIF Continental Concern Score: 12

STATUS AND RANK COMMENTS
Brewer's Sparrow (*Spizella breweri)* does not have any additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:
Two subspecies of Brewer's Sparrow are currently recognized: Brewer's Sparrow (*S. b. breweri*) and Timberline Sparrow (*S. b. taverneri*) [1-3]. In Wyoming, *S. b. breweri* is the only known subspecies [1]. *S. b. taverneri* is found in western Canada and southeast Alaska, but may breed as far south as northwestern Colorado [1, 3]. Subspecies designations are generally accepted based on genetic evidence and differences in ecology, behavior, and appearance [1]. Some argue that the two subspecies should be classified as unique species based on allopatric separation [3].

Description:
Brewer's Sparrow is identifiable in the field, especially during the breeding season. Identification of nonbreeding birds may be difficult in the presence of other *Spizella* sparrows. Identification of subspecies is not possible in the field [3]. Brewer's Sparrow is the smallest sparrow species and is typical of *Spizella* sparrows, having a small conical bill, long notched tail, and a slim body. Overall, the species is drab. Its body is dull white underneath with grayish flanks and brown rump and back. Brewer's Sparrow has a finely streaked brown crown with an indistinct, often absent median crown-stripe. Facial markings are weak and include pale gray supercilia, unmarked lores, complete white eye-ring, brown auricular, and a grayish white submoustachial stripe bordered by a thin black malar streak. Coloration of nonbreeding birds is similar but with less contrast of facial markings. Juveniles have a streaked underside but are otherwise similar in appearance to adults. Similar species include Clay-colored Sparrow (*S. pallida*) and Chipping

Sparrow (*S. passerina*). Brewer's Sparrow is identifiable by its complete white eye-ring and weakly contrasting facial markings compared to other species [3,4].

Distribution & Range:
Wyoming forms a substantial portion of the western edge of the breeding range of Brewer's Sparrow. Confirmed or suspected breeding has been documented in 27 of Wyoming's 28 latitude/longitude degree blocks [5]. The timberline subspecies has a much smaller distribution limited to portions of western Canada and southeast Alaska. However, distribution of *S. b. taverneri* is poorly understood and may extend much further south and may include portions of Wyoming [1]. Both *S. b. breweri* and *S. b. taverneri* winter outside of Wyoming. Distribution during migration and winter is poorly understood. The distribution of Brewer's Sparrow appears stable, with no documented expansions or contractions.

Habitat:
Brewer's Sparrow is a sagebrush obligate species. In Wyoming, Brewer's Sparrow is generally associated with habitats dominated by Big Sagebrush (*Artemisia tridentata*) [2,3]. In particular, the species prefers areas with sagebrush over 35 cm tall with canopy cover greater than 20% [6]. It may also be found in shrubby openings in forested habitats, mountain mahogany (*Cerocarpus* spp.) shrublands, and mixed desert shrublands [2]. Brewer's Sparrow relies on sagebrush for foraging, refugia from predation, and nesting substrate. Populations are found in much of Wyoming, especially in the southwestern portion of the state, where large tracts of sagebrush steppe habitat exist. Brewer's Sparrow breeds in Wyoming, but migrates south to winter in the southwestern U.S. and northern Mexico. In winter, habitat use is more general and includes shrublands dominated by saltbrush (*Atriplex* spp.) and Creosote (*Larrea tridentata*); but even in winter, Brewer's Sparrow is still largely associated with sagebrush habitats [1,3].

Phenology:
Brewer's Sparrow arrives in Wyoming for the breeding season in mid– to late March and departs for wintering grounds in mid-August through October. In Wyoming, nesting begins in mid-May and extends into early August. Inter-annual timing of migration and nesting can vary by several weeks depending on weather conditions. The species lays one egg per day and a clutch usually consists of 3 or 4 eggs. Chicks hatch after a 10 to 12 day incubation. Fledglings leave the nest 6 to 9 days after hatching. Brewer's Sparrow re-nests following nest failure and frequently produce more than one clutch per year [3].

Diet:
Brewer's Sparrow feeds primarily on small insects gleaned from bark and foliage of shrubs. Seeds are also consumed from the ground, especially during winter [3].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: ABUNDANT
In 2013, Partner's in Flight (PIF) estimated the global population of Brewer's Sparrow to be 13 million birds. Approximately 11% of the global population, or around 1.5 million birds, breed in Wyoming [7]. From 2009–2014, the Integrated Monitoring in Bird Conservation Regions (IMBCR) program estimated an average density of 30.54 birds per km^2 in appropriate habitats in Wyoming (standard deviation 7.67, standard error 3.13) [8].

Population Trends:
Historic: UNKNOWN
Recent: MODERATE DECLINE to STABLE
Some authors indicate significant declines in Brewer's Sparrow abundance range-wide, including Wyoming [1, 2]. Trends calculated from North American Breeding Bird Survey (BBS) data from 1968–2013 indicate that Brewer's Sparrow numbers in Wyoming declined by 0.38 percent annually. Range-wide, numbers declined 0.98 percent annually from 1966–2013. The decline for Wyoming was not statistically significantly, while the range-wide decline was statistically significant [9].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Brewer's Sparrow is moderately vulnerable to extrinsic threats. The species' primary vulnerability stems from the fact that it is a sagebrush obligate [3, 6, 10]. As a result, the species may be prone to declines related to impacts to this single habitat type.

Extrinsic Stressors:
MODERATELY STRESSED
Stressors to Brewer's Sparrow populations in Wyoming and range-wide are primarily from degradation, fragmentation, and loss of sagebrush steppe habitats. Sagebrush steppe is considered one of the most threatened ecosystems in North America [11]. Fragmentation of sagebrush habitats decreased reproduction of Brewer's Sparrow [6, 10]. In Washington, fragmentation of sagebrush habitats from agricultural activities decreased both nest success and reproductive success [10]. Sagebrush habitats in Wyoming have been fragmented by agricultural activities and energy development. Given the current level of development in Wyoming, similar decreases in reproduction are possible. For example, nest success was lower in areas with natural gas development than in control areas [6]. Similarly, daily nest survival of Brewer's Sparrow declined with increased habitat loss within 1 km^2 of the nest[12]. Likewise, abundance of Brewer's Sparrow was lower near roads associated with natural gas extraction than in areas away from roads [13]. Invasive grasses represent another important threat to sagebrush habitats, primarily from increased fire frequency, which has reduced the amount of sagebrush habitat [11]. However, in the presence of sagebrush, invasive grasses in the understory did not reduce nest survival in Grand Teton National Park [14].

KEY ACTIVITIES IN WYOMING

State-wide monitoring efforts for songbirds, including Brewer's Sparrow, have been implemented though the IMBCR program since 2009 [15]. Occupancy, density, population estimates, and decision support tools are available through the Rocky Mountain Avian Data Center [8]. In 2010, the Wyoming Cooperative Fish and Wildlife Research Unit completed a research project evaluating the influence of energy development on sagebrush-obligate songbirds. Results suggest that both nest success and numbers of Brewer's Sparrow decreased as the density of natural gas wells increased [6, 16]. Continuation of this work included a study identifying specific mechanisms for observed patterns of decreased nest survival of song birds in the Jonah-Pinedale Development Area in Wyoming [17]. Results from this work indicate that nest survival rates of Brewer's Sparrow decreased with increasing habitat loss due to natural gas development. Additionally, increased prevalence of nest predators in areas with natural gas development were observed and may be linked to increased nest predation observed in these areas [18]. In addition, a project initiated by the Wyoming Cooperative Fish and Wildlife Research

Unit in 2011 evaluated the effectiveness of using Greater Sage-Grouse (*Centrocercus urophasianus*) as a single-species surrogate for the conservation and management of co-occurring wildlife species in sagebrush steppe habitats through the Wyoming Governor's Greater Sage-Grouse Core Area Protection Policy. Results indicate that 36% of suitable habitat for Brewer's Sparrow is protected by the umbrella reserve created for Greater Sage-Grouse by the core area concept [19]. Up to 63% (median = 17.3%) of the suitable habitat of shrubland/grassland-associated SGCN falls within the Greater Sage-Grouse Core Area [19, 20]. Of the 52 SGCN examined, Brewer's Sparrow ranks 13th, with 36% of its habitat protected by the core area concept [19].

ECOLOGICAL INFORMATION NEEDS

Knowledge of Brewer's Sparrow distribution during migration and winter is lacking. Breeding range of *S. b. taverneri* is poorly understood and may extend into Wyoming and northern Colorado [3]. Better estimates of population trends are needed and will continue to be refined through the IMBCR program. It is unclear how Brewer's Sparrow will respond to habitat modifications related to climate change [15].

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. The Brewer's Sparrow is classified as a Species of Greatest Conservation Need (SGCN) in Wyoming [15]. Although populations are stable, the species is vulnerable to severe habitat impacts that can occur from increased industrialization in the state. Two separate but compatible survey programs are in place to monitor Brewer's Sparrow populations. The first is the long-term BBS started in Wyoming in 1968 with 108 established routes [9]. Species must be detected on at least 14 routes for data analyses to be significant for tracking population status and trend over time. The IMBCR program was established in 2009 in Wyoming with many state, federal, and nongovernmental organization partners that contribute funding, field personnel, technical assistance, or in-kind services. Data analyses produce density, occupancy, and population estimates at various scales and provide decision support tools for managers [8]. Best management practices to benefit Brewer's Sparrows include continued monitoring, as well as maintaining large unfragmented stands of sagebrush habitat comprised of a mosaic of shrubs of various ages and heights with a patchy distribution and open to moderate canopy cover for grass seed and insect production [15, 21]. The Wyoming Governor's Greater Sage-Grouse Core Area Protection policy provides a mechanism to reduce human disturbance in areas with large Greater Sage-Grouse populations [20]. The core area comprises approximately 62,000 km^2, or 24% of Wyoming [20].

CONTRIBUTORS

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Figure 1: Adult Brewer's Sparrow in Sweetwater County, Wyoming. (Photo courtesy of Tom Koerner, USFWS)

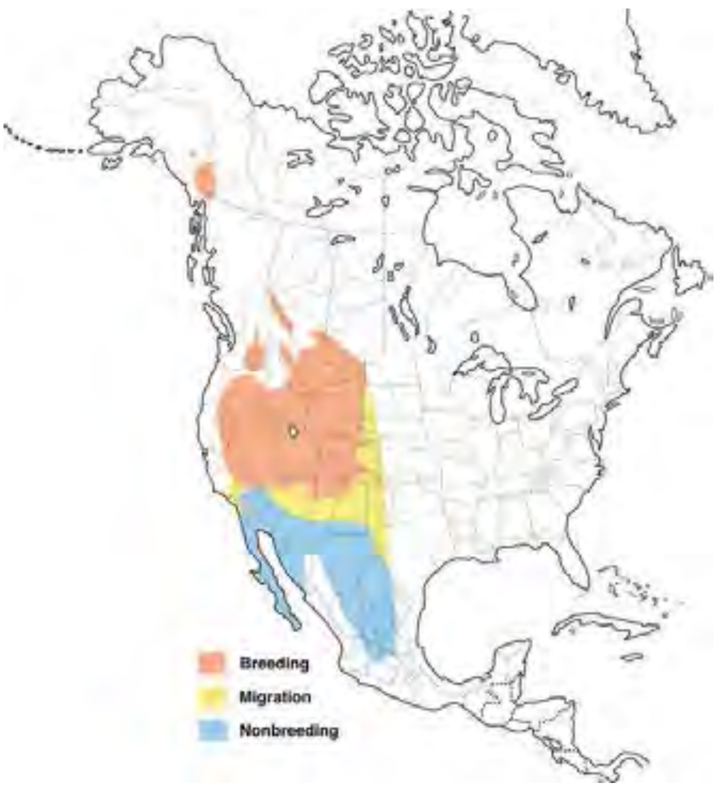

Figure 2: North American range of *Spizella breweri*. Disjunct range in Alaska and northwestern Canada represents known distribution of *taverneri* subspecies. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Wyoming Big Sagebrush habitat in Sweetwater County, Wyoming. (Photo courtesy of Ian M. Abernethy)

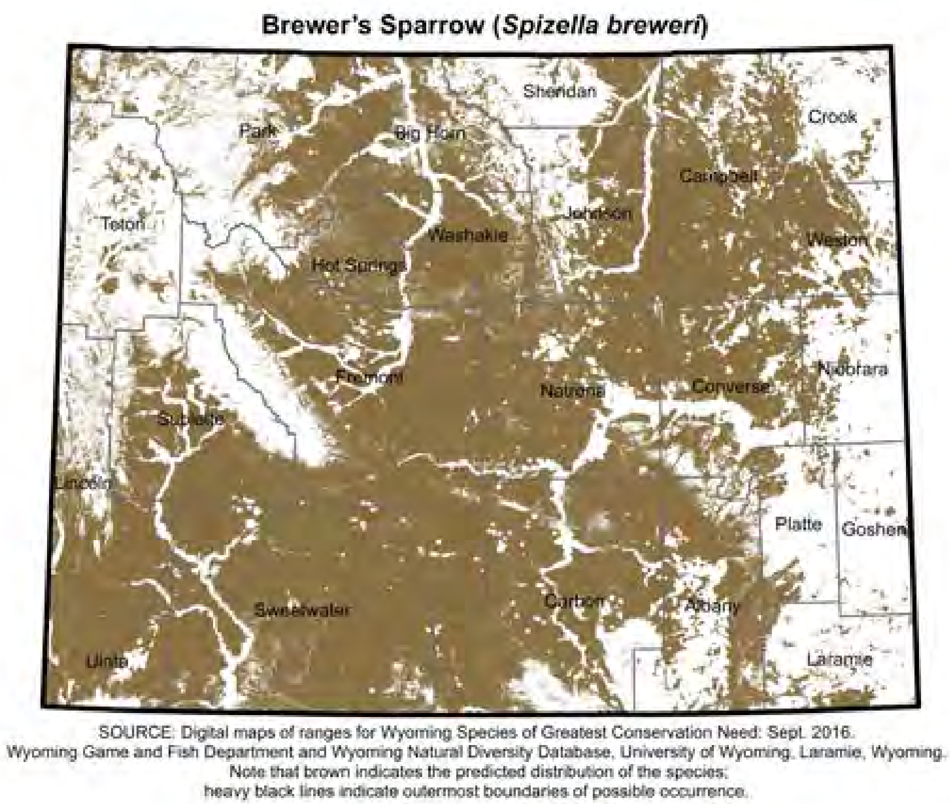

Figure 4: Range and predicted distribution of *Spizella breweri* in Wyoming.

Brown-capped Rosy-Finch

Leucosticte australis

REGULATORY STATUS

USFWS: Migratory Bird
USFS R2: No special status
UWFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: Bird of Conservation Concern
WGFD: NSSU (U), Tier II
WYNDD: G4, S1
    Wyoming Contribution: HIGH
IUCN: Least Concern
PIF Continental Concern Score: 17

STATUS AND RANK COMMENTS

Brown-capped Rosy-Finch (*Leucosticte australis*) has no additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:

There are no recognized subspecies of Brown-capped Rosy-Finch [1, 2]. In 1983, the three North American rosy-finch species (Brown-capped Rosy-Finch, *L. australis*; Black Rosy-Finch, *L. atrata*; and Gray-crowned Rosy-Finch, *L. tephrocotis*) were combined with Asian Rosy-Finch (*L. arctoa*) into one species [3]. In 1993, the American Ornithologist Union (AOU) reversed this change based upon lack of evidence supporting the merge [4]. Recent genetic evidence suggests that the three North American rosy-finches may only be one species, but this has not been formally accepted by AOU [5].

Description:

Identification of Brown-capped Rosy-Finch is possible in the field. Brown-capped Rosy-Finch is approximately 16 cm in length, similar in size and overall shape to large sparrows, but stockier. The species has a mid-sized conical bill, and a relatively short, notched tail. Adult males and females differ in plumage. The male is uniformly brown on the breast, neck, and the face below the eye. Coloration is similar on the back but appears streaky due to darker feather shafts. The belly, rump, upper and under-tail coverts, and bend of the wing are tipped with red. The cap is brown overall but is darker on the forehead. The bill is yellow during the summer breeding season, and gray to black in winter. Juveniles and females appear drabber than males overall [1, 6]. The species is most similar to Black Rosy-Finch (*L. atrata*) and Gray-crowned Rosy-Finch (*L. tephrocotis*); however, Brown-capped Rosy-Finch can be distinguished from both by its uniformly brown head [6].

Distribution & Range:
Brown-capped Rosy-Finch is a localized, high altitude breeder. The continental distribution includes northern New Mexico and western Colorado and extends into extreme southeastern Wyoming, where the species is only known to breed in the high peaks of the Snowy Range [1]. Brown-capped Rosy-Finch has been documented in 8 of Wyoming's 28 latitude/longitude degree blocks, with confirmed breeding documented in just 1 degree block [7]. In winter, Brown-capped Rosy-Finch can be found at lower elevations across its continental distribution [1, 6].

Habitat:
Brown-capped Rosy-Finch is a habitat specialist during the breeding season, found exclusively above tree-line in alpine tundra [1, 6, 8]. In the Wyoming portion of the species' range, suitable habitat is found among the highest peaks in the Snowy Range in the southern part of the state. Cliffs provide nesting sites, while snowfields and adjacent alpine tundra provide feeding habitat [1, 8]. In winter, Brown-capped Rosy-Finch uses open areas, including alpine tundra, meadows, and open valleys. The species regularly visits bird feeders and other anthropogenic food sources in urban areas during the winter [1].

Phenology:
Migration movements of Brown-capped Rosy-Finch are generally altitudinal, and are mainly tied to weather conditions. Harsh weather and deep snow drive the birds downslope, and they return upslope when conditions improve [1]. However, individuals may additionally move south within the breeding range to overwinter. Egg-laying has been observed from mid-June to August, incubation from late June to mid-August, and fledging from late July into September [1]. Brown-capped Rosy-Finch is believed to be a single-brood species.

Diet:
In the breeding season, Brown-capped Rosy-Finch eats spiders, insects, and seeds. During winter, the diet is primarily composed of seeds [1].

CONSERVATION CONCERNS

Abundance:
Continental: REGIONAL ENDEMIC
Wyoming: VERY RARE
There are no robust estimates of abundance available for Brown-capped Rosy-Finch in Wyoming. The species has a statewide abundance rank of VERY RARE and appears to be uncommon within suitable environments in the occupied area [7]. Informal volunteer surveys around Medicine Bow Peak in the Snowy Range have detected 6–12 individuals annually from 2010–2012 [9]. Brown-capped Rosy-Finch has never been detected during annual surveys for either the Wyoming Breeding Bird Survey (BBS) between 1968–2015 [10] or the Integrated Monitoring in Bird Conservation Regions program between 2009–2015 [11]. Given the extremely restricted and high-elevation distribution of Brown-capped Rosy-Finch in Wyoming, more targeted surveys would be required to adequately detect this species in the state.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN

Robust population trends are not available for Brown-capped Rosy-Finch in Wyoming, or anywhere else in its North American distribution, because the species is infrequently detected during monitoring surveys.

Intrinsic Vulnerability:
HIGH VULNERABILITY
Brown-capped Rosy-Finch has very limiting requirements for breeding habitat, breeding exclusively in alpine tundra, generally near cliff faces, which leads to a very restricted breeding range in Wyoming [8].

Extrinsic Stressors:
HIGHLY STRESSED
The main stressor for Brown-capped Rosy-Finch is global climate change. The already limited suitable alpine tundra habitat in Wyoming and across its range may decrease in area due to global climate change [1, 8]. Climate change may also alter the timing of prey abundance and result in temperatures above the species' tolerance threshold, resulting in local extirpations [8]. The species may not be able to alter the timing of its breeding cycle to adapt to such changes.

KEY ACTIVITIES IN WYOMING

The Laramie Audubon Society conducts informal annual surveys for Brown-capped Rosy-Finch around Medicine Bow Peak in the Snowy Range [9]. Plans are being developed by this organization and the Wyoming Natural Diversity Database to formalize these surveys so that trend estimates may be obtained. There are currently no research projects designed specifically for Brown-capped Rosy-Finch in Wyoming.

ECOLOGICAL INFORMATION NEEDS

Accurate population abundance and trend estimates, both in Wyoming and range-wide, as well as information on the demographic factors affecting population growth (e.g., overwinter survival, recruitment, breeding season survival) would help to refine assessments of conservation status for Brown-capped Rosy-Finch. Information on the fidelity of individuals to nest sites could also aid in development of monitoring and management strategies.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Zachary J. Walker. Brown-capped Rosy-Finch is classified as a SGCN in Wyoming due to restricted breeding range and data deficiencies. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [12] and the multi-partner IMBCR [11]. While these monitoring programs provide data for many species in Wyoming, targeted survey efforts are needed for Brown-capped Rosy-Finch. Wyoming management priorities for Brown-capped Rosy-Finch should focus on addressing data deficiencies, and information gained from target efforts should be used to create informed management recommendations.

CONTRIBUTORS

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Figure 1: Adult Brown-capped Rosy-Finch in Rocky Mountain National Park, Larimer County, Colorado. (Photo courtesy of Shawn Billerman)

Figure 2: North American range of *Leucosticte australis*. The breeding range in southern Wyoming is very localized. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Brown-capped Rosy-Finch breeding habitat, Medicine Bow Peak, Carbon County, Wyoming. (Photo courtesy of Michael T. Wickens)

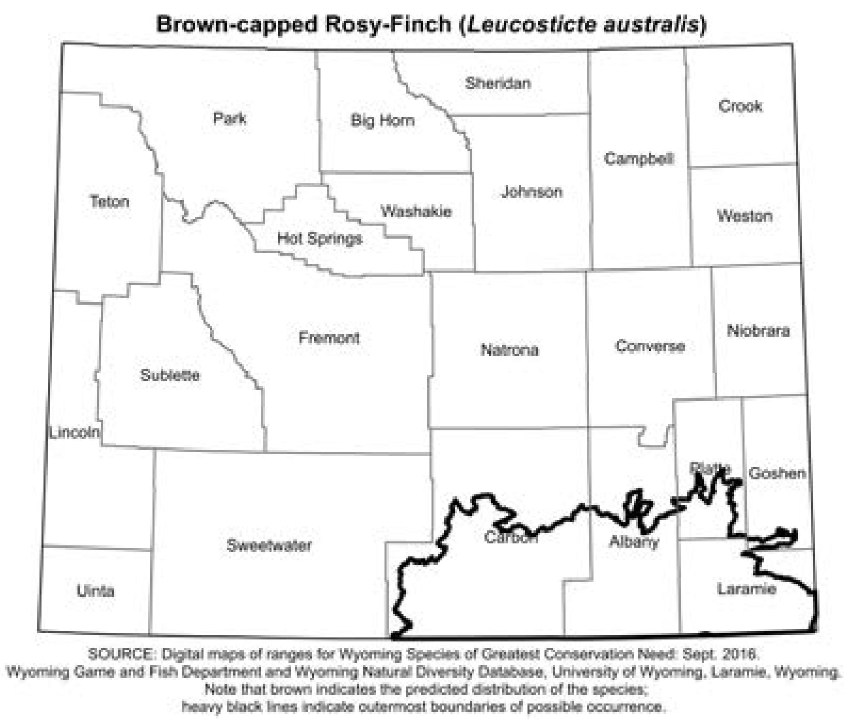

Figure 4: Range and predicted distribution of *Leucosticte australis* in Wyoming. Predicted breeding habitat is restricted to the slopes of Medicine Bow peak along the boundary of Carbon and Albany Counties.

Burrowing Owl
Athene cunicularia

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: Sensitive
USFS R4: No special status
Wyoming BLM: Sensitive
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: Bird of Conservation Concern
WGFD: NSSU (U), Tier I
WYNDD: G4, S3
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 12

STATUS AND RANK COMMENTS
The Wyoming Natural Diversity Database (WYNDD) has assigned Burrowing Owl (*Athene cunicularia*) a state conservation rank ranging from S3 (Vulnerable) to S4 (Apparently Stable) because of uncertainty over historic and recent population trends in Wyoming. WYNDD tracks the species at the subspecies level. Western Burrowing Owl (*A. c. hypugaea*) has the same conservation ranks as the full species.

NATURAL HISTORY

Taxonomy:
Up to twenty-five subspecies of Burrowing Owl have been described, but only fifteen are commonly accepted. *A. c. hypugaea* is the only subspecies found in Wyoming. This subspecies is found in western North America, from western Canada south to Baja California, Mexico, and Honduras. The *floridana* subspecies found in Florida and the Bahamas is the only other subspecies in North America. All other subspecies are found in South America and islands adjacent to the American continents [1].

Description:
Identification of Burrowing Owl is possible in the field. Burrowing Owl is a small owl, measuring 19–25 cm tall. Males and females are identical in appearance. The most distinguishing feature is the relatively long legs. The crown, nape, back, wings, and tail are brown, with scattered white spotting. The breast and belly are buffy-white with broad brown barring on the sides. The head is round with no ear tufts and a white chin stripe. Irises are bright yellow. The solid buff-colored chest of juveniles distinguishes them from adults [1, 2]. In the species' habitat of open plains and prairies, it is not likely to be confused with any other owl.

Distribution & Range:

The range of Burrowing Owl includes substantial portions of North, Central, and South America. During the summer breeding season, Burrowing Owl is found across western North America, including grasslands and shrub-steppe throughout Wyoming. Although the species is patchily distributed across western and central Wyoming, Burrowing Owl is most abundant in grasslands in eastern Wyoming [3]. The species' continental distribution has gradually shifted southward and the breeding range has contracted on its northern, eastern and western edges [1, 4]. The range in Canada has shrunk by two-thirds and extirpations have occurred in Iowa, Minnesota, and most of British Columbia and Manitoba [1]. Burrowing Owl has been documented in all of Wyoming's 28 latitude/longitude degree blocks, with confirmed breeding in 24 blocks [5].

Habitat:

Burrowing Owl is generally found in open terrain such as grasslands, prairies, shrub-steppe, and deserts, preferring well-draining or gently sloping areas with low vegetation and a high percentage of bare ground [1, 6]. Burrowing Owl requires burrows for nesting, escape cover, prey caching, and vigilance and prefers areas with a high density of available burrow in close proximity [6, 7]. Although some subspecies of Burrowing Owl can excavate their own burrows, Western Burrowing Owl does not. Instead, owls in western North America must nest in burrows previously excavated by mammals [1]. In Wyoming, Colorado, Nebraska, and South Dakota, Burrowing Owl is primarily found in prairie dog (*Cynomys* spp.) colonies, both active and inactive. Burrows made by ground squirrels (*Spermophilus* spp.), American Badgers (*Taxidea taxus*), marmots (*Marmota* spp.), and Coyotes (*Canis latrans*) can also be used [6]. Grasslands and similar habitats surrounding nest burrows provide foraging areas [8].

Phenology:

Burrowing Owl is migratory in the northern portion of its range, including Wyoming. Nesting phenology is expected to be similar in Wyoming as elsewhere in the species' range. In Idaho, migrants arrive in early March and leave for the winter between mid-September and October. In Montana, egg laying has been documented in early to mid-May. Incubation lasts between 28–30 days [1]. The young first begin to leave the burrows at about two weeks of age, and short flights and fledging occur at about four weeks of age [1, 9]. In Idaho, young were fully fledged at about 58 days of age, which occurred around the end of July [9].

Diet:

Burrowing Owl feeds upon any prey that it can physically handle. Although the species primarily feeds on a variety of arthropods and small mammals such as shrews, voles, and mice, Burrowing Owl will also consume amphibians, snakes, earthworms, birds, bats, and larger mammals such as ground squirrels [1].

CONSERVATION CONCERNS

Abundance:

Continental: WIDESPREAD
Wyoming: UNCOMMON

In 2013, Partners in Flight estimated the Wyoming population of Burrowing Owl to be 13,000 owls [10]. However, this estimate is extrapolated from Breeding Bird Survey (BBS) data and should be viewed with caution due to the low number of detections of the species both in Wyoming and across its range using this survey technique.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Population trends for Burrowing Owl in Wyoming are largely unknown. Trend data from BBS routes in Wyoming from 1968–2013 suggest that the overall population might be stable, however, data are insufficient to provide conclusive results [11]. Burrowing Owl has declined in other parts of its range, particularly in Canada, the midwestern United States including North Dakota, Minnesota, Nebraska, Kansas, and Oklahoma, and the western edge of the species range in California and Washington [1, 4, 12].

Intrinsic Vulnerability:
HIGH VULNERABILITY
Burrowing Owl is highly vulnerable to extrinsic stressors because the species has relatively narrow habitat requirements and restricted breeding biology. In Wyoming, the species is largely restricted to prairie dog towns. Burrowing Owl requires multiple available burrows in close proximity for nesting, cover, prey caching, and vigilance [6, 7]. Furthermore, the probability that a prairie dog colony is occupied or colonized by Burrowing Owl increases with prairie dog colony size [13]. Thus, habitat, and burrow availability within habitat, can be limiting. Reproduction is also limited by prey availability. Clutch size, number of young fledged, and post-fledging survival can fluctuate significantly with prey abundance and density [1, 6, 14].

Extrinsic Stressors:
MODERATELY STRESSED
Factors that negatively impact prairie dog abundance and colony size or prey species availability threaten Burrowing Owl persistence. Prairie dog declines resulting from land development, eradication programs (usually via poisoning), recreational shooting, and Sylvatic Plague (*Yersinia pestis*) negatively affect Burrowing Owl [6]. Application of pesticides to control insect or rodent populations has both direct and indirect negative impacts on Burrowing Owl through toxicity and reduced prey availability [1]. Energy development is increasing in Burrowing Owl habitat in Wyoming and activities that impact prairie dog or ground squirrel abundance or the quality or quantity of their habitat could also affect Burrowing Owl. Additionally, wind energy development could threaten Burrowing Owl depending on proximity to prairie dog or ground squirrel colonies and owl nests, prey availability, and the type and placement of turbines [15]. At Altamont Pass Wind Resource Area in California, an estimated 600 Burrowing Owls are killed by wind turbines each year [16, 17]. Other common anthropogenic sources of mortality include vehicle collisions, shooting, and barbed wire fences [1].

KEY ACTIVITIES IN WYOMING

In 2007 and 2008, the Wyoming Game and Fish Department (WGFD) Landowner Incentive Program funded eight projects to maintain and conserve prairie dog colonies on private lands in the Shirley Basin and Thunder Basin [18]. This program benefits multiple species, including Burrowing Owl. In 2008, WGFD surveyed 16 prairie dog towns near Lysite but did not detect any Burrowing Owls [19]. Annual monitoring surveys for Burrowing Owl have been conducted in the Pinedale Anticline oil and gas development area since 2009 [20]. Additionally, WGFD initiated a targeted grassland SGCN monitoring program in 2015 for Burrowing Owl, Mountain Plover, Upland Sandpiper, and Long-billed Curlew [22]. Annual BBS surveys are conducted in the state, and these detect Burrowing Owl in limited numbers [11, 22]. The Integrated Monitoring in Bird

Conservation Regions (IMBCR) program also detects Burrowing Owl in limited numbers in Wyoming [23, 24].

Ecological Information Needs

Monitoring efforts focused on Burrowing Owl are needed to accurately assess abundance and population trends because general efforts, like BBS and IMBCR, are insufficient for this species [1, 8]. Although some information about the winter range of Wyoming's population of Burrowing Owl is known, the full extent of the winter range is unknown. A complete knowledge of the winter range and threats to the species in those areas is needed [8]. Knowledge about immigration patterns of populations is unknown, but would increase understanding of local population fluctuations [1]. Research is also needed to determine the magnitude of impacts from extrinsic threats, such as pesticide application and wind development, on this species in Wyoming.

Management in Wyoming

This section authored solely by WGFD; Zachary J. Walker. Burrowing Owl is classified as a Species of Greatest Conservation Need in Wyoming due to unknown population trends, habitat loss and degradation, and incompatible land use. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the North American BBS [11] and the IMBCR [23]. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, a targeted, species-specific survey method is warranted to obtain these data for Burrowing Owl. The WGFD has implemented species specific surveys to provide additional data on population trends of Burrowing Owl. Best management practices or key management recommendations to benefit Burrowing Owl include retaining prairie dogs and ground squirrels within preferred Burrowing Owl habitat, preservation of Burrowing Owl nesting sites, retaining prey species where Burrowing Owl is known to occur, and avoiding habitat fragmentation in known Burrowing Owl nesting areas [25].

Contributors

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Figure 1: Burrowing Owl in Torrington, Goshen County, Wyoming. (Photo courtesy of Shawn Billerman)

Figure 2: North American range of *Athene cunicularia*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Grassland habitat of Burrowing Owl, with a prairie dog town. (Photo courtesy of Michael T. Wickens)

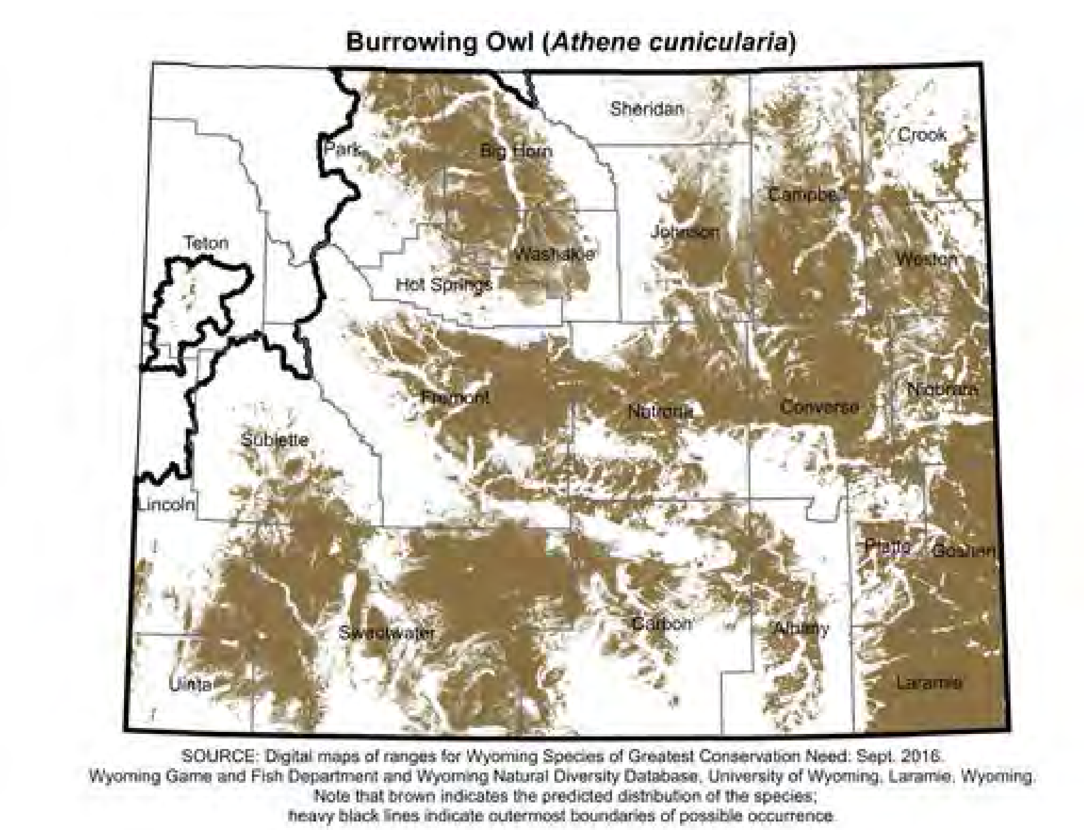

Figure 4: Range and predicted distribution of *Athene cunicularia* during the breeding season in Wyoming.

Figure 5: Burrowing Owl at a burrow of a Black-tailed Prairie Dog (*Cynomys ludovicianus*) in Thunder Basin National Grassland, Wyoming. (Photo courtesy of Michael T. Wickens)

Bushtit

Psaltriparus minimus

REGULATORY STATUS

USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G5, S2S3
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 11

STATUS AND RANK COMMENTS

The Wyoming Natural Diversity Database has assigned Bushtit (*Psaltriparus minimus*) a state conservation rank ranging from S2 (Imperiled) to S3 (Vulnerable) because of uncertainty about the abundance, proportion of range occupied, and population trends for this species in Wyoming.

NATURAL HISTORY

Taxonomy:

Bushtit is the only member of the long-tailed tit family (*Aegithalidae*) found in the New World [1]. The taxonomy of Bushtit is poorly understood and further complicated by polychromatism within the species [1]. The 6–9 recognized subspecies are divided between three groups (i.e., *minimus*, *plumbeus,* and *melanotis*), which are distinguished by distribution and variations in color and head markings [1-5]. Of the currently recognized subspecies, only *P. m. plumbeus* of the *plumbeus* group is found in Wyoming [1, 2].

Description:

Identification of Bushtit is possible in the field. Adults are small (7.0–8.0 cm long, approx. 5.3 g) with round bodies, short wings (wingspan approx. 15.2 cm), and distinctly long tails (4.6–6.2 cm) for their body size [1, 6]. In Wyoming, both sexes are plain leaden gray with light gray underparts, a pale brownish mask around the eyes, black legs, and a very short black bill [1, 6]. As adults, the sexes are easily identified by the color of the iris, which is dark brown in males and white, cream or yellow in females [1]. The plumage coloration of Bushtit is similar to Juniper Titmouse (*Baeolophus ridgwayi*), but Juniper Titmouse has a short crest and is substantially larger (i.e., wingspan 22.9 cm and weight 17 g) [6].

Distribution & Range:

Bushtit only occurs in parts of North and Central America, and the species is found year-round in extreme southwestern British Columbia, the western United States, and Mexico [1]. Southwestern

Wyoming is on the eastern edge of the core range of Bushtit [1], and the species is a year-round resident in the state [2]. Although the species has been observed as far north as Sheridan, most observations come from an isolated population in Casper and from southwestern Wyoming [2]. Confirmed or suspected breeding has been documented in just 2 of the 28 latitude/longitude degree blocks in the state, both in southwestern Wyoming [7].

Habitat:
Bushtit is a habitat generalist that inhabits a wide range of environments across its continental distribution, but it is most commonly associated with open, mixed pine or oak woodlands with an understory of evergreens or shrubs [1]. However, this species is considered a juniper obligate in Wyoming, where it is found along the edges of Utah Juniper (*Juniperus osteosperma*) woodlands with understory shrubs such as Mountain Mahogany (*Cercocarpus montanus*) and sagebrush (*Artemisia* spp.) [8-10]. Bushtit nests in trees, with pairs creating intricate, sack-like, hanging nests out of spider web silk, plant material, lichen, feathers, and fur [1, 8].

Phenology:
Little is known about the specific breeding habits of Bushtit in Wyoming. The species is believed to be non-migratory, with the exception of some short-distance movements outside of the breeding season [1, 2]. Bushtit is highly social year-round, moving and foraging in flocks of up to 40+ individuals that may include other bird species [1]. Timing of nest and egg initiation is not well known in the state, but one pair in southwestern Wyoming was observed building a nest in mid-May, young were heard within the nest in late June, and young had fledged by late July [8]. Clutch size typically ranges from 4–10 eggs (average 6 eggs), and both sexes incubate [1]. The species is considered a plural cooperative breeder, with breeding pairs commonly accepting the presence of multiple nest helpers of both sexes and all ages [1]. These helpers may aid in nest construction, feed nestlings and fledglings, sleep in the nest at night, and male helpers may occasionally mate with the female of the nesting pair [1]. Bushtit is known to produce a second brood in parts of its range [1].

Diet:
Bushtit is a specialized foliage-gleaner that forages in trees and shrubs [1]. Its diet is comprised almost entirely of small insects and spiders, although it may occasionally consume fruits and small seeds [1].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
Partners in Flight estimated the global population of Bushtit at approximately 3.2 million in 2013 [11]. There are no robust estimates of abundance available for Bushtit in Wyoming. The species has a statewide abundance rank of VERY RARE but appears to be uncommon within suitable environments in the occupied area [7]. From 1968–2015, annual Wyoming Breeding Bird Survey (BBS) detections of Bushtit ranged from 0 to 13, with none recorded in most years [12]. Bushtit was not detected during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [13]. More targeted surveys in juniper woodland habitat may be necessary to adequately detect Bushtit in Wyoming.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Robust population trends are not available for Bushtit in Wyoming because the species is infrequently detected during monitoring surveys. Survey-wide trend data from the North American BBS indicate that Bushtit numbers declined annually by 0.74% from 1966–2013 and 0.48% from 2003–2013, but neither trend estimate was statistically significant [14].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
The intrinsic vulnerability of Bushtit in Wyoming is not well understood. The species appears to be inherently tolerant of disturbance, and is known to utilize a wide variety of natural, managed, disturbed, developed, and even urban environments across its continental distribution [1, 15-22]. However, Bushtit is strongly associated with juniper woodlands within its very restricted distribution in Wyoming, and is not known to breed in any other environments in the state [7]. Therefore, this species likely has higher intrinsic vulnerability in Wyoming than it does in other parts of its continental distribution.

Extrinsic Stressors:
SLIGHTLY STRESSED
Habitat loss, degradation, and disturbance could negatively impact Bushtit in Wyoming, although this species may tolerate some level of habitat alteration. Piñon and juniper woodlands have been expanding in many areas of the western United States since the mid-1800s [23], and Bushtit has been shown to utilize developing juniper woodlands in northern Arizona [24]. However, existing juniper woodlands in Wyoming are vulnerable to changes in fire regime; invasive species such as Cheatgrass (*Bromus tectorum*); drought and climate change; habitat fragmentation; and human disturbance, including juniper removal and thinning programs [10]. In addition, juniper woodlands in southwestern Wyoming are often associated with rocky habitats, which are threatened by potential energy development and exposure to anthropogenic disturbances from recreational activities [10, 25]. Wyoming is predicted to lose a majority of its Utah Juniper woodlands over the next century due to changing climate conditions [26]. However, Bushtit has utilized and even thrived in disturbed and developed habitats in other parts of its continental distribution, including urbanized environments in California, Washington, British Columbia, and Mexico [15, 17, 18, 20]; mechanically-thinned piñon-juniper woodlands in Colorado [16]; second-growth pine-oak forest in Mexico [19]; restored coastal habitat in California [21]; and woodland fragments in vineyard landscapes in California [22]. Currently, it is not known how potential extrinsic stressors may impact this species in Wyoming.

KEY ACTIVITIES IN WYOMING

Bushtit is classified as a Species of Greatest Conservation Need (SGCN) by the Wyoming Game and Fish Department (WGFD), and as a Level II Priority Bird Species requiring monitoring in the Wyoming Bird Conservation Plan [27]. Current statewide activities for monitoring annual detections and population trends for Bushtit in Wyoming include the BBS program conducted on 108 established routes since 1968 [14], and the multi-agency IMBCR program initiated in 2009 [13]. In 2016, the WGFD began a two-year project designed to collect data on the distribution, relative abundance, and habitat use of piñon-juniper obligate species, including Bushtit, in the woodlands of southwestern Wyoming.

ECOLOGICAL INFORMATION NEEDS

Bushtit would benefit from research to determine its detailed distribution, habitat use, and actual abundance in Wyoming. Very little is known about the specific breeding habits of this species in the state, and nothing is known about nest success or fledgling survival. Additional research is needed to determine how Bushtit populations in Wyoming might respond to natural and anthropogenic disturbances to existing habitat.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Bushtit is classified as a SGCN in Wyoming due to unknown population status and trends in the state; a need for robust information on breeding status; limited distribution of required breeding habitat; loss, degradation, and fragmentation of Utah Juniper habitat due to industrial developments; and incompatible management practices. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [14] and IMBCR [13]. While these monitoring programs provide robust estimates of occupancy, density, or population trends for many avian species in Wyoming, survey efforts do not tend to detect Bushtit at adequate levels, suggesting targeted, species-specific monitoring efforts are needed. Initial work and written species accounts on avian Utah Juniper obligate species, including Bushtit, occurred in 1988 [28]. However, higher priorities and limited personnel and funding precluded conducting additional work on these species. Best management practices to benefit Bushtit are similar to those for sympatric Utah Juniper obligate species and include implementing a sufficient monitoring technique; maintaining mature stands of Utah Juniper habitat where Bushtit nests, including herbaceous vegetation and shrubs for foraging; implementing prescribed and natural fire management to maintain savannah-like stands of juniper woodlands in areas occupied by Bushtit; coordinating Utah Juniper management to provide a mosaic of juniper woodland conditions [29].

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Figure 1: Female Bushtit (note light iris) in Pueblo County, Colorado. (Photo courtesy of Bill Schmoker)

Figure 2: North American range of *Psaltriparus minimus*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Bushtit habitat in southwestern Wyoming, dominated by Utah Juniper. (Photo courtesy of Leah H. Yandow, WGFD)

Figure 4: Range and predicted distribution of *Psaltriparus minimus* in Wyoming.

Calliope Hummingbird

Selasphorus calliope

REGULATORY STATUS

USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: Bird of Conservation Concern
WGFD: NSS4 (Bc), Tier II
WYNDD: G5, S2
Wyoming Contribution: MEDIUM
IUCN: Least Concern
PIF Continental Concern Score: 11

STATUS AND RANK COMMENTS

Calliope Hummingbird (*Selasphorus calliope*) does not have any additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:

No subspecies of Calliope Hummingbird are currently recognized. The species is known to hybridize with Anna's (*Calypte anna*) and Costa's (*C. costae*) Hummingbirds [1]. Some argue that this species should be grouped in a much larger genus *Archilochus*, but currently there are no formal proposals to change this [2].

Description:

Identification of Calliope Hummingbird is possible in the field. Calliope Hummingbird is Wyoming's smallest hummingbird and the smallest bird in North America, north of Mexico [3]. Calliope Hummingbird males are somewhat easier to identify in the field than females. Male upperparts are bronzy-green, the head is bronzy-green on top, the cheek has a white stripe, and the neck has a diagnostic metallic magenta gorget that is divided into separate rays – Calliope Hummingbird is the only North American hummingbird with distinctly separated rays. Females also have bronzy-green upperparts, but are more buff below, and have a speckled drab neck versus a showy gorget. Juvenile Calliope Hummingbirds resemble adult females. Both sexes have grayish legs, feet, and bills [1]. Female Rufous (*S. rufus*) and Broad-tailed (*S. platycercus*) Hummingbird underparts are similar to the female Calliope Hummingbird; however, the overall size, short tail, and wingtip termination at tail tip all contribute to female Calliope Hummingbird identification [4].

Distribution & Range:
Wyoming forms a limited portion of the southeastern edge of Calliope Hummingbird's breeding range [1]. The species has been documented in 19 of Wyoming's 28 latitude/longitude degree blocks, with confirmed or circumstantial evidence of breeding occurring in 10 of those 19 degree blocks [5]. Breeding records tend to be clustered in the western and north-central areas of the state. Nine of the 19 degree blocks where Calliope Hummingbird observations have occurred are scattered throughout the state [5, 6]. Calliope Hummingbird is known to be profuse in Jackson Hole and Story, Wyoming during the summer [6]. The species winters outside of Wyoming in Mexico from Sinaloa and Durango to points as far south as Oaxaca [7]. Little is known about its spring migration, although, generally this species travels along the Pacific Coast before heading east to Wyoming. During fall migration, Calliope Hummingbird tends to utilize Wyoming's mid-elevation (~1,500–2,600 m) montane habitats, where there are plentiful flowering species. Calliope Hummingbird travels along the Rocky Mountains en route to winter grounds [6, 8].

Habitat:
In Wyoming, Calliope Hummingbird typically utilizes montane willow (*Salix* spp.) and alder (*Alnus* spp.) dominated riparian habitats during breeding season. Nests are usually constructed in conifer trees (typically *Pinus* spp.) adjacent to the riparian corridor [1, 6]. Range-wide, the species is known to breed at elevations as low as 185 m near the Columbia River and as high as 3,400 m in the Sierra Nevada Range [1, 9]. The species also utilizes deciduous species such as birch (*Betula* spp.), maple (*Acer* spp.), and Quaking Aspen (*Populus tremuloides*) for nesting in other portions of its range. As Calliope Hummingbird migrates along the Pacific slope in spring, it will stopover in desert washes and a variety of coastal habitats. During fall migration, it is typically found in high elevation meadows with many flowers, but is known to frequent hummingbird feeders and nectar-rich landscape plantings as well. In winter, Calliope Hummingbird is found in chaparral, low elevation scrub, desert, semi-desert, and human-influenced areas [1, 3].

Phenology:
Calliope Hummingbird arrives in Wyoming in mid-May, although there is an early report of 28 April [6]. Breeding records tend to be concentrated in the western half and north-central regions of Wyoming [5]. The species typically lays 1 clutch per season of 2 eggs. Incubation is usually 15–16 days, followed by a nestling period of 18–21 days; parental duties during both are performed entirely by the female. The species is not known to re-nest or produce a second clutch [1]. By late August, Calliope Hummingbirds begin migrating to wintering grounds, although there is a late report of 12 September [6].

Diet:
Calliope Hummingbird feeds primarily on flower nectar and small insects. Although research indicates a preference for red tubular flowers, it also consume nectar from purple, blue, white, and yellow flowers. Favored insects include true flies (Diptera), bees, wasps, ants, sawflies (Hymenoptera), and beetles (Coleoptera). Calliope Hummingbird uses a hawking method to capture insects, which consists of flying out from a branch to retrieve prey from the air. This species also obtains food from sap wells constructed by sapsuckers (*Sphyrapicus* spp.), as well as from residential hummingbird feeders [1, 3, 9].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD BUT DISJUNCT
Wyoming: UNCOMMON
Using North American Breeding Bird Survey (BBS) data, the Partners in Flight Science Committee estimated the global population of Calliope Hummingbird to be 2 million birds [10]. Approximately 3.0% of the global population, or an estimated 70,000 birds, breed in Wyoming [11], but this estimate is likely high and should be viewed with caution given the paucity of observation data on which it is based. The statewide rank of UNCOMMON is based on the limited area of the state known to be occupied in any given season, and the relatively small coverage of suitable habitat within that area. However, within suitable habitat in the occupied area, Calliope Hummingbird appears to be common and is usually encountered during surveys that could be expected to indicate its presence [5]. From 2009–2015, no Calliope Hummingbirds were detected on Integrated Monitoring in Bird Conservation Regions (IMBCR) survey grids in Wyoming [12].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Population trends are not available for Calliope Hummingbird in Wyoming due to low detection rates during monitoring surveys and a general lack of documented observations. Currently, there are no robust North American BBS trend data for Calliope Hummingbird in Wyoming due to an extremely limited sample size (N = 11 routes; 1968–2013) and data that fall within a credibility category containing important deficiencies [13]. However, 1966–2013 BBS trend analyses for this species survey-wide and for the western region indicate an annual population decrease of 0.18% (N = 221 routes, 95% CI: -1.25–0.93), and an annual population decrease for the United States of 0.97% (N = 168 routes, 95% CI: -2.24–0.25) [13]. All BBS data presented in this account have been determined to fall within a credibility category containing data with deficiencies, likely due to low relative abundance and number of routes with Calliope Hummingbird detections [13].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
In Wyoming, Calliope Hummingbird has moderate intrinsic vulnerability. The species' primary vulnerabilities stem from its somewhat limited breeding range in the western and northern mountain ranges and low fecundity, producing only 1 clutch of 2 eggs per breeding season [1, 6]. Additionally, the taxon's preferred breeding habitat appears to be restricted to montane riparian areas adjacent to mid-elevation conifer forests, generally within a landscape that supports an abundance of large-flowered plants [6].

Extrinsic Stressors:
SLIGHTLY STRESSED
Stressors to Calliope Hummingbird in Wyoming are most likely associated with land use practices in montane riparian corridors and adjacent mid-elevation conifer forests. Riparian lands constitute a small percentage of Wyoming's landscape [14] and their importance to avian migration, nesting, and foraging is well documented [8]. While local, state and federal measures may limit certain impacts in these areas, the cumulative effects of development (e.g., grazing, timber harvest, recreation), invasive species, and hydrologic regime change (e.g., impoundments, irrigation withdrawals, channel alterations) contribute to the degradation of riparian lands [8, 14].

Common impacts to conifer habitat in Wyoming include recreation, timber harvest, fragmentation due to roads and trails, livestock grazing, and residential development [8]. However, processes that maintain a diversity of seral stages, including the grass-forb stage, may be beneficial to Calliope Hummingbird. Despite numerous stressors, it is possible that Calliope Hummingbird also benefits from the presence of maintained sugar water feeders, especially when natural nectar sources are not yet available or are past their season [1].

KEY ACTIVITIES IN WYOMING

Calliope Hummingbird is listed as a Species of Greatest Conservation Need (SGCN) in Wyoming by the Wyoming Game and Fish Department, and as a Level II Priority Species requiring monitoring action in the Wyoming Bird Conservation Plan [8]. The species is not adequately monitored by current national or regional avian monitoring efforts in Wyoming, including the BBS program conducted on 108 established routes since 1968 [13] or the IMBCR program initiated in 2009 (0 detections since initiation) [12]. No additional, targeted, systematic survey of Calliope Hummingbird has been implemented in Wyoming.

ECOLOGICAL INFORMATION NEEDS

More information is needed on Calliope Hummingbird distribution and breeding status in portions of its Wyoming range outside of the Jackson area, as well as overall population trends in the state. A more comprehensive survey of habitat use and preference would give resource managers information necessary to include Calliope Hummingbirds in management action planning and implementation.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Calliope Hummingbird is classified as a SGCN in Wyoming due to insufficient information on breeding, distribution, and population status and trends. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [13] and the multi-partner IMBCR [12]. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, Calliope Hummingbird may require a targeted, species-specific survey method to obtain these data. Best management practices for Calliope Hummingbird includes managing forests to include an open to intermediate canopy cover and a variety of seral stages, including early successional plant communities that support growth of flowering plants as a food source; reducing impacts of recreation, grazing, and wildlife foraging to flowering plants favored by this species; and managing for low to intermediate canopy cover within conifer stands near water for Calliope Hummingbird nesting sites [8].

CONTRIBUTORS

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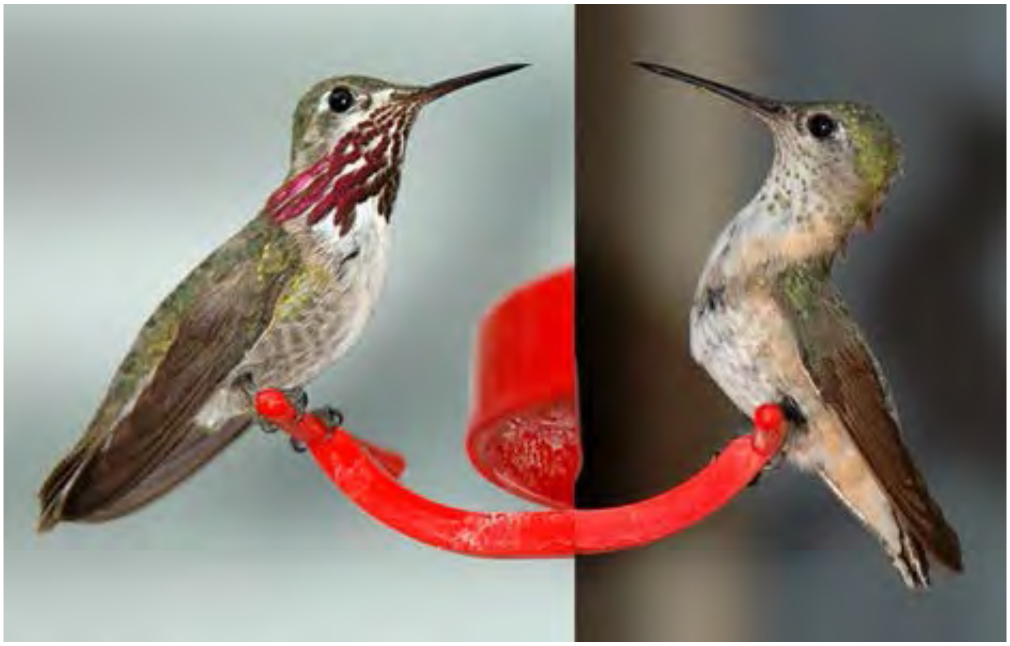

Figure 1: Adult male (left) and female (right) Calliope Hummingbirds in Durango, Colorado. (Photos courtesy of Bill Schmoker)

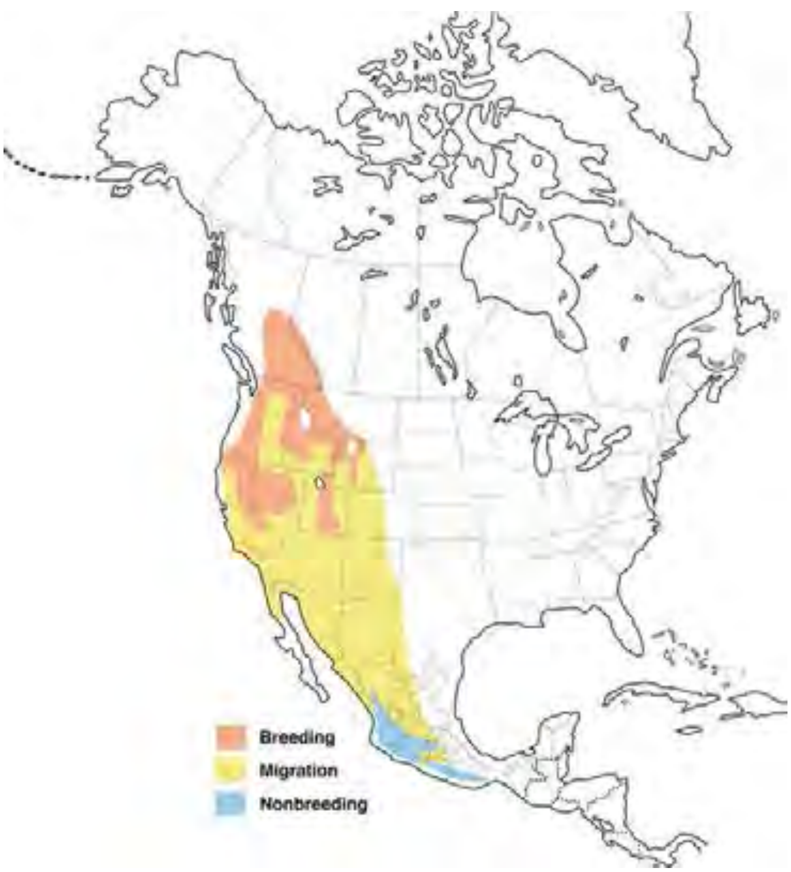

Figure 2: North American range of *Selasphorus calliope*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

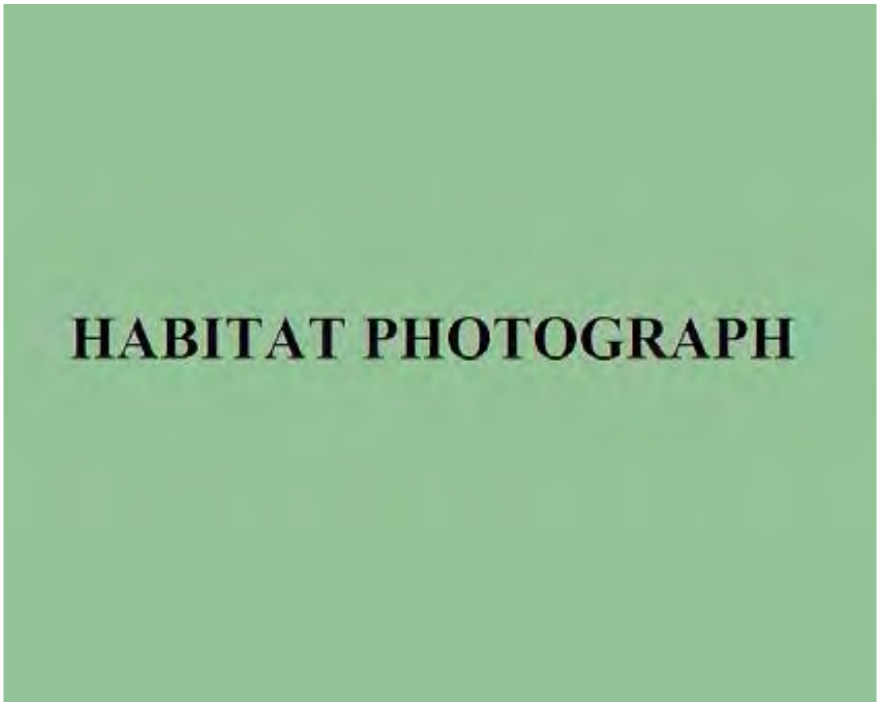

Figure 3: Photo not available.

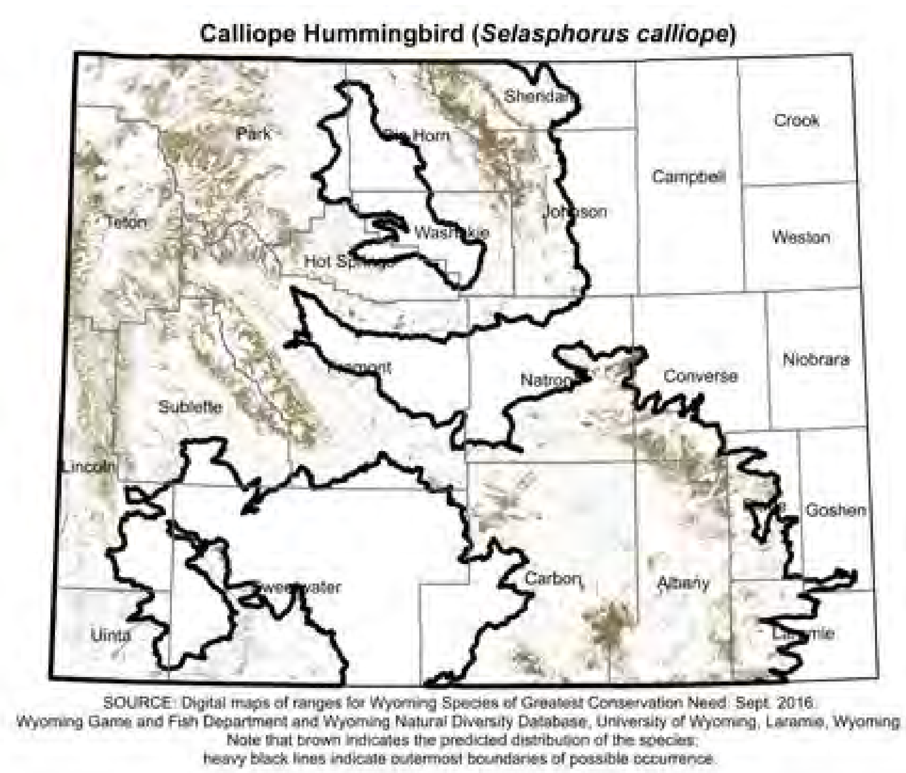

Figure 4: Range and predicted distribution of *Selasphorus calliope* in Wyoming.

Canyon Wren

Catherpes mexicanus

Regulatory Status

USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

Conservation Ranks

USFWS: No special status
WGFD: NSS4 (Bc), Tier III
WYNDD: G5, S4
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 11

Status and Rank Comments

Canyon Wren (*Catherpes mexicanus*) has no additional regulatory status or conservation rank considerations beyond those listed above.

Natural History

Taxonomy:

Canyon Wren has previously been placed in the genera *Thryothorus* and *Salpinctes*, but is now placed in the genus *Catherpes*. The number of subspecies is debated and ranges from 3 to 8 depending on the source. This account follows the Birds of North America, which recognizes 3 subspecies; only *C. m. conspersus* is found in Wyoming [1].

Description:

Identification of Canyon Wren is possible in the field. Canyon Wren is a small wren that averages 13 cm in length (range 11.4–15.4 cm). The species does not display sexual dimorphism in plumage, although males are larger than females. Size also varies throughout the range of the species, with northern populations generally smaller and paler than southern populations. The back, wings, and belly are reddish brown with varying amounts of white spots; the head is grayish and somewhat flattened, with a slightly decurved bill. The throat and breast are white, and the tail is more brightly rust-colored than the rest of the body with black bars [1]. Five species of wrens are commonly found in Wyoming, including Canyon Wren, but only Rock Wren (*S. obsoletus*) shares similar habitats and is likely to be mistaken for Canyon Wren [2]. Rock Wren is paler, grayer, has streaking on the breast, and does not display a sharp definition between the chest and belly plumage [1]. The song repertoire of Canyon Wren is fairly limited [3] but is generally described as a series of descending notes, somewhat resembling the sound of a pebble falling down canyon walls. The species may sing more often and with lower frequency and harsher notes when defending territory [4]. Singing can be heard throughout the year but is most common in the breeding season [1].

Distribution & Range:
Canyon Wren is distributed nearly continuously in the western United States and Mexico from southern British Columbia, Canada in the north to Oaxaca, Mexico in the south. The range extends from the Pacific Ocean east to western Montana, Wyoming, Colorado, the panhandle of Oklahoma, and central Texas. A disjunct population is found in the Black Hills of South Dakota, northeastern Wyoming, and southeastern Montana [1] as well around the Laramie Mountains in Wyoming [2]. Canyon Wren has been observed in 25 of Wyoming's 28 latitude/longitude degree blocks, and confirmed or suspected breeding has been documented in 15 degree blocks [5]. Canyon Wren is found year-round throughout its range and consistently defends the same territories annually [1].

Habitat:
As the name suggests, Canyon Wren is typically found in arid, rocky habitats, including cliffs, canyons, rock outcrops, and boulder piles between 300 and 1,850 m in elevation [1]. Cliffs with overhangs, as opposed to vertical cliffs [6], and large rocks may be particularly important for nest-site selection [7]. Canyon Wren is often found near water, which may be a byproduct of its canyon habitat as opposed to a limiting factor. Canyon Wren does not seem to display a preference in vegetative communities, as long as rocky habitat is available, and may be found in grasslands, chaparral, deserts, and forests dominated by piñon-juniper (*Pinus* spp.-*Juniperus* spp.), oak (*Quercus* spp.), and conifers such as Ponderosa Pine (*P. ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*) [1]. In Idaho, however, areas with vegetation tended to be selected less than expected, although nearly a third of Canyon Wren observations in the Lower Salmon River Gorge were in grasslands with steep slopes and scattered rock outcrops [7]. Nests may be reused in subsequent years [8] and are composed of twigs, moss, grasses, and dead leaves and lined with lichens, plant down, wool, cobwebs, and feathers [1]. Nests are typically located in cliffs, rock outcrops and caverns, and cliffs and banks [1], where they are protected from wind and rain [8], and microclimates tend to be more stable [7]. Breeding and winter habitat is similar [1]. In Colorado, Canyon Wren tended to be associated with the presence of Cliff Swallow (*Petrochelidon pyrrhonota*), and would use Cliff Swallow nests not only for nesting but also for foraging [6].

Phenology:
Canyon Wren does not migrate, although it may exhibit limited altitudinal changes between seasons. Little is known on the breeding phenology of Canyon Wren. In Colorado, pair formation begins in early February, although pairs often remain together throughout the winter. Copulation occurs in March, egg-laying begins in mid-May, and young fledge in late June. Clutch size averages 5 eggs (range 3–7). Incubation averages 16 days (range 12–18 days), and young fledge after 15 days (range 12–17 days). Adults will continue to provide for fledglings for 5–10 days post-fledging, and young can remain with adults in family groups for up to several months. Canyon Wren can produce two broods per year, with the second brood fledging roughly 1.5 months after the first [1, 8]. Rarely, Canyon Wren may have 3 broods in a season [8].

Diet:
Canyon Wren is insectivorous, gleaning both insects and spiders from cliff walls, rock crevices, under rocks, and occasionally from nearby foliage [1]. Insects, lice, and mites may also be gleaned from nests of other cliff-nesting species [6]. The slightly flattened head and long, slender bill allows Canyon Wren to probe into small interstitial spaces in rocks to forage. Like many other

species adapted to arid environments, Canyon Wren likely acquires all needed water from prey items [1].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
Using North American Breeding Bird Survey (BBS) data, the Partners in Flight (PIF) Science Committee estimated the global population of Canyon Wren to be 400,000 birds [9]. Approximately 0.6% of the global population, or around 2,000 birds, is estimated to breed in Wyoming [10]. The statewide rank of RARE is based on the rather small area of the state known to be occupied in any given season and the small coverage of suitable habitat within that area. However, within suitable habitat in the occupied area, Canyon Wren appears to be uncommon, occurring in relatively low densities and requiring intensive survey efforts to detect the species [5]. Canyon Wren density (number of birds per square km) and population size estimates for Wyoming are available from the Integrated Monitoring in Bird Conservation Regions (IMBCR) program for the years 2009, 2010, 2012, 2013, and 2015, although detections are limited so data must be interpreted with caution [11].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Population trends are not available for Canyon Wren in Wyoming due to a limited number of survey routes or grids in place in the state where this species occurs and low detection rates during monitoring surveys. Currently, there are no robust North American BBS trend data for Canyon Wren in Wyoming due to an extremely limited observation sample size (N = 17 routes; 1968–2013) and data that fall within a credibility category containing data with important deficiencies [12].

Intrinsic Vulnerability:
LOW VULNERABILITY
Cliffs, canyons, and rock outcrops tend to represent a small percentage of the landscape overall, which may limit habitat available to Canyon Wren. However, within this rocky habitat, Canyon Wren is a generalist and does not seem to display a preference in vegetative communities as long as rocky habitat is available [1]. In fact, habitat availability may not be limiting, as not all suitable habitat is used every year, and territory occupancy varies across years [6, 8], although overall density may be low [6]. In Colorado, nesting success ranged from 79–86%, with only 14% of nests known to have failed [8]. Other life history characteristics do not predispose the species to declines from changes in environmental conditions.

Extrinsic Stressors:
MODERATELY STRESSED
PIF assigns the Canyon Wren a threat level of 2, indicating that the future suitability of breeding and non-breeding conditions is expected to remain stable and has no significant threats [9]. Cliff and canyon habitat is fairly stable through time and not likely to be heavily impacted by land use changes [7]. Recreational rock climbing and bouldering may impact individuals at a local scale [1, 13], but this is not expected to have noticeable impacts at the population level [2]. Overwinter survival may drive population size, although studies addressing this issue have been limited [8].

KEY ACTIVITIES IN WYOMING

Canyon Wren is listed as a Species of Greatest Conservation Need (SGCN) in Wyoming by the Wyoming Game and Fish Department and a Wyoming PIF Level III Priority Species [14]. The species is not adequately monitored by current avian monitoring efforts in Wyoming, including the IMBCR program initiated in 2009 (12 detections since initiation) [11] or the BBS program conducted on 108 established routes since 1968 [12]. No additional, targeted, systematic surveys of Canyon Wren have been implemented in the state.

ECOLOGICAL INFORMATION NEEDS

More information is needed on specific breeding locations of Canyon Wren in Wyoming. Better estimates of Canyon Wren population trends are also needed. Additional studies on Canyon Wren winter ecology, population dynamics, and seasonal or post-breeding movements would further increase our understanding of this species in the state [2]. Effects of drought and climate change on Canyon Wren are unknown but could potentially impact the species in Wyoming.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Canyon Wren is classified as a SGCN in Wyoming due to insufficient information on breeding, distribution, and population status and trends. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [12] and the multi-partner IMBCR [11]. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, survey efforts do not tend to detect Canyon Wren at adequate levels, suggesting targeted, species-specific monitoring efforts are needed. Best management practices or key management recommendations to benefit Canyon Wren include maintaining the integrity of canyons and rock outcrops, and preventing land conversion of these areas; protecting known nesting areas, as pairs will return to nesting sites in subsequent years; limiting human activities, such as intensive rock climbing, near known Canyon Wren nests during the breeding season; and minimizing insecticide use in canyon habitats to maintain a food source for Canyon Wren (and other insectivores) [14].

CONTRIBUTORS

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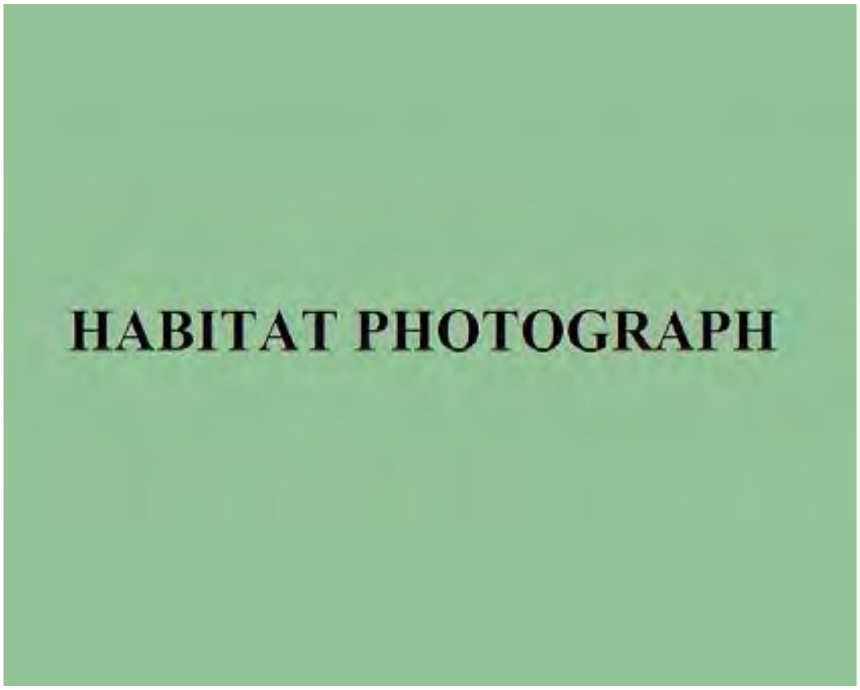
Figure 1: Adult Canyon Wren in Arizona. (Photo courtesy of Bill Schmoker)

Figure 2: North American range of *Catherpes mexicanus*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)



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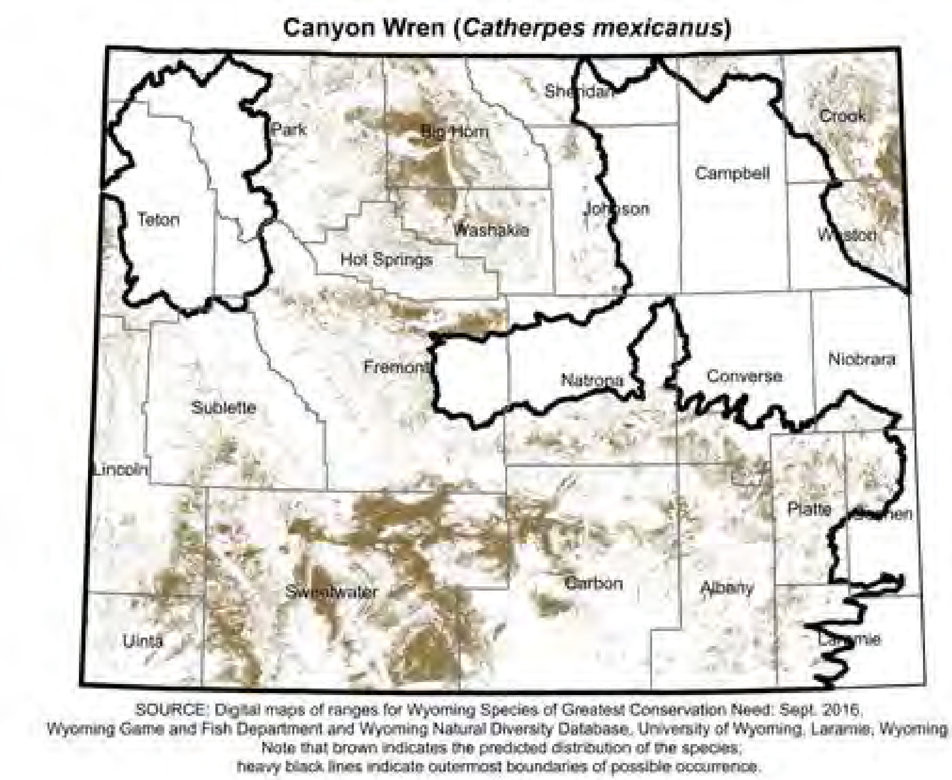

Figure 4: Range and predicted distribution of *Catherpes mexicanus* in Wyoming.

Caspian Tern
Hydroprogne caspia

Regulatory Status
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

Conservation Ranks
USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G5, S1
Wyoming Contribution: MEDIUM
IUCN: Least Concern
PIF Continental Concern Score: Not ranked

Status and Rank Comments
Caspian Tern (*Hydroprogne caspia*) has no additional regulatory status or conservation rank considerations beyond those listed above.

Natural History
Taxonomy:
Following the reclassification of the genus *Sterna* in 2006, Caspian Tern (formerly *S. caspia*) was moved to the genus *Hydroprogne* [1]. Although American and Australian subspecies have been suggested, there are currently no formally recognized subspecies of Caspian Tern [2, 3].

Description:
Identification of Caspian Tern is possible in the field. It is the largest species of tern; adults weigh between 530–782 g, range in length from 47–54 cm, and have a wingspan of approximately 127 cm [2, 4]. The sexes are similar in size and appearance [2]. Caspian Tern has a slightly crested crown and a dark cap that extends below the eye (solid black in the breeding season and mottled dark gray in the non-breeding season), white underbody, pale gray wings, primaries that are dark on the underside, a short slightly notched tail, dark eyes, thick red bill with a dark grey tip that fades to a pale orange or red at the extreme tip, and black legs and feet [2, 4]. Two other species of tern are known to breed in Wyoming: Black Tern (*Chlidonias niger*) and Forster's Tern (*S. forsteri*) [5, 6]. Caspian Tern resembles Forster's Tern in the breeding season, but Forster's Tern has a smaller orange bill with a black tip and orange legs and feet [4].

Distribution & Range:
The breeding distribution of Caspian Tern is widely scattered within five main regions of North America: Pacific Coast/Western Region, Central Canada, Gulf Coast, Atlantic Coast, and Great Lakes [7]. There is recent evidence of limited gene flow between the Pacific Coast/Western Region, Central Canada and the Great Lakes breeding populations, as well as genetic

differentiation between sites on the Pacific Coast and those located east of the Rocky Mountains [8]. Wyoming borders the northeastern edge of the Pacific Coast/Western region [7], and contains several small breeding areas [2]. Caspian Tern migrates through the state in the spring and fall and is a summer resident [5, 6]. Although this species has been observed at many waterbodies across the state, confirmed breeding has been documented in just 4 of the 28 latitude/longitude degree blocks [6].

Habitat:
Caspian Tern is found in a diverse range of marine and freshwater habitats across its range, including coastal beaches, estuaries, barrier islands, lagoons, bays, harbors, salt and freshwater marshes and lakes, wetlands, and major rivers [2, 7]. This species also frequently uses, and even benefits from, artificial and manmade habitats, such as dredge spoil islands, dikes, artificial lakes and reservoirs, levees, and landfills [7]. However, Caspian Tern breeds exclusively on islands in large lakes and reservoirs in Wyoming [5]. Preferred nesting sites are on the ground in sparsely vegetated, open areas that are > 2–3 m above the water surface to prevent flooding [2]. Nests are typically shallow depressions scraped into soft substrate, or existing/natural depressions in harder substrate, which may be lined with small pebbles, shells, sticks, or pieces of vegetation [2].

Phenology:
In Wyoming, spring arrival of migrating and breeding Caspian Terns occurs in mid-April. Very little is known about the specific nesting and breeding phenology of this species in Wyoming, but they are often seen nesting in close proximity to other colonial bird species [2, 5]. Clutches of 1–3 eggs are initiated 2–3 weeks after arrival at the breeding colony [2]. The incubation period lasts for 25–27 days, and fledging occurs when the young are about 37 days old [2]. Caspian Tern is considered a single-brood species, but will often renest following loss of the first clutch [2]. Fall migration from Wyoming occurs in September, with all migrants and residents departing the state by the end of the month [5].

Diet:
Caspian Tern is almost exclusively piscivorous, consuming many different species and sizes (5–30 cm) of fish depending on location and time of year [2]. In addition, it may also opportunistically feed on insects and crayfish [2].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD BUT PATCHY
Wyoming: VERY RARE
There are no robust estimates of abundance available for Caspian Tern in Wyoming. The species has a statewide abundance rank of VERY RARE but appears to be uncommon within suitable environments in the occupied area [6]. Colonial nesting waterbird surveys conducted from 2002–2006 by the Wyoming Game and Fish Department (WGFD) recorded 12 to 43 individuals annually across all surveyed sites [9-13]. From 1968–2015, annual Wyoming Breeding Bird Survey (BBS) detections of Caspian Tern ranged from 0 to 6, with none recorded in most years [14]. Caspian Tern was not detected during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [15]. While surveys conducted as part of the BBS and IMBCR programs may occasional detect this species, neither is specifically designed to capture tern observations.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Robust population trends are not available for Caspian Tern in Wyoming because the species is infrequently detected during monitoring efforts. North American BBS survey-wide trend data have deficiencies, and should be viewed with caution, but suggest that Caspian Tern numbers declined annually by 0.18% from 1966–2013 and increased annually by 3.16% from 2003–2013 [16]. Neither trend estimate was statistically significant.

Intrinsic Vulnerability:
HIGH VULNERABILITY
The high intrinsic vulnerability of Caspian Tern stems from very restricted habitat use in the state, low density of occurrence colonial nesting behaviors that can expose large numbers of breeding individuals to disturbance, and inherent risk of bioaccumulation of environmental toxins. In Wyoming, Caspian Tern only breeds on islands in large lakes and reservoirs [5], which is a rather rare habitat. Natural or anthropogenic disturbance to Caspian Tern breeding colonies can potentially affect large numbers of nesting individuals and negatively impact local populations. Caspian Tern is known to be highly sensitive to direct human disturbance, which can lead to high rates of nest abandonment and mortality of eggs and chicks [2, 17, 18]. As a primarily piscivorous species, Caspian Tern is at risk for physiological and reproductive stress caused by bioaccumulation of environmental contaminants from feeding in polluted aquatic habitat [2, 17, 19-23].

Extrinsic Stressors:
MODERATELY STRESSED
Caspian Tern is moderately stressed by extrinsic factors in Wyoming, where already limited island and aquatic habitat is potentially vulnerable to climate change and drought, invasive plant species, and development [24]. Drought and remediation projects in the state have exposed previously protected island breeding colonies to predation, disturbance, and abandonment [5].

KEY ACTIVITIES IN WYOMING
Caspian Tern is classified as a Species of Greatest Conservation Need (SGCN) by the WGFD. Current statewide bird monitoring programs are designed for monitoring breeding songbird populations and are unlikely to provide useful information on Caspian Tern. These monitoring programs include the BBS program conducted on 108 established routes since 1968 [16], and the multi-agency IMBCR program initiated in 2009 [15]. Since 1984, WGFD has conducted annual or periodic monitoring at the most important and productive sites for colonial waterbird SGCN to determine species presence and distribution, and to estimate number of nesting pairs. The most recent effort was the culmination of a multi-year cooperative agreement between the WGFD and the United States Fish and Wildlife Service to conduct an intensive survey of all historic, known, potential, and new colonial waterbird breeding sites statewide as part of a western range-wide effort to track population size, trends, and locations of breeding colonial waterbirds in the western United States [25, 26]. In 2014, an online Atlas of western colonial waterbird nesting sites was produced with data collected and submitted by participating states [27]. Every three to five years, WGFD personnel visit known colonial waterbird nesting sites outside of Yellowstone National Park to evaluate water level conditions, determine species present at each site, and estimate the number of nesting pairs of colonial waterbirds. There are currently no research projects designed specifically for Caspian Tern in Wyoming.

Ecological Information Needs

In Wyoming, Caspian Tern would benefit from research to determine its detailed distribution and the annual abundance of migrating and breeding adults. Beyond approximate arrival and departure dates, very little is known about migratory pathways, or the phenology of local breeders in Wyoming. Likewise, nothing is known about nest success or fledgling survival at the few known breeding locations in the state. Given Caspian Tern's demonstrated sensitivity to human disturbance, and the scarcity and inherent vulnerability of Wyoming's aquatic habitats, current and future anthropogenic and natural stressors should be identified to ensure the persistence of existing nesting locations.

Management in Wyoming

This section authored solely by WGFD; Zachary J. Walker. Caspian Tern is classified as a SGCN in Wyoming due to varying annual availability and suitability of breeding sites and sensitivity to human disturbance during the nesting period. Colonial water bird surveys are conducted within the state, but existing data are not robust enough to support estimates of occupancy, density, or population trend. Targeted, species-specific survey methods may be warranted. Best management practices or key management recommendations to benefit Caspian Tern include protection of suitable breeding locations, minimize nesting disturbance, and maintenance of stable water levels throughout the nesting season [24].

Contributors

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Figure 1: Adult Caspian Tern in Weld County, Colorado. (Photo courtesy of Bill Schmoker)

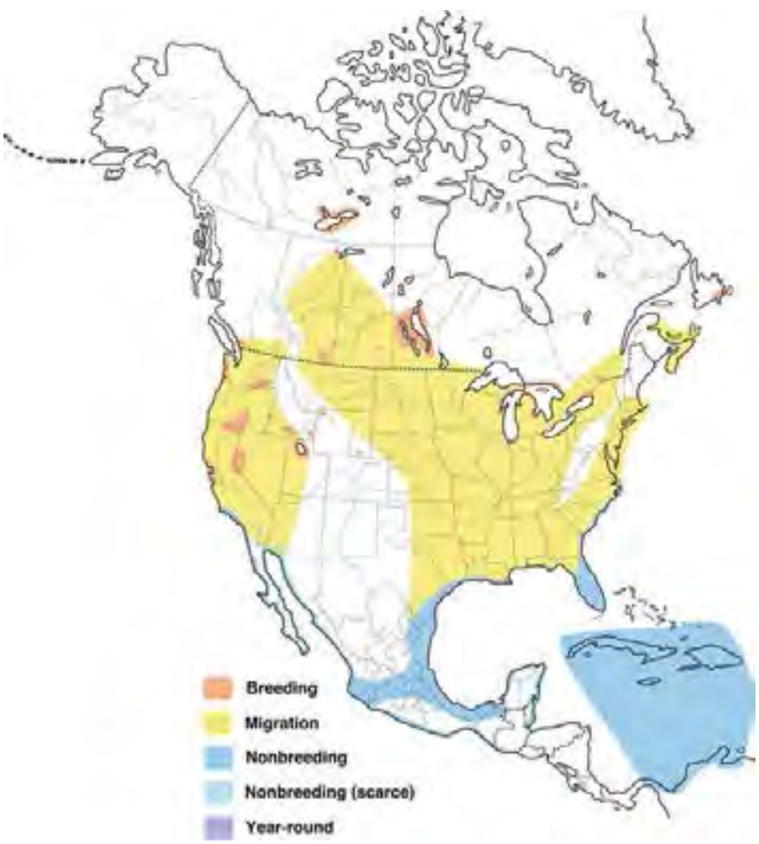
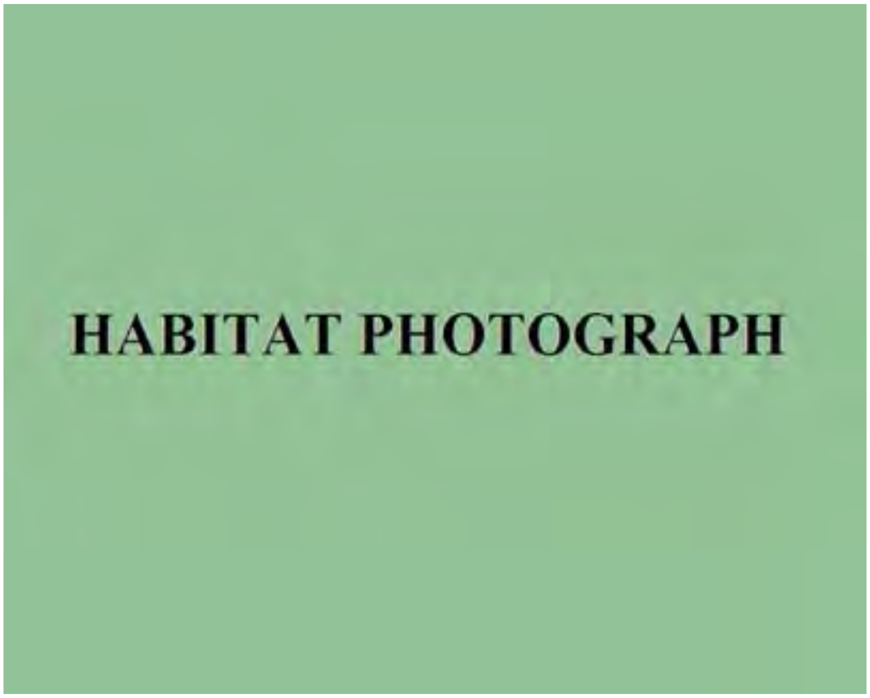


Figure 2: North American range of *Hydroprogne caspia*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

ꙮ Wyoming Species Account ꙮ



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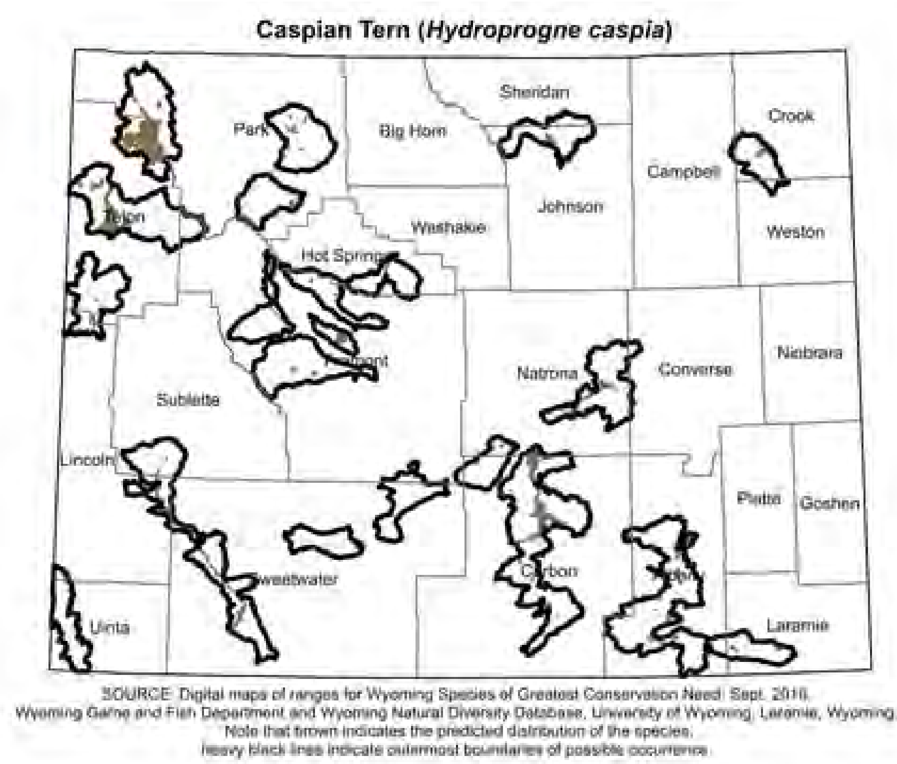

Figure 4: Range and predicted distribution of *Hydroprogne caspia* in Wyoming.

Figure 5: Adult Caspian Tern (with leg bands) in flight over Elk Lake, Montana. (Photo courtesy of Elizabeth Boehm)

Cattle Egret
Bubulcus ibis

Regulatory Status
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

Conservation Ranks
USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G5, S1S2
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: Not ranked

Status and Rank Comments
The Wyoming Natural Diversity Database has assigned Cattle Egret (*Bubulcus ibis*) a state conservation rank ranging from S1 (Critically Imperiled) to S2 (Imperiled) because of uncertainty about population trends for this species in Wyoming.

Natural History
Taxonomy:
Two subspecies of Cattle Egret are recognized based on differences in size and breeding season plumage [1]. The subspecies are disjunct from one another, so may be viewed as separate species. *B. i. ibis* is more widespread and breeds in North America, South America, Europe, Asia, Africa, Madagascar, and on islands in the Indian Ocean, while *B. i. coromandus* breeds in Asia, China, Japan, Australia, and New Zealand [2]. Outside of the breeding season, the two subspecies have similarities in plumage [2]. However, variations in courtship displays and vocalizations exist, both between subspecies and among populations [3].

Description:
Cattle Egret can be identified in the field, especially during the breeding season. Males and females are similar in appearance, although females have slightly shorter breeding plumes [2]. Adults are stocky with a short neck and white plumage overall. During most of the breeding season, they have orange-buff plumes on the breast, head, and lower back; yellow-green legs; and dark yellow irises [4]. For a short time during the height of the breeding cycle, adults have bright reddish bills, legs, and irises, and purplish-pink lores [4]. Adults are 51 cm long, have a 91-cm wingspan, and weigh 340 g [5]. Juvenile Cattle Egrets have all white plumage with a small, light buff area on the crown; black legs; a mostly black bill with yellow-ochre coloration on the upper mandible; and yellow eyes [4]. Snowy Egret (*Egretta thula*) is also known to breed in Wyoming, and Great Egret (*Ardea alba*) has been documented but is considered an accidental

species [6, 7]. Both Snowy Egret and Great Egret are larger than Cattle Egret and have longer necks and bills [5]. During the breeding season, Snowy Egret can be distinguished from Cattle Egret by its all-white plumage, black bill, and yellow feet [5].

Distribution & Range:
Originally from Africa, Cattle Egret began expanding its range worldwide in the late 1800s [2]. Cattle Egret first appeared in South America in 1877 and in the United States in 1941, with the first documented nesting in the United States occurring in 1953 [2, 8]. The species continues to colonize new areas and has become one of the most abundant species of heron (Family Ardeidae) in North America [2, 8]. Confirmed breeding has been documented in all but four of the contiguous United States (i.e., Montana, New Hampshire, Washington, and West Virginia) [2]. Cattle Egret was first recorded in Wyoming in August 1978. To date, the species has been documented in 18 of Wyoming's 28 latitude/longitude degree blocks, with the first and only confirmed breeding record documented on 18 July 1996 on Hutton Lake National Wildlife Refuge in degree block 27, approximately 19 km southwest of Laramie, Wyoming [7, 9]. Observations of Cattle Egret have occurred in 14 counties in Wyoming, with most from Goshen, Laramie, Natrona, Sweetwater, and Teton counties [6].

Habitat:
Unlike other egret species, Cattle Egret prefers upland habitats for foraging, and is often associated with grazing animals such as cattle [2]. It can also be found foraging on lawns and in fields, pastures, and agricultural areas [2]. Documented breeding in Wyoming occurred in bulrush (*Scirpus* spp.) habitat on Rush Lake, along with nesting Black-crowned Night-Heron (*Nycticorax nycticorax*) and White-faced Ibis (*Plegadis chihi*) [7, 9].

Phenology:
Cattle Egret has been documented in Wyoming as early as 18 April, with most observations occurring between 18 April and 28 May [6]. The single documented breeding record in Wyoming occurred in 1996, with 12 adults flushed from nests on 18 July and 12 downy young observed in 4 nests on 28 July [7, 9]. Cattle Egret lays a single clutch usually consisting of 3 to 4 eggs, and infrequently 2 to 5 eggs [10]. The majority of eggs are laid at 2-day intervals [2]. Incubation takes place for 22 to 28 days, and young fledge within 21 to 30 days [2, 10]. In North America, one brood per year is typical [11]. Most reports of fall migration in Wyoming are from 24 October to 4 November [6].

Diet:
Cattle Egret consumes a varied diet depending on conditions, location, date, time of day, food availability, and foraging habits [2]. Foraging usually takes place on dry or moist ground away from water and near grazing animals such as cattle or horses [12]. Diet typically consists of insects such as grasshoppers, crickets, and flies [2]. Additional prey items can include small vertebrates, mollusks, crustaceans, earthworms, and nestling birds [10].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
There are no robust population estimates for Cattle Egret in Wyoming. The statewide rank of VERY RARE is based on the rather small area of the state known to be occupied in any given

season, and the small coverage of suitable habitat within that area. However, within suitable habitat in the occupied area, Cattle Egret appears to be rare, as it occupies only a small percentage of preferred habitat within its range and may not be readily detected during surveys expected to indicate its presence [7]. Detections of Cattle Egret in Wyoming during the breeding season are limited during periodic surveys conducted for colonial waterbirds at wetland sites. From 2009–2015, no Cattle Egrets were detected on Integrated Monitoring in Bird Conservation Regions (IMBCR) survey grids in Wyoming [13].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends are not available for Cattle Egret in Wyoming due to a limited distribution in the state and low detection rates during monitoring surveys. Currently, there are no robust North American Breeding Bird Survey (BBS) trend data for Cattle Egret in Wyoming due to a lack of observations. Regional data, however, indicate a moderate increase, although results should be interpreted with caution because data fall within the 'important deficiencies' credibility category [14].

Intrinsic Vulnerability:
HIGH VULNERABILITY
Cattle Egret has high intrinsic vulnerability in Wyoming due to selective habitat requirements, which limit its distribution and abundance in the state. Suitable wetland breeding habitat for Cattle Egret is limited in Wyoming, and changes to the hydrologic regime can either flood nests during high water events, or leave nests susceptible to predation during low water years. The species may also exhibit sensitivity to human disturbance during the breeding season.

Extrinsic Stressors:
MODERATELY STRESSED
Stressors to Cattle Egret in are primarily from limited wetland habitat for nesting, and the susceptibility of this habitat to climate change, drought, and invasive plant species [15]. Natural wetlands in Wyoming are limited in size and distribution, with less than 2% of the total state area classified as wetland habitat [15].

KEY ACTIVITIES IN WYOMING

Cattle Egret is classified as a Species of Greatest Conservation Need (SGCN) by the Wyoming Game and Fish Department (WGFD). From 1984–1986, WGFD personnel conducted inventories of nesting colonial waterbirds in Wyoming; Cattle Egret was not detected during this effort [16, 17]. WGFD personnel have continued to conduct annual or periodic monitoring at the most important and productive sites for colonial waterbird SGCN to determine species presence and distribution, and to estimate number of nesting pairs. Survey results have shown Cattle Egret nesting at only one site in Wyoming (Rush Lake on Hutton Lake National Wildlife Refuge in 1996) [7, 9]. Due to their sensitivity to human disturbance during the nesting season, the survey technique used for colonial waterbirds is minimally invasive and provides only an estimate of the number of breeding pairs and coarse habitat associations of each waterbird species present in the colony. Actual nests, eggs, or young are not located or counted to prevent colony disruption and reduce predation risk. From 2009–2012, WGFD and the U.S. Fish and Wildlife Service cooperated to conduct a rigorous survey of all historic, known, potential, and new colonial waterbird breeding sites statewide as part of a western range-wide effort to track population size, trends, and locations of breeding colonial waterbirds in the western United States [18, 19]. A total of 90 sites were evaluated in Wyoming; 86 potential colonial waterbird nesting sites and 4 known nesting sites. A lack of adequate emergent vegetation to provide secure nesting areas for colonial waterbirds was noted at most potential sites visited. In 2014, an online Atlas of western colonial waterbird nesting sites was produced with data collected and submitted by participating states [20]. Every 3 to 5 years, WGFD personnel visit known colonial waterbird nesting sites outside of Yellowstone National Park to evaluate water level conditions, determine species present at each site, and estimate the number of nesting pairs of colonial waterbirds. Observations of this species are reported to the WGFD and vetted through the Wyoming Bird Records Committee. Currently, there are no research projects designed specifically for Cattle Egret in Wyoming.

ECOLOGICAL INFORMATION NEEDS

In Wyoming, Cattle Egret would benefit from research to determine its nesting and population status in the state; if breeding occurs on a regular basis or is a function of irruptive behavior from breeding colonies in northern Colorado, south of Hutton Lake National Wildlife Refuge; and the annual abundance of migrating and breeding adults. In addition, information on selection of breeding and foraging areas and breeding site fidelity would be beneficial [2]. Beyond approximate arrival and departure dates, very little is known about the specific breeding habits of this species in Wyoming, and nothing is known about nest success or fledgling survival at the only known breeding location in the state. It would be valuable to examine how current and future land use practices and the potential impacts of climate change could affect the availability and quality of already limited wetland habitat in Wyoming, as these stressors could influence the future persistence of this species, and other colonially nesting waterbirds, in the state.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. The colonial nature of nesting Cattle Egrets and other waterbirds makes these species particularly vulnerable across their range to loss or degradation of nesting sites, stochastic weather events such as drought and flooding, changing land use practices, pollution, and climate change. In Wyoming, Cattle Egret is classified as a SGCN due to limited suitable wetland breeding habitat, sensitivity to human disturbance during the breeding season, and susceptibility of nests to fluctuating water levels and predation. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [14] and IMBCR [13] programs. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, colonial waterbirds are one of the species groups that warrant a targeted, species-specific survey method approach to obtain these data. Best management practices to benefit Cattle Egret include maintaining large, high quality wetland complexes; keeping water levels stable during the nesting season; protecting any colony site used by Cattle Egret; keeping human disturbance to a minimum during the breeding season; and monitoring colony sites every three years to determine Cattle Egret presence and estimate number of nesting pairs [21].

CONTRIBUTORS

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Figure 1: An adult Cattle Egret in breeding plumage in Goshen County, Wyoming. (Photo courtesy of Shawn Billerman)

Figure 2: North American range of *Bubulcus ibis*. Note: This map does not accurately reflect the recent expansion or current range of this species in the United States or Wyoming. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

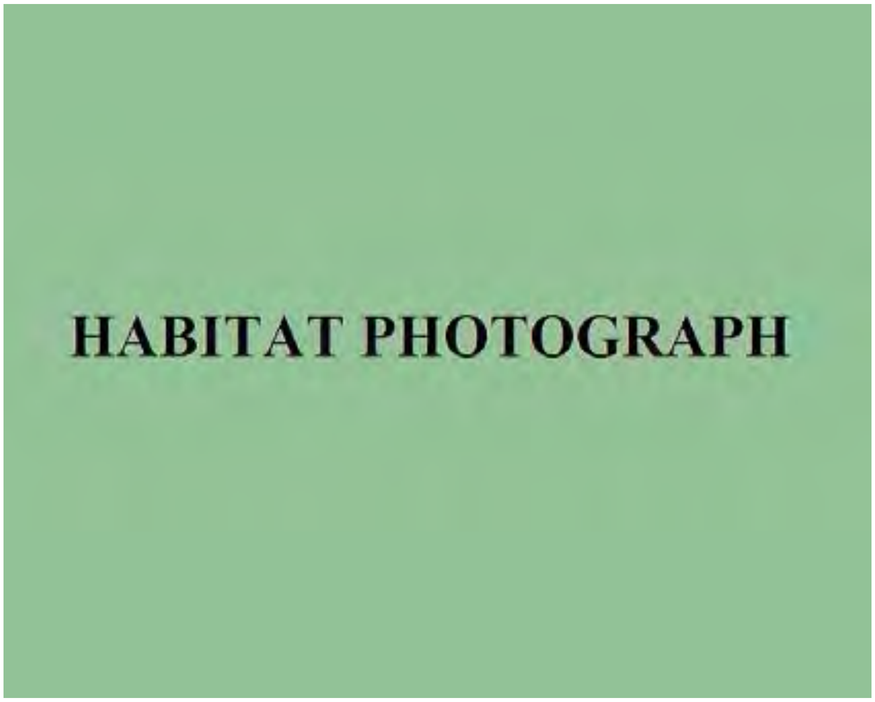

Figure 3: Photo not available.

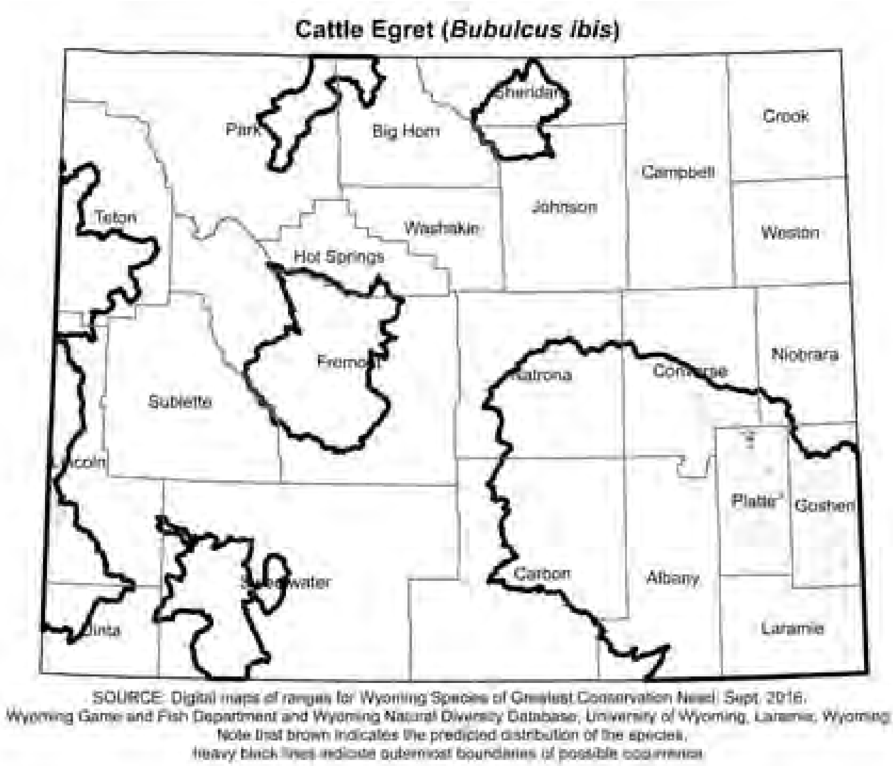

Figure 4: Range and predicted distribution of *Bubulcus ibis* in Wyoming.

Figure 5: Cattle Egret in flight in Lacassine National Wildlife Refuge, Louisiana. (Photo courtesy of Bill Schmoker)

Chestnut-collared Longspur
Calcarius ornatus

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: Sensitive
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: Bird of Conservation Concern
WGFD: NSS4 (Bc), Tier II
WYNDD: G5, S3
Wyoming Contribution: HIGH
IUCN: Near Threatened
PIF Continental Concern Score: 14

STATUS AND RANK COMMENTS
Chestnut-collared Longspur (*Calcarius ornatus*) has no additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY
Taxonomy:
There are currently no recognized subspecies of Chestnut-collared Longspur [1, 2]. Hybridization with McCown's Longspur (*Rhynchophanes mccownii*) is possible but apparently rare [1].

Description:
Identification of Chestnut-collared Longspur is possible in the field. Adults weigh 17–23 g, range in length from 13–16.5 cm, and have a wingspan of about 26.7 cm [1, 3]. The species is sexually dimorphic. During the breeding season, adult males have a black crown, hind cheek, shoulder patch, breast, and belly; white to buffy yellow cheeks and throat; rufous nape; and brown streaked upperparts. Females have light, sandy-brown streaked upperparts; pale, gray-brown underparts with faint streaking on the breast and belly; brown crown; and a buffy face with darker rear-cheek. Both sexes have small, cone-shaped, grayish bills and white tails with a dark triangle that is visible in-flight [1, 3]. Similar sympatric species in Wyoming include McCown's Longspur and Lapland Longspur (*C. lapponicus*) [4]. Breeding male McCown's Longspurs have a gray nape, gray belly, and rufous wing-bars, and both sexes have an inverted black "T" on the otherwise white tail. Lapland Longspur occurs in Wyoming only in the winter (when Chestnut-collared Longspur is absent from the state) and both sexes have a dark tail with thin white sides [3].

Distribution & Range:
Both the breeding and winter ranges of Chestnut-collared Longspur are restricted to North America. Fragmentation of shortgrass and mixed-grass prairies has resulted in a disjunct distribution overall, and the species has experienced large contractions of both its historic summer and winter ranges [1, 5]. Chestnut-collared Longspur currently breeds in the northern Great Plains of the north-central United States and south-central Canada [1]. Northeastern Wyoming is on the southern edge of the core breeding range, while southeastern Wyoming encompasses one of several smaller, discrete southern breeding areas [1]. Chestnut-collared Longspur migrates through the state in the spring and fall and is a summer resident [4, 6]. Confirmed and suspected breeding has been documented in 5 of the 28 latitude/longitude degree blocks in the state, all in far eastern Wyoming [6]. The species primarily overwinters in western Texas and eastern New Mexico, but annual shifts in winter distribution have been observed [1, 5].

Habitat:
Across its continental range, including Wyoming, Chestnut-collared Longspur typically breeds in large, arid, open tracts of shortgrass and mixed-grass prairie [1]. Grazing by ungulates, mowing, and burning help to maintain the species' preferred vegetation structure (i.e., < 30 cm tall, sparse, scarce ground litter), and Chestnut-collared Longspur is known to be more abundant in grasslands that have recently been exposed to such disturbances [1]. Although Chestnut-collared Longspur will occasionally breed in non-native grasslands, such as planted hay fields and pastures, abundance and productivity can be lower in these agricultural landscapes [1, 5]. The species may also use Black-tailed Prairie Dog (*Cynomys ludovicianus*) colonies [7, 8]. Chestnut-collared Longspur is a ground nesting species; females construct open cup nests out of grass in excavated depressions, often directly adjacent to taller vegetation or features on the landscape (i.e., grass, shrub, livestock dung pile) [1]. In general, nest sites typically have more vegetation cover and ground litter than the surrounding area. Habitat use by Chestnut-collared Longspur is often compared to that of McCown's Longspur; both taxa use grassland with relatively short and sparse vegetation, but the former uses notably taller and heavier vegetation than the latter [1, 9].

Phenology:
In Wyoming, spring arrival of Chestnut-collared Longspur consistently occurs in mid-April [4]. Pair formation and nest building begin once females arrive on the breeding grounds, generally about 1–2 weeks after the first males appear [1]. Egg laying likely begins in early or mid-May, but varies depending on location and annual conditions. Most clutches contain 4 eggs (range 2–6 eggs), which are incubated by the female for approximately 11 days (range 7–15 days). Young are altricial at hatching and remain in the nest until about 11 days old (range 7–15 days). Fledglings are capable of limited flight 1–2 days after leaving the nest, but parents may continue to provide food for up to 2 weeks. Chestnut-collared Longspur can produce 2–3 broods a year in some parts of its distribution and may renest up to 3 times following multiple nest failures in a single breeding season [1]. In Wyoming, fall migration to wintering grounds peaks in late September, with most migrants and summer residents leaving the state by early October [4].

Diet:
Chestnut-collared Longspur consumes larval and adult insects (e.g., grasshoppers, caterpillars), spiders, and the seeds of grasses and forbs during the breeding season. Nestling are fed a wide variety of invertebrate prey, with grasshoppers constituting a large proportion of the diet [1]. The species relies entirely on grains and seeds during the winter [1].

CONSERVATION CONCERNS

Abundance:
Continental: REGIONAL ENDEMIC
Wyoming: UNCOMMON
Robust population estimates for Chestnut-collared Longspur in Wyoming are lacking. The patchy distribution with opportunistic shifts to burned, mowed, or grazed areas make accurate population estimates difficult [5]. Chestnut-collared Longspur has a statewide abundance rank of UNCOMMON, and appears to be uncommon in suitable environments within its Wyoming range [6]. In 2013, Partners in Flight estimated the Wyoming population of Chestnut-collared Longspur to be around 50,000 individuals, or about 1.9% of the global population [10]; however, this abundance estimate is based primarily on Breeding Bird Survey (BBS) data and should be viewed with caution due to the low detection rate of this species in the state. From 1968–2015, annual BBS detections of Chestnut-collared Longspur in Wyoming ranged from 0 to 91 (average = 29), with 7 recorded in 2015 [11]. Annual detections of Chestnut-collared Longspur ranged from 0 to 39 during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [12]. Estimated mean density from 2010–2015 was 0.58 birds per km^2 (standard deviation 0.55, standard error 0.25) in suitable habitats in Wyoming [12].

Population Trends:
Historic: LARGE DECLINE
Recent: LARGE DECLINE
Long-term, historic declines of Chestnut-collared Longspur in North America are attributed to the fragmentation of native grasslands by agriculture, urbanization and associated infrastructure, and other disturbances [1]. North American BBS trend data suggest that Chestnut-collared Longspur has experienced large population declines in all regions of its continental breeding distribution, including Wyoming, between 1966–2013 and 2003–2013 [13]. Survey-wide BBS trend data indicate that Chestnut-collared Longspur numbers experienced statistically significant annual declines of 4.35% from 1966–2013 and 3.48% from 2003–2013 [13].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Chestnut-collared Longspur has moderate intrinsic vulnerability in Wyoming because it is restricted to a narrow range of habitat types and has nesting behaviors that may leave the species susceptible to nest loss. The species can tolerate some disturbances to grassland, but Chestnut-collared Longspur may be negatively affected by processes that convert native shortgrass and mixed-grass prairie to other cover types, or that promote especially dense and heavy vegetation. As a species that nests on the ground in relatively exposed environments, Chestnut-collared Longspur is vulnerable to predation and ground disturbance (both natural and anthropogenic) during the breeding season [1].

Extrinsic Stressors:
MODERATELY STRESSED
Prairie grassland habitats in eastern Wyoming are vulnerable to development for energy, infrastructure, and agriculture; invasive plant species such as Cheatgrass (*Bromus tectorum*) and Canada Thistle (*Cirsium arvense*); off-road recreational activities; altered fire and grazing regimes; and drought and climate change [6]. Habitat loss and conversion represent significant threats to Chestnut-collared Longspur across its continental distribution, and have already led to population declines and range contractions [1, 5]. Additionally, the species has shown sensitivity to

reduced habitat patch size and increased density of edges with other habitats [1, 14]. Chestnut-collared Longspur avoids most croplands, is found at lower densities and has reduced fitness in fields and pastures planted with non-native grasses, and is less likely to occur in habitats with a high percent cover of introduced forbs [1, 5, 14]. The species is very tolerant of, and sometimes favors, habitat disturbances that help maintain short and sparse vegetation, especially grazing [1]. Chestnut-collared Longspur responses to natural resource development (i.e., wind, oil, natural gas) are variable across its distribution [1, 15, 16]. The species is vulnerable to direct and indirect effects from various pesticides used to control agricultural pests [1, 5]. However, it is unknown how these potential stressors are affecting Chestnut-collared Longspurs in Wyoming.

KEY ACTIVITIES IN WYOMING

Chestnut-collared Longspur is classified as a Species of Greatest Conservation Need (SGCN) by the Wyoming Game and Fish Department, and as a Level II Priority Bird Species requiring monitoring in the Wyoming Bird Conservation Plan [17]. In 2009, the Wyoming Natural Diversity Database conducted migration and breeding season surveys of upland songbirds on the Laramie Plains National Wildlife Refuges. These surveys detected Chestnut-collared Longspur and provided baseline knowledge on habitat use and abundances for the species in that area [18]. Current statewide activities for monitoring annual detections and population trends for Chestnut-collared Longspur in Wyoming include the BBS program conducted on 108 established routes since 1968 [13], and the multi-agency IMBCR program initiated in 2009 [12]. There are currently no research projects designed specifically for Chestnut-collared Longspur in Wyoming.

ECOLOGICAL INFORMATION NEEDS

In Wyoming, Chestnut-collared Longspur would benefit from research to learn more about nest success and fledging survival. It is unknown how breeding Chestnut-collared Longspurs in the state respond to grassland management practices such as livestock grazing and prescribed fires. Additional research is needed to examine how the species is affected by various forms of industrial development in the state (e.g., wind energy, oil and natural gas, agriculture, urbanization). Pesticide applications, especially in the context of grasshopper outbreaks in Wyoming, have the potential to drastically lower Chestnut-collared Longspur reproductive success and population performance, and should be studied further.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Zachary J. Walker. Chestnut-collared Longspur is classified as a SGCN in Wyoming due to habitat loss, fragmentation, and susceptibility to anthropogenic disturbances. Declines have been documented, both recent and historic, for Chestnut-collared Longspur, and it is important to monitor species populations. Currently, there are two separate but compatible survey programs in place to monitor populations of many avian species that breed in Wyoming. The first is the long-term BBS started in Wyoming in 1968 with 108 established routes (Sauer et al. 2014). The second is the IMBCR program which was established in 2009 in Wyoming with many state, federal, and nongovernmental organization partners that contribute funding, field personnel, technical assistance, or in-kind services. It is recommended that these survey programs be continued into the future to help monitor Chestnut-collared Longspur. Additional targeted surveys and research may be warranted for Chestnut-collared Longspur to address specific population maintenance questions. It is recommended that nesting areas for Chestnut-collared Longspur be managed to minimize habitat alteration and fragmentation, while maintaining the species' preferred vegetation structure. Pesticide application should be postponed when possible to avoid impacting breeding populations. Prescribed burns conducted in known breeding habitats for Chestnut-collared Longspur should be conducted in early fall and designed to retain nesting cover.

CONTRIBUTORS

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Figure 1: Adult male (left) and female (right) Chestnut-collared Longspurs in Albany County, Wyoming. (Photos courtesy of Shawn Billerman)

Figure 2: North American range of *Calcarius ornatus*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Chestnut-collared Longspur habitat in Thunder Basin National Grassland, Wyoming. (Photo courtesy of Michael T. Wickens)

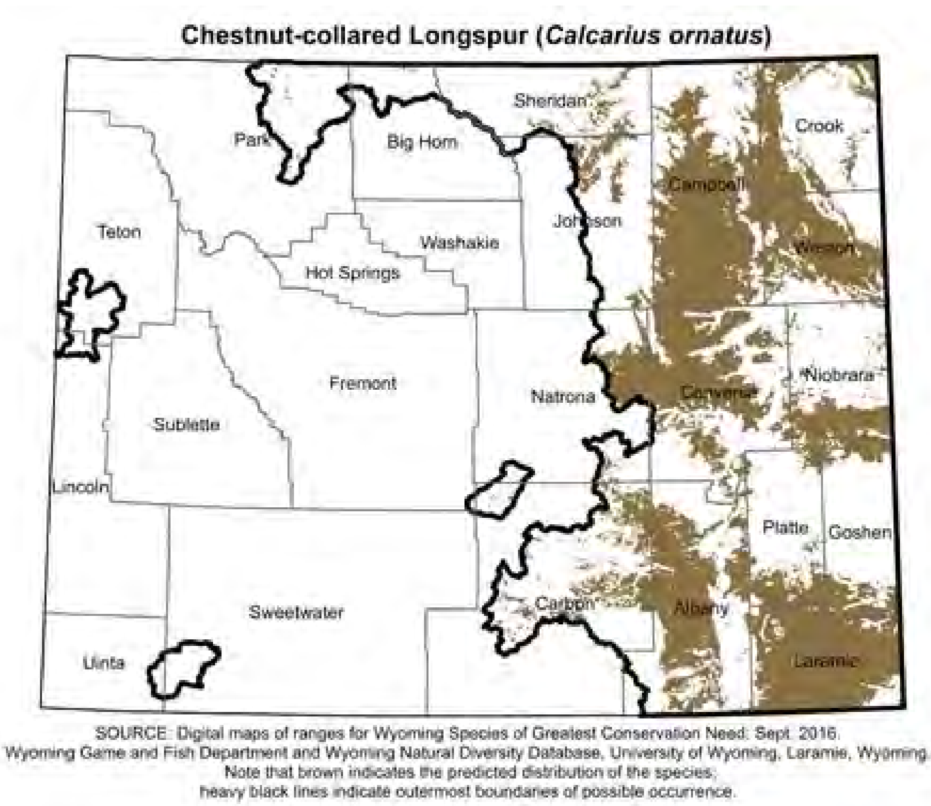

Figure 4: Range and predicted distribution of *Calcarius ornatus* in Wyoming.

Clark's Grebe
Aechmophorus clarkii

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: No special status
WGFD: NSSU (U), Tier II
WYNDD: G5, S2S3
 Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: Not ranked

STATUS AND RANK COMMENTS
The Wyoming Natural Diversity Database has assigned Clark's Grebe (*Aechmophorus clarkii*) a state conservation rank ranging from S2 (Imperiled) to S3 (Vulnerable) because of uncertainty about historic and recent population trends for this species in Wyoming.

NATURAL HISTORY
Taxonomy:
Clark's Grebe was believed to be a light color morph of Western Grebe (*A. occidentalis*) until it was officially recognized as a separate species in 1985 based on genetic evidence and differences in advertising calls [1]. Due to the relatively recent separation of these two closely related species, a majority of the basic life history information for Clark's Grebe remains combined within the Western Grebe literature [2, 3]. Therefore, Western Grebe literature (especially the species account within the Birds of North America series) is frequently referenced throughout this document. The 2 species are known to occasionally hybridize [3-6]. There are two recognized subspecies of Clark's Grebe, but only *A. c. transitionalis* is found in Wyoming and surrounding states [2, 7].

Description:
Identification of Clark's Grebe is possible in the field. It is a large aquatic diving bird; adults weight between 800–1,800 g, range in length from 55–75 cm, and have a wingspan of approximately 61 cm [3, 8]. The sexes are similar in appearance [2], but females are smaller-bodied with shorter narrower bills that appear slightly upturned [3, 9]. Both sexes have bright red eyes, a bright orange-yellow bill with a defined black culmen, yellowish-green legs attached to the rear of the body, and flat lobed toes [2, 3, 8]. In the breeding season, the cheeks, throat, front of the neck, and breast are all white, while the forehead, crown, and back of the neck are black [2, 8]. The back is dark gray, and sides are paler and streaked with varying amounts of white [8]. Non-breeding plumage is almost identical, but the face may darken slightly around the eyes [8]. Three other

species of grebe are classified as summer residents in Wyoming and are known to breed in the state: Western Grebe, Pied-billed Grebe (*Podilymbus podiceps*), and Eared Grebe (*Podiceps nigricollis*) [10]. Clark's Grebe is very similar in appearance to Western Grebe, but Western Grebe has a greenish-yellow bill, a black crown that extends below the eyes, and typically darker sides [2, 3].

Distribution & Range:
The distribution of Clark's Grebe overlaps substantially with that of Western Grebe [2, 3]. Clark's Grebe is found year-round in inland Mexico and also breeds in southwestern Canada and the western and mid-western United States [3]. Wyoming is centrally located within Clark's Grebe's breeding distribution. The species migrates through the state in the spring and fall and is a summer resident [10, 11]. Clark's Grebe has been observed at waterbodies across much of Wyoming [10, 11]; however, confirmed or suspected breeding has been documented in just 5 of the 28 latitude/longitude degree blocks, primarily in the western half of the state [11]. The species winters along the western coast of North America, in New Mexico and far western Texas, and along the Gulf Coast of Texas [2].

Habitat:
Clark's Grebe breeds primarily on large, freshwater lakes and marshes with several square kilometers of open water and areas of flooded emergent vegetation [3]. In Wyoming, Clark's Grebe colonies are found on large, deep, open-water lakes and reservoirs with emergent vegetation for nesting [10, 12]. Nests are constructed by both sexes as mounds or floating platforms of aquatic vegetation, usually anchored to emergent or dense submerged vegetation in > 25 cm of water [3, 12]. Migrating individual may be observed at open, freshwater sites of various sizes, but are most common on large waterbodies [3]. Clark's Grebe typically winters in coastal bays, estuaries, and sheltered marine shorelines, but may occasionally be found in freshwater lakes and rivers [3].

Phenology:
In Wyoming, spring arrival of migrating and breeding Clark's Grebes begins in mid-April [10], but very little is known about the nesting and breeding habits of this colonial nesting species in the state. *Aechmophorus* grebes have extremely complex and ritualized courtship ceremonies, including one that involves "rushing", where a pair run side-by-side along the surface of the water [3, 13]. The courtship ceremonies of Clark's Grebe and Western Grebe are identical except for the number of notes in the advertising call [3, 4], and the two species are known to occasionally interbreed and produce fertile hybrid offspring [3-6]. Mean clutch size may decrease over the course of a breeding season [3], but averaged 2.4 (n = 105 clutches) across a season for a population of Clark's Grebe in Utah [2]. Eggs begin to hatch after an incubation period of 22–24 days, and both parents take turns back-brooding the chicks for the first 2–4 weeks [3]. Young are dependent on parents for 6–7 weeks [3]. Clark's Grebe is a single brood species, but will renest if the first nest is lost [3]. In Wyoming, fall migration of Clark's Grebe likely coincides with that of Western Grebe, which peaks in October [10].

Diet:
Clark's Grebe is primarily piscivorous, but will also consume frogs, salamanders, crustaceans, and aquatic worms [3, 12]. Grebes are specialized divers and capture a majority of their prey underwater [3].

Conservation Concerns

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
There are no robust estimates of abundance available for Clark's Grebe in Wyoming. The species has a statewide abundance rank of VERY RARE and appears to be uncommon within suitable environments in its range [11]. Colonial nesting waterbird surveys conducted from 2002–2006 by the Wyoming Game and Fish Department (WGFD) recorded a range of 0 to 80 individuals annually across all surveyed sites [14-18]. From 1987–2015, following Clark Grebe's split from Western Grebe, annual Wyoming Breeding Bird Survey (BBS) detections of Clark's Grebe ranged from 0 to 6 with none recorded in most years [19]. Clark's Grebe was not detected during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [20]. While surveys conducted as part of the BBS and IMBCR programs may occasional detect this species, neither is specifically designed to capture grebe observations.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Robust population trends are not available for Clark's Grebe in Wyoming because the species is infrequently detected during monitoring efforts. North American BBS survey-wide trend data have deficiencies, and should be viewed with caution, but suggest that Clark's Grebe numbers declined annually by 1.61% from 1966–2013 and increased annually by 2.70% from 2003–2013 [21]. Neither trend estimate was statistically significant.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Clark's Grebe has moderate intrinsic vulnerability in Wyoming due to a narrow range of habitat requirements for breeding (e.g., expansive open water, sufficient water depth, rooted emergent or submerged vegetation), and colonial nesting and nest-building behaviors that can leave the species susceptible to disturbance. Natural or anthropogenic disturbance to breeding colonies can potentially affect large numbers of nesting individuals and negatively impact local populations of Clark's Grebe. The floating nests of this species are vulnerable to damage or loss from surface disturbance and fluctuating water levels [3, 22], which commonly occur on water bodies in Wyoming. However, Clark's Grebe has demonstrated some ability to adjust breeding phenology to changing habitat conditions in other parts of its range [23], and has been known to use man-made floating nest platforms [22].

Extrinsic Stressors:
MODERATELY STRESSED
Clark's Grebe is moderately stressed by extrinsic stressors in Wyoming, where already limited aquatic and wetland habitat is potentially vulnerable to climate change and drought, invasive plant species, and development for infrastructure, energy, and agriculture [12, 24, 25]. Annual colony size is often dependent on water levels, and recent drought conditions in Wyoming have already led to the desertion of existing *Aechmophorus* colonies [10]. Clark's Grebe colonies are also vulnerable to abandonment or increased predation risk from repeated anthropogenic disturbance [12]. This species may experience bioaccumulation of environmental contaminants from feeding in polluted aquatic habitats [12, 26-28].

KEY ACTIVITIES IN WYOMING

Clark's Grebe is classified as a Species of Greatest Conservation Need (SGCN) by the WGFD, and as a Level III Priority Bird Species requiring local interest in the Wyoming Bird Conservation Plan [12]. Some current statewide bird monitoring programs are designed for monitoring breeding songbird populations and are unlikely to provide useful information on Clark's Grebe. These monitoring programs include the BBS program conducted on 108 established routes since 1968 [21], and the multi-agency IMBCR program initiated in 2009 [20]. Since 1984, WGFD has conducted annual or periodic monitoring at the most important and productive sites for colonial waterbird SGCN to determine species presence and distribution, and to estimate number of nesting pairs. The most recent effort was the culmination of a multi-year cooperative agreement between the WGFD and the United States Fish and Wildlife Service to conduct an intensive survey of all historic, known, potential, and new colonial waterbird breeding sites statewide as part of a western range-wide effort to track population size, trends, and locations of breeding colonial waterbirds in the western United States [29, 30]. In 2014, an online Atlas of western colonial waterbird nesting sites was produced with data collected and submitted by participating states [31]. Every three to five years, WGFD personnel visit known colonial waterbird nesting sites outside of Yellowstone National Park to evaluate water level conditions, determine species present at each site, and estimate the number of nesting pairs of colonial waterbirds. There are currently no research projects designed specifically for Clark's Grebe in Wyoming.

ECOLOGICAL INFORMATION NEEDS

Clark's Grebe would benefit from research to determine its detailed distribution, the location and habitat characteristics of current breeding colonies, and the annual abundance of migrating and breeding adults in Wyoming. Beyond approximate arrival and departure dates, very little is known about migratory pathways, or the specific breeding habits of this species in the state. Nothing is known about nest success or fledgling survival at the few known breeding locations. Due to the scarcity and inherent vulnerability of Wyoming's aquatic habitats, it would be valuable to identify current and future anthropogenic and natural stressors to ensure the persistence of breeding habitat for Clark's Grebe.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona and Zachary J. Walker. The colonial nature of Clark's Grebe and other waterbirds makes these species particularly vulnerable across their range to loss or degradation of nesting sites, stochastic weather events such as drought and flooding, changing land use practices, pollution, and climate change. In Wyoming, Clark's Grebe is classified as a SGCN due to limited suitable aquatic or wetland breeding habitat, sensitivity to human disturbance during the breeding season, and susceptibility of nests to fluctuating water levels [12]. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [21] and IMBCR [20] programs. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, colonial waterbirds are one of the species groups that warrant a targeted, species-specific survey method approach to obtain these data. Because of this need, targeted colonial waterbird surveys are conducted every three years to determine Clark's Grebe presence. Surveys should be continued to determine nesting sites for this species in the state. Best management practices to benefit Clark's Grebe include maintaining large, high quality wetland complexes, including buffer zones to block siltation, pesticides, and fertilizer runoff into wetlands; keeping water levels stable during the nesting season; installing artificial nest platforms where needed; protecting any colony site used by Clark's Grebe; keeping human disturbance to a minimum during the breeding season; and monitoring colony sites.

CONTRIBUTORS

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Figure 1: Adult Clark's Grebe in Laramie County, Wyoming. (Photo courtesy of Pete Arnold)

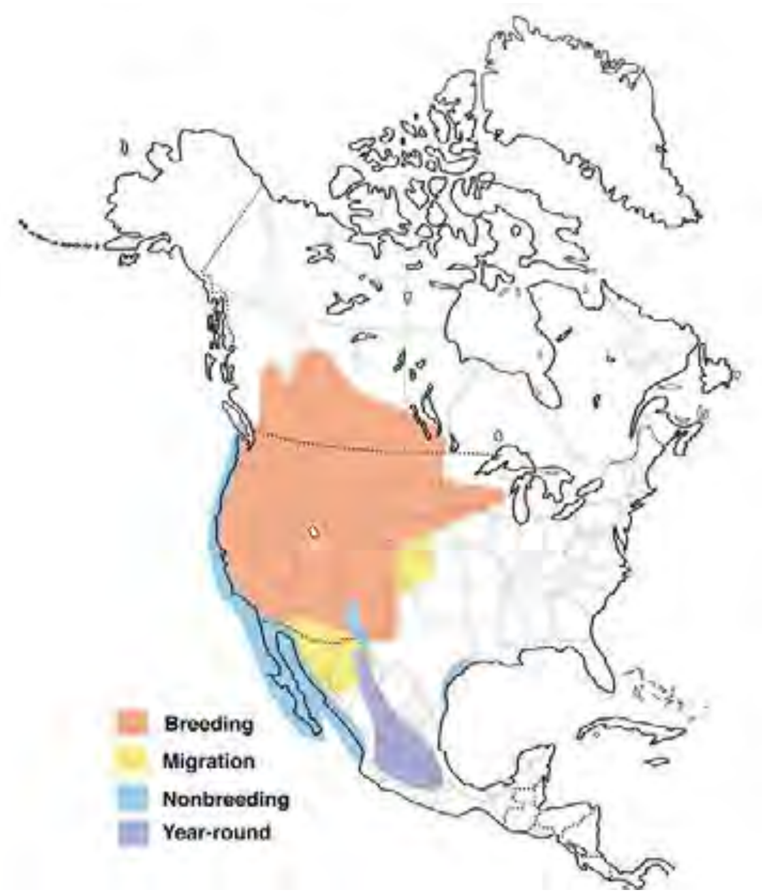

Figure 2: North American range of *Aechmophorus clarkii*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

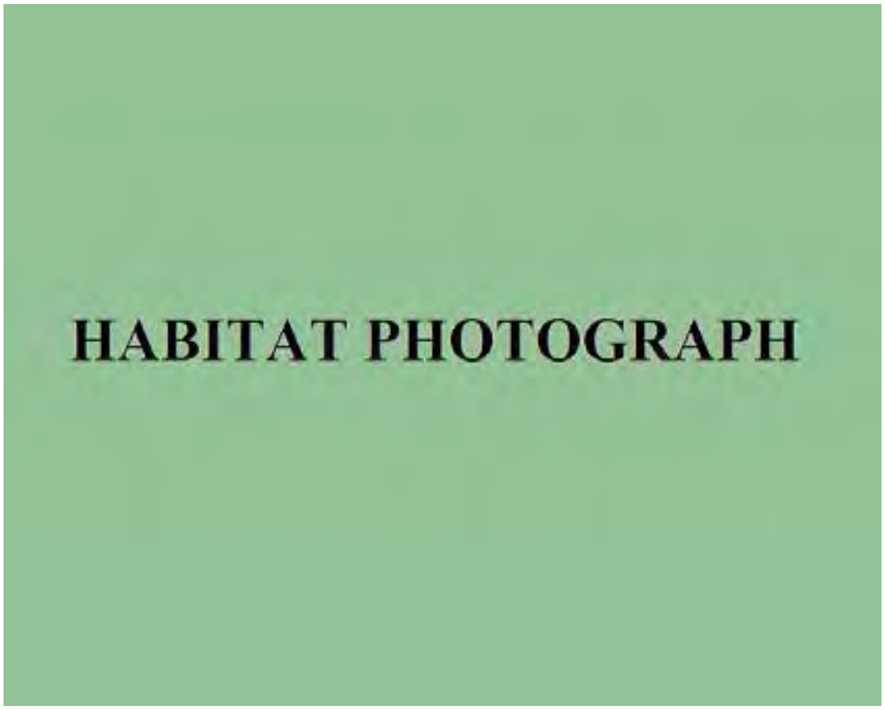

Figure 3: Photo not available.

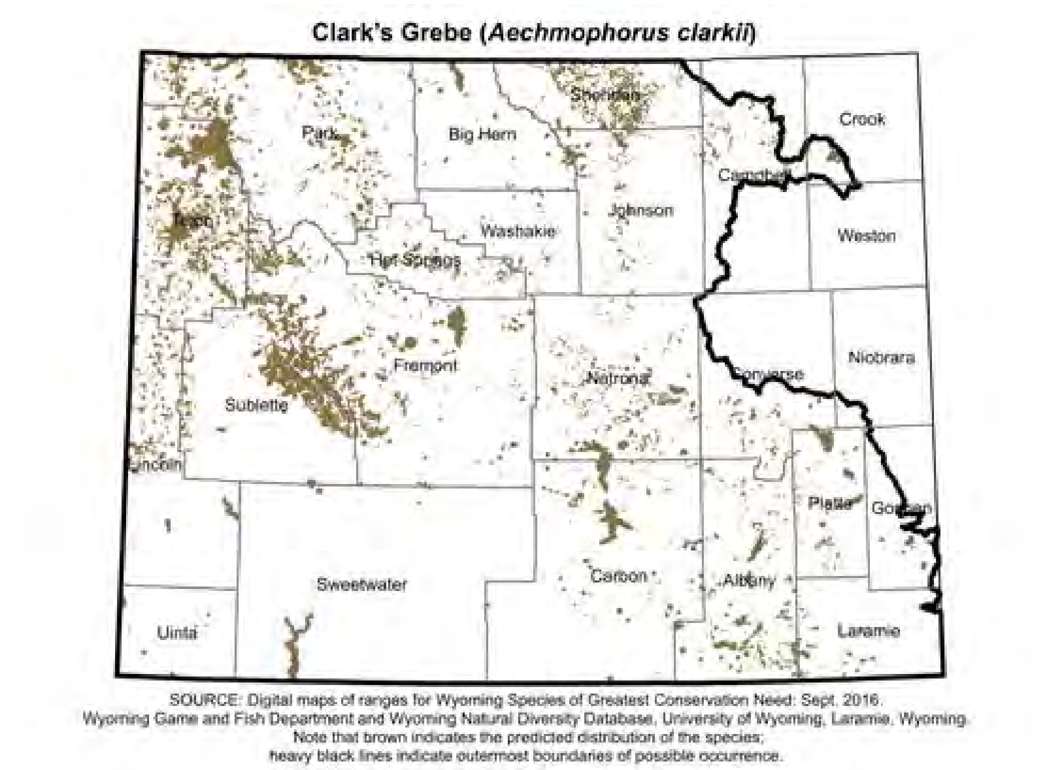

Figure 4: Range and predicted distribution of *Aechmophorus clarkii* in Wyoming.

Clark's Nutcracker
Nucifraga columbiana

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: No special status
UWFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS4 (Bc), Tier II
WYNDD: G5, S3S4
Wyoming contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 10

STATUS AND RANK COMMENTS
The Wyoming Natural Diversity Database has assigned Clark's Nutcracker (*Nucifraga columbiana*) a range of state conservation ranks due to uncertainties in actual abundance within the state and the severity of extrinsic stressors.

NATURAL HISTORY
Taxonomy:
Clark's Nutcracker is the only North American bird in the genus *Nucifraga*. The Spotted Nutcracker (*N. caryocatactes*) is the only other species in the genus, but is completely restricted to Eurasia [1]. No subspecies of Clark's Nutcracker are recognized. Recent work has confirmed that populations are not highly differentiated across their range, likely a result of gene flow from periodic mass irruptions that swamp local adaptation except in peripheral populations [2].

Description:
Clark's Nutcracker is a jay-sized corvid associated with conifer forests. It has crow-like features (e.g., rounded head and short tail) and flight characteristics [1]. Sexes are similar in appearance, with males slightly larger than females. Plumage is primarily light to medium gray; wings are black with large white patches on the secondary flight feathers. Center of the tail is black, outlined by white outer feathers. Contrast between the white and black feathers on the wings and tail is striking in flight. The bill is long, pointed, and black with short nasal bristles; legs and feet are also black. The species has a unique sublingual pouch located below the tongue for carrying seeds. The distinctive guttural calls can be heard at great distance. Clark's Nutcracker is distinctive in appearance and not easily confused with other species. Gray Jay (*Perisoreus canadensis*) is most similar in appearance and habitat, but can be easily distinguished by its dark gray wings, lack of white on the wings and tail, and much shorter bill. Juvenile Clark's

Nutcracker is buffy gray and fluffy, often with dull black or brown wings. First-year birds are indistinguishable from adults by July.

Distribution & Range:
Clark's Nutcracker is widespread in Wyoming, with confirmed or circumstantial evidence of breeding in all but 4 latitude/longitude degree blocks [3]. It is found in conifer forests in all major mountain ranges in the state, but wanders widely during winter, even into urban areas where it frequents bird feeders (S. Patla, pers. obs.) [4]. Clark's Nutcracker breeds below the subalpine zone, but moves to higher elevations post-nesting when its preferred food of Whitebark Pine (*Pinus albicaulis)* seeds are abundant [5]. The species' continental range extends from central British Columbia and southwestern Alberta south through the Rocky Mountains to central Arizona and New Mexico, and as far west as California and Washington. An isolated, stable population exists in Nuevo Leon, Mexico. Large irruptions occur in some years in response to simultaneous cone crop failures of major seed sources with many birds moving to new areas both within and beyond the expected range [1, 6].

Habitat:
Clark's Nutcracker breeds in a variety of forest habitats from the lower montane to the subalpine zone, including pinon-juniper woodlands (*P. edulis, P. monophylla,* and *Juniperus* spp.), Ponderosa Pine (*P. ponderosa*), Douglas-fir (*Pseudotsuga menziesii*), Jeffrey Pine (*P. jeffreyi*), and mixed coniferous subalpine communities which include Whitebark or Limber Pine (*P. flexilis*) [1]. The bird is an important seed disperser for many conifer species, especially Whitebark Pine, which is an obligate mutualist and depends entirely on the nutcracker for regeneration [7, 8]. Nutcrackers store excess conifer seeds when available in fall in thousands of individual seed caches to be retrieved later in the year. Cached seeds are important for both winter survival and spring breeding [7, 9]. Preferred habitat varies geographically, and size of home ranges varies by season, available seed crops, and breeding status [1, 5, 10]. Both altitudinal and latitudinal migrations occur in response to fluctuating conifer seed crops [1, 6, 10]. In western Wyoming, breeding and nonbreeding Clark's Nutcrackers strongly selected for Douglas fir habitat with home range size averaging 101 ha ± 23 ha for breeders compared to 202 ha ± 53 ha for nonbreeders [5]. In the Cascade Range of Washington, resident birds used mixed conifer (Ponderosa Pine, Douglas-fir) and Whitebark Pine habitat through the summer and then extended their ranges to forage in lower elevation areas after mid-September [10]. Summer habitat used in the subalpine zone throughout the western U.S. includes open to semi-open stands of shrubby Whitebark or Limber Pine often mixed with fir, spruce, or other pines growing on steep, rocky hillsides or on ridges interspersed with moist meadows, small lakes, and creeks with birds migrating to lower elevation areas in winter and spring [1]. In winter Clark's Nutcracker uses generally similar habitats but often increases use of lower elevations to avoid deep mountain snow [1].

Phenology:
Breeding begins in the second winter, and pairs remain together year-round [9]. Clark's Nutcracker breeds exceptionally early, with courtship beginning in January and nest building starting in early March [1, 5, 9]. Eggs are laid in March and April; clutches range from 2–5 eggs. Both males and females develop incubation patches, but females spend more time on the nest. Incubation lasts 18–22 days. Nestlings remain in the nest for 20 days, and fledge in April and May. Young remain dependent on parents through mid-August. Birds that nest at lower elevations will travel to subalpine elevations in late summer to collect and cache seeds, sometimes traveling > 30 km [11]. Within the same population some birds may migrate altitudinally while others remain year-

round on stable home ranges [10]. Severe cone crop failures cause many birds to wander widely in search of food and new ranges, resulting in Clark's Nutcracker appearing in unusual habitats well outside of its normal distribution [1]. In years with low Whitebark Pine cone production and high snow pack, a population of Clark's Nutcrackers was found to forgo reproduction completely but remained in the same breeding area in western Wyoming [12].

Diet:
Clark's Nutcracker is a conifer seed specialist, and its diet year-round consists mainly of fresh and stored pine seeds [1]. Nestlings and fledglings are also fed stored seeds. Seed sources vary geographically and seasonally. In the Northern Rocky Mountains, Whitebark, Limber, and Ponderosa Pines and Douglas-fir are the most commonly used species, with the latter species possibly being especially important in areas where large-seeded pines are declining [1, 5]. Birds collect seeds directly from cones and transport uneaten seeds in the sublingual pouch to multiple cache sites in litter, soil, logs, stumps and similar structures [1]. Clark's Nutcracker also opportunistically feeds on insects, small mammals, and carrion throughout the year [13, 14]. Main insect orders eaten include Coleoptera (beetles), Hymenoptera (bees and ants), Orthoptera (grasshoppers and crickets), Lepidoptera (moths and butterflies), Diptera (flies), Plecoptera (stone flies), and Homoptera (leafhoppers) [13]. Invertebrates may comprise a more important part of the breeding season diet than previously documented [5].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: UNCOMMON
Using North American Breeding Bird Survey (BBS) data, the Partners in Flight (PIF) Science Committee estimated the global population of Clark's Nutcracker to be 230,000 birds [15]. Extrapolation suggests approximately 14.5% of the global population, or around 30,000 birds, could breed in Wyoming [16], but this estimate should be viewed with caution. The species' habit of concentrating in areas of high food availability makes precise abundance estimation especially difficult. The statewide rank of UNCOMMON is based on the limited area of the state known to be occupied in any given season, and the relatively small coverage of suitable habitat within that area. However, within suitable habitat in the occupied area, Clark's Nutcracker appears to be common and is usually encountered during surveys that could be expected to indicate its presence [3]. Clark's Nutcracker density (number of birds per square km) and population size estimates for Wyoming are available from the Integrated Monitoring in Bird Conservation Regions (IMBCR) program for the years 2009–2015 [17].

Population Trends:
Historic: UNKNOWN
Recent: MODERATE DECLINE
There are no reliable data from which to infer historic population trends for Clark's Nutcracker. The species' habits of concentrating in areas of high food availability and variable reproductive output depending on food availability makes trend estimation especially difficult. Data from the IMBCR effort suggest a possible population decline over the past seven years, but may not yet be complete enough to use for robust trend estimation. Data from the BBS suggest a statistically insignificant moderate decline of 0.83 annually (N = 46 routes, 95% CI: -3.36–1.15) from 1968–

2013 [18]. Population declines in Glacier National Park and the Cascade Mountains of Washington have been reported [18].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Clark's Nutcracker uses all available conifer habitats in Wyoming, especially at higher elevations, but breeding success appears to depend upon the availability of seeds from preferred conifers [1, 12]. Clark's Nutcracker's relies on Whitebark Pine as a primary food source for feeding young in early spring with seeds that had been cached the previous autumn [1]. It is assumed that Limber Pine, Ponderosa Pine, and Douglas Fir perform this role in portions of Clark's Nutcracker range where Whitebark Pine does not occur (e.g., southern Wyoming). Nutcrackers remember cache sites for 7 to 9 months, and remaining seeds are subject to spoilage, germination, or robbery by other species; thus, caches from years with high cone crops cannot supplement the diet during low cone years [19]. In two low cone production years out of a five year study in the Greater Yellowstone Ecosystem (GYE), Clark's Nutcracker failed to breed [12].

Extrinsic Stressors:
MODERATELY STRESSED
Although Clark's Nutcracker is capable of dispersing widely, the ecosystems, and particularly the conifer species, upon which the bird depends are currently under threat. Widespread mortality of Whitebark Pine and Limber Pine as a result of White Pine Blister Rust (*Cronartium ribicola*) and Mountain Pine Beetle (*Dendroctonus ponderosae*) outbreaks are likely to reduce breeding populations of nutcrackers in Wyoming and the region for many decades. Global climate change may be exacerbating these effects – Whitebark Pine is only weakly adapted to resist bark beetles, and increasing minimum winter temperatures at high elevations have allowed beetle outbreaks to extend upwards into Whitebark Pine forests resulting in heavy tree mortality and, presumably, significant reductions in habitat quality for Clark's Nutcracker [20, 21]. Advanced forest succession at high elevations as a result of decades of fire suppression may have also depressed populations of preferred pines [1, 12]. Long-term BBS data suggest that some populations are declining even in relatively protected and pristine areas such as Glacier National Park [12, 18]. Clark's Nutcracker is a major disperser of Whitebark Pine seeds, enabling rapid migration of seeds and genes across landscapes [11, 22]. Declines in nutcracker populations may thus have long-term, significant ecosystem-wide effects on conifer communities in the Rocky Mountain west [12, 23].

KEY ACTIVITIES IN WYOMING

Clark's Nutcracker is classified as a Species of Greatest Conservation Need (SGCN) by the Wyoming Game and Fish Department, and a Wyoming PIF Level III Priority Species due to restricted habitat distribution and the need for long-term viability of Whitebark and Limber Pine forests [24]. Recent work includes a Cornell University Ph.D. dissertation on Clark's Nutcracker in the GYE in 2015 and 2016 [5, 12]. Eight Clark's Nutcrackers were marked with satellite transmitters in fall 2014; work continues on tracking their long distance movements and collecting additional data on habitat trends and occupancy in the Greater Yellowstone study area (T. Schaming, pers. comm.) [5, 12]. Working with numerous partners, the U.S. Forest Service (USFS) has developed a long-term, region-wide strategy for restoring Whitebark Pine, which is currently a candidate for listing under the federal Endangered Species Act [25].

ECOLOGICAL INFORMATION NEEDS

Standardized, long-term monitoring and occupancy data for different habitat types and areas of the state are needed for Clark's Nutcracker. Long-term demographic data are needed on annual survivorship of different age classes, annual reproductive success, and how changes in food availability and climate affect these variables. Additional studies on nutcracker/ pine mutualism would be beneficial. Clark's Nutcracker concentrates in areas where food is abundant, making accurate censusing a challenge [1]. In general, research that provides clear and effective management recommendations for protecting and enhancing the population viability of Whitebark and Limber Pine will enhance the ability of resource managers to benefit Clark's Nutcracker.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Susan M. Patla. Clark's Nutcracker is classified as a SGCN in Wyoming due to drought, disease and climate change that affect its preferred habitat. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming. The first is the long-term BBS started in Wyoming in 1968 with 108 established routes [18]. The IMBCR program was established in 2009 in Wyoming with many state, federal, and nongovernmental organization partners that contribute funding, field personnel, technical assistance, or in-kind services. Data analyses produce density, occupancy, and population estimates at various scales; present habitat associations; and provide decision support tools for managers [17]. Best management practices to benefit Clark's Nutcracker include maintaining and restoring mature Whitebark and Limber Pine forests, and using forest management techniques that favor mature stands of these species to ensure abundant food [24]. The USFS has developed a restoration strategy for Whitebark Pine that can provide guidance for future work on Forest Service lands [25]. Whitebark Pine Ecosystem Foundation, a nonprofit focused on Whitebark Pine conservation and restoration, publishes a biannual newsletter "Nutcracker Notes", with updates on news, projects, and ongoing research related to Whitebark Pine: http://whitebarkfound.org/?page_id=408. Recent work has highlighted the importance of Douglas-fir as an alternative seed source and of providing year-round habitat for Clark's Nutcracker, especially in areas where Whitebark Pine has declined significantly in western Wyoming [12]. Landscape level management of Whitebark Pine restoration should be optimized by focusing restoration efforts on locations adjacent to a mosaic of habitats which specifically include Douglas-fir [12].

CONTRIBUTORS

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Figure 1: Adult Clark's Nutcracker in Albany County, Wyoming. (Photo courtesy of Pete Arnold)

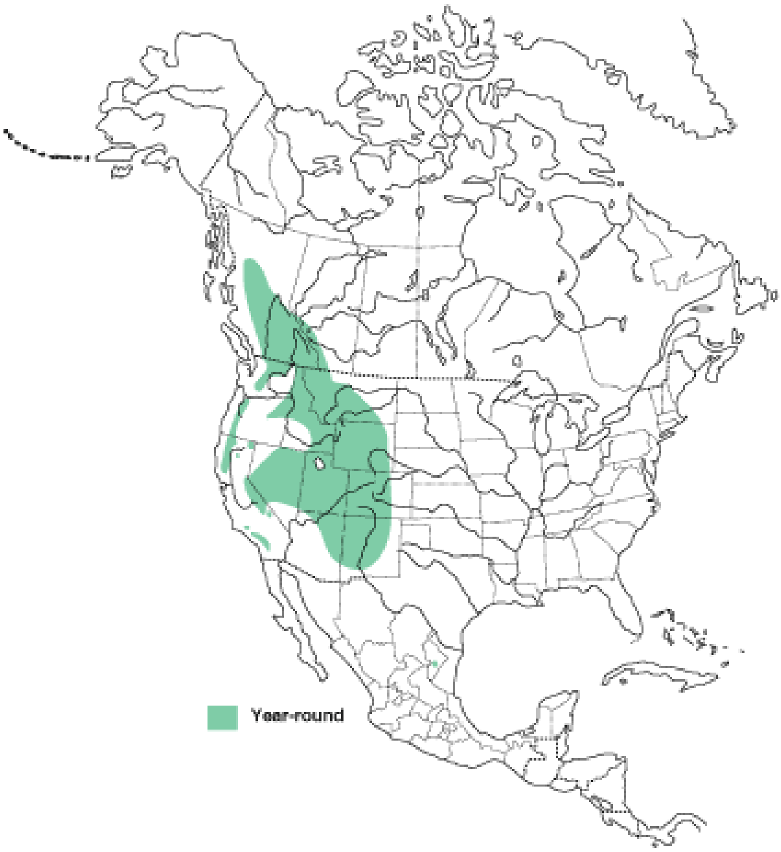
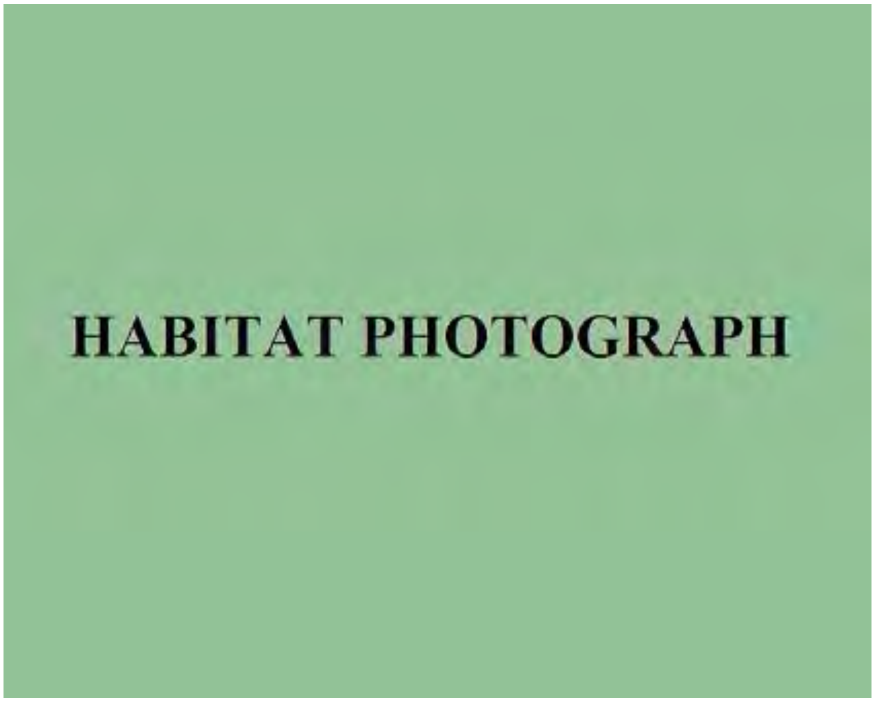


Figure 2: North American range of *Nucifraga columbiana*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)



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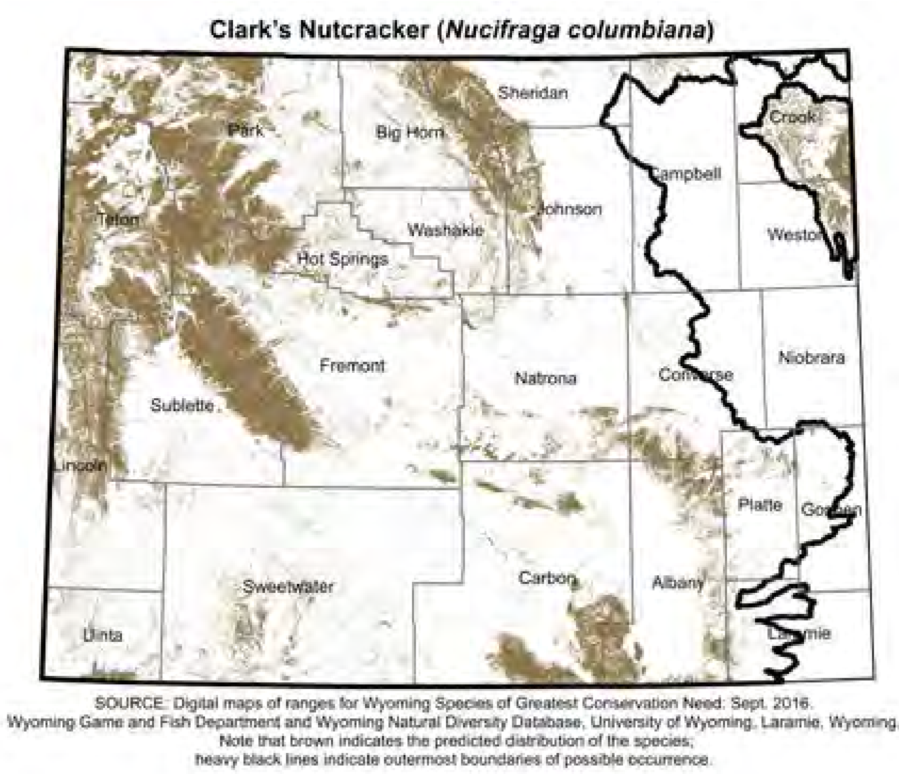

Figure 4: Range and predicted distribution of *Nucifraga columbiana* in Wyoming.

Columbian Sharp-tailed Grouse

Tympanuchus phasianellus columbianus

REGULATORY STATUS

USFWS: Listing Not Warranted
USFS R2: Sensitive
USFS R4: Sensitive
Wyoming BLM: Sensitive
State of Wyoming: Game Bird (see regulations)

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS4 (Cb), Tier II
WYNDD: G4T3, S1
Wyoming Contribution: HIGH
IUCN: Not evaluated
PIF Continental Concern Score: Not ranked

STATUS AND RANK COMMENTS

Two petitions to list Columbian Sharp-tailed Grouse (*Tympanuchus phasianellus columbianus*) under the Endangered Species Act have been filed with the U.S. Fish and Wildlife Service in the recent past. The Service most recently determined the subspecies was not warranted for listing in 2006 [1].

NATURAL HISTORY

Taxonomy:

There are currently seven recognized subspecies (1 extinct) of Columbian Sharp-tailed Grouse in North America [1]. Recent genetic studies have found that Sharp-tailed Grouse in south-central Wyoming and northwest Colorado are genetically different from both the Columbian form farther west and the Plains (*T. p. jamesi*) form in the Great Plains; south-central Wyoming birds were most similar to the Plains form [2]. Until taxonomy is assessed more completely, Sharp-tailed Grouse occurring west of the Continental Divide in Wyoming are considered Columbian Sharp-tailed Grouse. Hybridization between Columbian Sharp-tailed Grouse and Greater Sage-Grouse (*Centrocercus urophasianus*) can occur when leks are in close proximity, as occurs in south-central Wyoming.

Description:

Columbian Sharp-tailed Grouse is a medium-sized grouse (41–47 cm total length; 596–1,031 g body mass) [3]. Males are slightly larger than females, but otherwise both sexes are similar with round bodies, short legs, short crests, and elongated central rectrices. Plumage is mostly drab gray-brown, with darker brown (approaching black) barring on head, neck, back, and wings. Breast, belly, and undertail coverts are white, and primaries have conspicuous white spots. Both males and females have a yellow-orange, crescent-shaped comb over each eye. Males expose and inflate pale violet air sacs on each side of neck during mating displays. Males also have linear marks on the central rectrices, whereas females have barred central rectrices [3]. The distinctive pointed tail, V-shaped marks on the upper belly feathers, and white spots on the upper surface of the wing feathers separate Sharp-tailed Grouse from Greater Sage-Grouse and Dusky Grouse (*Dendragapus obscurus*). Columbian Sharp-tailed Grouse is the smallest and darkest of all 7 subspecies of *T. phasianellus*, with more pronounced spotting on the throat and narrower underside markings [1].

Distribution & Range:
Various historical accounts indicate that Columbian Sharp-tailed Grouse was once much more abundant throughout its range where suitable habitats occurred [1]. Past declines in the subspecies' abundance and distribution have isolated various extant populations. However, at large geographic scales (e.g., states, ecoregions), the overall range of Columbian Sharp-tailed Grouse appears to have changed little since the mid-1900s [1]. Past reports suggested the range for Columbian Sharp-tailed Grouse may have declined by up to 90% in Wyoming [1] but recent updates to the sub-species distribution map more thoroughly considered historic observations and habitats, and ultimately removed the Red Desert and most of the Upper Green River Basin from previously delineated historic habitat. Columbian Sharp-tailed Grouse is endemic to Big Sagebrush (*Artemisia tridentata*), shrub-steppe, mountain shrub, and riparian shrub plant communities in western Wyoming and other western states. Columbian Sharp-tailed Grouse occupies two locations in Wyoming. One small population occupies the southeastern corner of Grand Teton National Park, in a portion of the subspecies' former range from which it was extirpated in the 1940s. Presumably, this population (one small lek) is the result of range expansion from a population in Teton Valley, Idaho. The second population is much larger and occupies the Little Snake River drainage in south-central Wyoming. As of 2016, there are over 30 leks in this small but robust sub-population, which is a northward extension of a much larger population that inhabits northwest Colorado.

Habitat:
Columbian Sharp-tailed Grouse inhabits mountain-foothills shrub communities of serviceberry (*Amelanchier* spp.), snowberry (*Symphoricarpos* spp.), Chokecherry (*Prunus virginiana*), and Gambel Oak (*Quercus gambelii*); sagebrush-grassland; and willow (*Salix* spp.)-riparian habitats [4]. In Wyoming, it prefers mountain-foothills shrub and sagebrush-snowberry habitats in the transitional zone between sagebrush-grass and forested habitats [5]. Leks are the hub of breeding activity and are typically located in relatively flat areas with low and sparse vegetation, such as knolls, ridgetops, or benches that allow good visibility [6]. Nests are located within 2 km (1.2 mi) of the lek in relatively tall and dense residual vegetation from the previous year [4]. Brood-rearing areas contain a mosaic of dense shrubs and grasses with rich forb and insect foods, usually in mountain-foothills shrub or sagebrush-snowberry habitats [7]. These areas must be structured so chicks can easily move through the vegetation. During winter, Columbian Sharp-tailed Grouse relies on riparian areas and other sites within 6.4 km (4 mi) of the breeding complex with deciduous trees and shrubs for feeding, roosting, and escape cover [4]. Columbian Sharp-tailed Grouse also uses dense agronomic grasslands and old hay meadows, and populations have responded positively to the Conservation Reserve Program that set aside former agricultural lands in Colorado and Idaho [4].

Phenology:
Columbian Sharp-tailed Grouse is a year round resident in Wyoming with interchange between both Colorado and Idaho. Males display in the spring (April–May) to attract females to

communal dancing grounds called leks. Established leks may be used for many years, although their precise locations may shift over time. After breeding, females build nests under shrubs or grasses, typically within 2.0 km of the lek where they were bred and within good brood rearing habitat [4]. Hens incubate eggs for 21–24 days. Re-nesting often occurs if the first nest is abandoned or depredated [4]. Clutch size typically ranges from 10–12 [4]. After hatching, chicks remain with their mothers in broods for 6–8 weeks. Columbian Sharp-tailed Grouse remains in shrub-steppe habitats until the onset of snow, when it forms small flocks and moves to either riparian or mountain shrub communities where vegetation remains exposed. Columbian Sharp-tailed Grouse is believed to have a life span of up to three years [4].

Diet:
Adult Columbian Sharp-tailed Grouse mainly eat plant materials, changing from forbs, grasses, fruits and seeds in summer to the buds and fruits of deciduous trees and shrubs in winter [4]. Insects are a minor component of adult Columbian Sharp-tailed Grouse diet; however, chicks feed almost exclusively on insects during their first 2–3 weeks of life [4].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD BUT PATCHY
Wyoming: RARE
In 2015, a total of 710 Columbian Sharp-tailed Grouse were counted on 25 leks across Wyoming. 704 (both males and females) of these grouse were located in the Little Snake River area of occurrence across 24 counted leks, while only 6 grouse (males only) were counted in the Jackson portion of the population. Although rare at a statewide scale and within Jackson Hole, the subspecies is considered common within the Little Snake River area of occurrence.

Population Trends:
Historic: LARGE DECLINE
Recent: INCREASE
Past reports suggested the range for Columbian Sharp-tailed Grouse may have declined by up to 90% in Wyoming [1], but recent assessments more thoroughly considered historic observations and habitats, and ultimately removed the Red Desert and most of the Upper Green River Basin from previously delineated historic habitat. Populations of Columbian Sharp-tailed Grouse in Wyoming are monitored only through raw lek counts. This technique has limitations based on number of leks counted each year and weather. Despite this uncertainty, indications are that populations in south-central Wyoming are increasing. The highest number of grouse counted on leks in this area prior to 2015 was 354 in 2005. The population in the Jackson area is small but stable. Since 2010 male counts on the lek have ranged from 4–10 with an average of 6.

Intrinsic Vulnerability:
LOW VULNERABILITY
There are few intrinsic stressors to Columbian Sharp-tailed Grouse in Wyoming. One potential stressor may be the overlap in habitat with Greater Sage-Grouse in the Little Snake River center of occurrence [5]. Currently 9 Columbian Sharp-tailed Grouse leks fall with the South Rawlins Greater Sage-Grouse core area. The potential for competition for nesting and brood rearing habitat between the two species is high. There is also potential for hybridization, with many Columbian Sharp-tailed Grouse leks located close to Greater Sage-Grouse leks.

Extrinsic Stressors:
MODERATELY STRESSED
Threats to Columbian Sharp-tailed Grouse populations in Wyoming and range wide are primarily from degradation, fragmentation, and loss of habitat. Given the potential for more industrial development in Wyoming, increased loss and fragmentation of Columbian Sharp-tailed Grouse habitat is likely [4]. While Sharp-tailed Grouse appear to adapt to human disturbance better than other species of prairie grouse [4], very few studies have assessed the impact of industrial development on Columbian Sharp-tailed Grouse [4]. The few such studies in existence have mainly involved reclaimed coal mines, and thus are not relevant to the occupied areas within Wyoming. A majority of impacts will be from oil and natural gas development within the Little Snake River area. As energy developments, including wind energy, increase within this area it will be important to closely monitor Columbian Sharp-tailed Grouse populations. Effects from prescribed and wildfire vary with site conditions and are not well understood [4]. The effects of livestock grazing are complex and often contentious, but managing grazing to maintain long-term stability of Columbian Sharp-tailed Grouse habitat as well as viable ranching operations is a realistic goal [4].

KEY ACTIVITIES IN WYOMING
In 2015, the Wyoming Game and Fish Department, Bureau of Land Management (BLM) and the University of Wyoming modeled the relative probability of lek occurrence within the known distribution of Columbian Sharp-tailed Grouse in the state to assist in locating previously undocumented leks. That work located 6 previously undocumented Columbian Sharp-tailed Grouse leks in south-central Wyoming [8]. This research is part of a new focus on the Little Snake River population, and new projects involving radio-tagging and genetics have recently been proposed and partially funded by the BLM.

ECOLOGICAL INFORMATION NEEDS
Knowledge of Columbian Sharp-tailed Grouse distribution and seasonal habitat use in Wyoming is limited. There is a strong need to determine the response of Columbian Sharp-tailed Grouse to human activities, including energy development. There is also a need to determine the genetic status of the birds in the Little Snake River area and adjacent northwestern Colorado to more confidently distinguish them from, or group them with, the Plains or Columbian sub-species as they are currently understood.

MANAGEMENT IN WYOMING
This section authored solely by WGFD; Tony Mong. Current management activities focused on Columbian Sharp-tailed Grouse involve collecting better population demographic data and genetic identity of the Little Snake River population. Information on demographics of the Wyoming populations is currently non-existent, which has led to a lack of management specifically for this subspecies. As energy development increases in occupied areas it will be necessary to have solid baseline data to understand the impacts. In addition, there has been much discussion regarding hunting the Little Snake River population. Although a very limited season is possible, understanding the demographics of the population will allow for more confident establishment of any future harvest regulations. As previously mentioned, recent genetic research suggests Sharp-tailed Grouse in northwestern Colorado and south-central Wyoming may be somewhat unique from populations farther to the west and east. This genetic situation needs to be

better understood in order to determine future management activities and proper conservation status.

CONTRIBUTORS

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Tom Christiansen, WGFD
Gary P. Beauvais, WYNDD

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Figure 1: Adult male Columbian Sharp-tailed Grouse in Carbon County, Wyoming. (Photo courtesy of Gary Sundberg)

Figure 2: Historic and current distribution (includes translocation sites) of *Tympanuchus phasianellus columbianus* in western North America. (Map updated and modified from: Stinson, D. W., and Schroeder, M. A. (2012) Washington state recovery plan for the Columbian Sharp-tailed Grouse. Washington Department of Fish and Wildlife, Olympia, USA.)

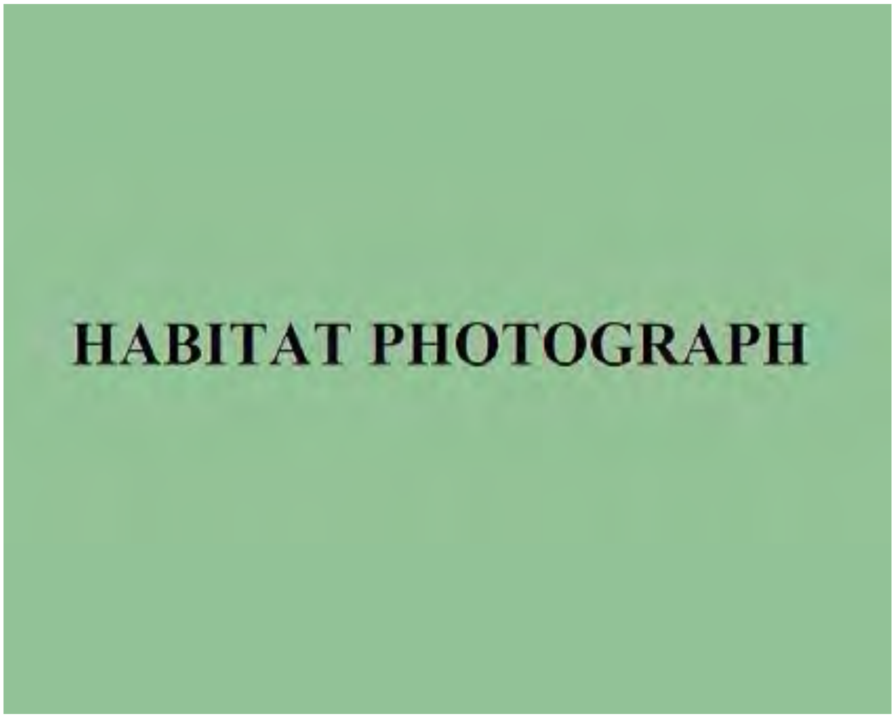

Figure 3: Photo not available.

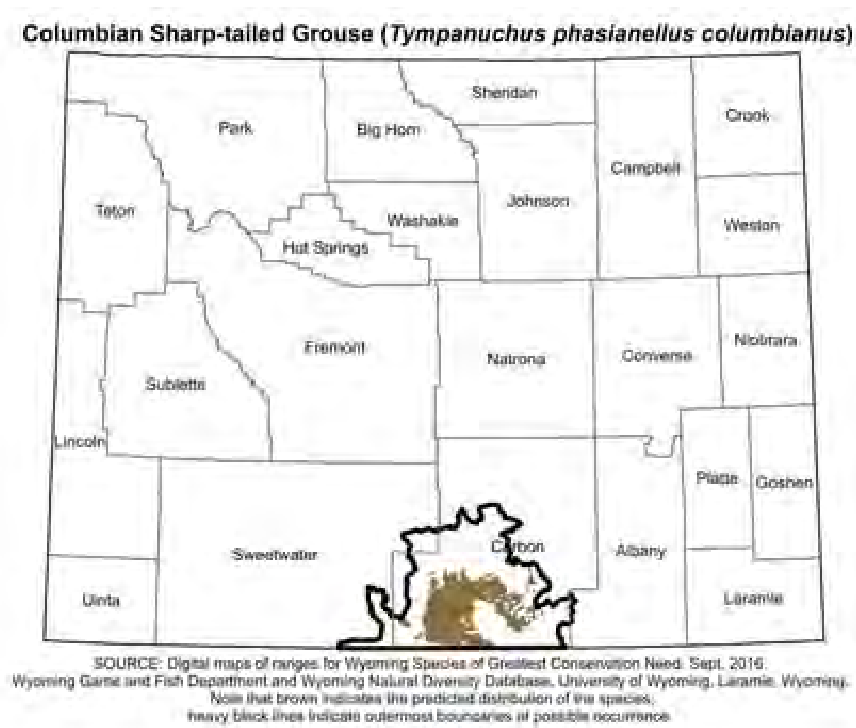

Figure 4: Range and predicted distribution of *Tympanuchus phasianellus columbianus* in Wyoming.

Figure 5: Male Columbian Sharp-tailed Grouse displaying on a lek in Carbon County, Wyoming. (Photo courtesy of Jacob Hennig)

Common Loon
Gavia immer

Regulatory Status
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: Sensitive
Wyoming BLM: No special status
State of Wyoming: Protected Bird

Conservation Ranks
USFWS: No special status
WGFD: NSS1 (Aa), Tier I
WYNDD: G5, S1B/S3N
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: Not ranked

Status and Rank Comments
The Wyoming Natural Diversity Database has assigned Common Loon (*Gavia immer*) a state conservation rank for both the breeding and non-breeding season because the species has a broader state range, lower intrinsic vulnerability, and lower extrinsic stressors during migration than during the breeding season.

Natural History

Taxonomy:
There are no recognized subspecies of Common Loon [1, 2].

Description:
Identification of Common Loon is possible in the field. Common Loon is a large waterbird, slightly larger than largest ducks. Males and females are identical in appearance, though males are larger than females. Adults range from 66–91 cm in length. During the breeding season, the bill, head, neck, back, wings, and sides are black. The belly and breast are white. The wings have rectangular white markings. The neck has two white patches, one nearly circling the neck at the base, and another higher on the neck just below the chin. These white patches have fine, black, vertical striping. Juveniles, sub-adults, and wintering birds have gray to gray-brown upperparts, a white to grayish-white throat, and a gray bill [1, 3]. There are no similar species during the breeding season in Wyoming.

Distribution & Range:
The breeding range of Common Loon includes most of Canada, northern portions of the United States, and limited areas outside of North America. The only breeding population in Wyoming is found in the northwestern portion of the state. This population is isolated from the remainder of the species' range by over 320 km [4]. A few non-breeding adults are often found statewide during the breeding season and numbers of migrants that nest farther to the north pass through the state

in both spring and fall [5]. Most Common Loons migrate to coastal areas for the winter. Range contractions have occurred across southern portions of the breeding range, with local extirpations occurring in some areas. Recent range expansions have occurred in northeastern North America. The species has also recolonized areas where it was previously extirpated, such as Idaho [1, 6].

Habitat:
During the breeding season, Common Loon uses freshwater lakes and ponds [1, 4]. The species prefers lakes with clear water, and numerous small islands, which are used for nesting. Streams are generally avoided but oxbows with minimal current may be used [1]. Water bodies must be at least 2 m deep, and are generally free of human disturbance [7]. Habitat preference has not been studied in Wyoming. In Wyoming, the only known breeding locations are in and around Yellowstone and Grand Teton National Parks [1, 4, 7]. In winter, the species is generally found along coastal waterways in coves, channels, bays, and open ocean, and on large, slow moving rivers [1]. One female adult from Wyoming tagged with a geolocator wintered around the southern end of the Baja Peninsula [4].

Phenology:
Spring migration of Common Loon in Wyoming occurs from mid-April to early May [5]. Incubation averages 28 days. Fledging occurs past 10 weeks [1]. While actual dates of nesting events are not known in Wyoming, adults with young are expected by July [8]. Fall migration occurs in September and October. Migration continues until lakes in the state freeze over [5].

Diet:
Diet of Common Loon is primarily comprised of live fish. In Wyoming, fish species composition of the diet is not known. In other portions of Common Loon range, Yellow Perch (*Perca flavescens*), Pumpkinseed (*Lepomis gibbosus*), and Bluegill (*L. macrochirus*) are most frequently taken. Crustaceans are sometimes eaten [1]. Some loons in Wyoming nest in lakes that are fishless or have low fish populations suggesting that amphibian and invertebrate prey may be important at these sites [4].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
Common Loon has a widespread breeding distribution in northern North America, but breeding pairs are very rare in the western United States and Wyoming. In 2013, a total of 105 territorial pairs were recorded across Montana, Washington, Wyoming, and Idaho; the Greater Yellowstone Ecosystem (GYE) of Wyoming supported 14 of those breeding pairs as well as 8 unpaired adults [9]. In 2015, a total 17 territorial pairs were documented in the GYE [4]. From 1968–2015, annual Wyoming Breeding Bird Survey (BBS) detections of Common Loon ranged from 0 to 3, with none recorded in most years [10]. Common Loon was not detected during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [11]. While surveys conducted as part of the BBS and IMBCR programs may occasionally detect this species, neither is specifically designed to capture loon observations. Recent surveys in the Wind River Range of Wyoming documented a few resident loons in the breeding season which suggest that habitat could support a breeding population [4].

Population Trends:
Historic: UNKNOWN
Recent: MODERATE DECLINE
Annual monitoring from 1987–2013 indicate that Common Loon populations are declining in Wyoming [9]. Number of nesting pairs increased slightly however in 2014 and 2015 [4]. Wyoming trend data from the North American BBS suggest that Common Loon experienced annual declines from 1968–2013 and from 2003–2013, but these state estimates have low credibility and are not statistically significant [12]. Survey-wide trend data from the North American BBS indicate that Common Loon numbers increased by 0.72% annually from 1966–2013 and 1.12% annually from 2003–2013; however, neither trend estimate was statistically significant [12].

Intrinsic Vulnerability:
HIGH VULNERABILITY
The Common Loon breeding population in Wyoming is extremely small and isolated from other populations making it vulnerable to extirpation [4]. Availability of breeding habitat in Wyoming is also limited and may be declining [13]. Lakes of at least 24 ha are typically used for breeding. Lakes smaller than 24 ha may be used by the species, but are typically part of a larger territory that includes other lakes and ponds. Additionally, lakes must be free of ice for at least four months of the year, and have clear, unpolluted water with some emergent vegetation [1, 4, 6]. The species is unlikely to occupy new habitats because it has high site fidelity and low rates of dispersal [4]. Common Loon may also be limited by low fecundity. Specifically only one or two young are raised each year. Additionally, successful breeding does not normally occur until individuals are at least three years of age [1].

Extrinsic Stressors:
HIGHLY STRESSED
Common Loon is very sensitive to human disturbance. Recreational activities such as boating, hiking, and fishing may cause nest abandonment or failure [1, 7]. Human disturbances may have led to reduced reproductive success on Loon and Moose Lakes in northwestern Wyoming [14]. The species may also be threatened by fluctuating water levels in lakes and reservoirs that may flood nests during runoff or increases in water storage. Reduced water levels may lead to nest abandonment and increased rates of nest predation [1]. Lead is often accidentally ingested by the species which may lead to reproductive failure or death [1]. Exposure to other contaminants such as heavy metals, synthetic chemicals, and cyanotoxins are of concern [1, 6]. Mortality of loons by entanglement in gillnets used to control invasive trout on Yellowstone Lake has been documented recently [4].

KEY ACTIVITIES IN WYOMING

Since 1987, Common Loon site occupancy and productivity surveys have been conducted annually by state and federal agencies in Wyoming. From these surveys, breeding attempts have been observed at a total of 28 lakes in the GYE [13]. Results from these surveys suggest declines in the number of breeding pairs and reduced productivity. However, these monitoring efforts have been somewhat inconsistent between the monitoring agencies and years. Starting in 2012, the Biodiversity Research Institute (BRI) initiated a 5-year, continent-wide conservation study funded by the Ricketts Conservation Foundation in partnership with state and federal agencies that includes a focused monitoring effort of the Wyoming breeding population [4]. Objectives of this project include monitoring occupancy and reproductive success at all existing loon territories, surveying potential breeding habitat, identifying anthropogenic threats to the species, and developing measures to restore and expand the Wyoming loon population [4]. In 2013–2105 nesting season, a total of 15 adults and 3 young have been captured and measured and sampled for genetics, stable isotope analysis, and health evaluation [4]. Health evaluation includes both blood and feather sampling for lead, mercury, infectious disease, hemoparasites, plasma biochemistry, and hematology. A Wyoming Common Loon Working Group has been formed that meets annually to review project findings and objectives (S. Patla, pers. comm.).

ECOLOGICAL INFORMATION NEEDS

Current work on Common Loons in Wyoming focuses on monitoring the breeding population in the northwestern portion of the state and surveying for additional pairs and suitable nesting habitat outside of the documented range [4]. The species is known to occur elsewhere in the state during the breeding season, but it is unknown if breeding occurs outside the GYE. Data currently being collected to fulfill existing information gaps include adult and juvenile survivorship, dispersal and migration movements; causes of nest failure; investigation of prey use; and evaluation of genetic and health status of this population.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Susan M. Patla. The Wyoming Game and Fish Department and Yellowstone National Park initiated surveys of Common Loon nesting pairs in northwestern Wyoming in 1987. Beginning in 2012, BRI began a comprehensive study of loons in Wyoming as part of a continent-wide conservation effort [4]. BRI is working with federal land management agencies and the state to expand monitoring efforts, to enact management actions including closures and deploying nest rafts where applicable to aid nesting loons, and to capture, sample, and band loons in the region. These efforts are increasing the understanding of the threats, wintering locations, health status and natural history of this breeding population. The Wyoming Loon Working Group (formed in 2013) meets on an annual basis to collaboratively work to understand and address the status, management, and future of the Wyoming loon population. Recommendations for future work include continued annual inventory and monitoring efforts of nesting pairs to track population status and determine causes of nest failure; additional survey work in other areas of the state that may support nesting pairs; investigation of translocation and other management strategies to possibly expand and increase the current extremely small breeding population; and continued data collection on habitat and prey requirements, health parameters, and winter/migration movements to aid conservation efforts. Existing nest sites should be managed to minimize the potential for degradation and disturbance given the high site fidelity of this species.

CONTRIBUTORS

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Figure 1: Adult Common Loon in breeding plumage in California. (Photo courtesy of Glen Tepke, http://www.pbase.com/gtepke/profile)

Figure 2: North American range of *Gavia immer*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Common Loon habitat, Leigh Lake in Grand Teton National Park, Wyoming. (Photo courtesy of Susan M. Patla, WGFD)

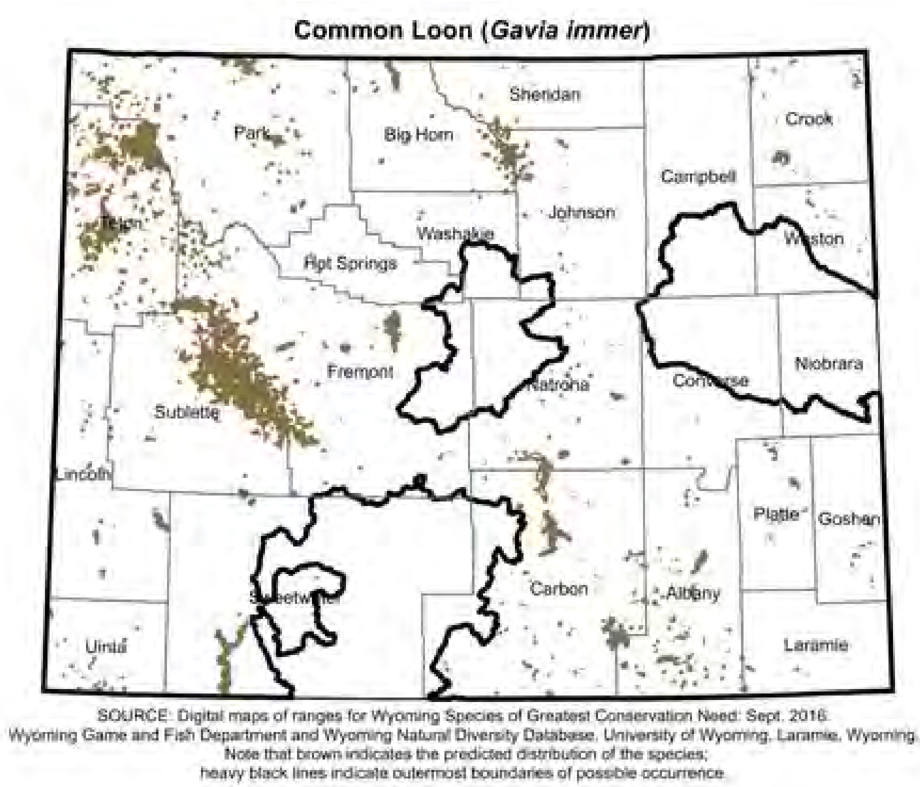

Figure 4: Range and predicted distribution of *Gavia immer* in Wyoming.

Figure 5: Adult Common Loon with young on Emma Matilda Lake in Grand Teton National Park, Wyoming. (Photo courtesy of Thomas Stanton, Jackson Hole Daily)

Common Nighthawk
Chordeiles minor

Regulatory Status
USFWS: Migratory Bird
USFS R2: No special status
UWFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

Conservation Ranks
USFWS: No special status
WGFD: NSS4 (Bc), Tier III
WYNDD: G5, S5
Wyoming contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 11

Status and Rank Comments
Common Nighthawk (*Chordeiles minor*) has no additional regulatory status or conservation rank considerations beyond those listed above. Interestingly, the species is listed as Threatened in Canada due to large-scale declines [1].

Natural History
Taxonomy:
Although the Order Caprimulgiformes may be polyphyletic, the Family Caprimulgidae is monophyletic. The taxonomic history of Common Nighthawk has included both lumping and splitting at both the species and subspecies level. Currently, 9 subspecies are recognized, 4 of which are or may be found in Wyoming [1]. Howell's Nighthawk (*C. m. howelli*) breeds throughout the state outside of Yellowstone National Park; Pacific Nighthawk (*C. m. hesperis*) breeds in western Wyoming; and Sennett's Nighthawk (*C. m. sennetti*) breeds in eastern Wyoming. The Common Nighthawk subspecies (*C. m. minor*) may also be found in eastern Wyoming during migration [2].

Description:
Identification of Common Nighthawk is possible in the field. Common Nighthawk displays geographic variation in plumage coloration and pattern as well as body size, with more northerly populations having larger bodies. Like other caprimulgids, Common Nighthawk is cryptically colored and has a large, flattened head; large eyes; small bill; and very large mouth. Common Nighthawk lacks rictal bristles. The wings are long and slender with an obvious white patch at the base of the primaries, which is very visible when in flight. Males have a white tail band and white throat; the throat patch is buffy and less obvious in females. Both sexes have a mixture of brown, black, and buffy barring on the rest of the body; juveniles look similar to adults but tend to be lighter in color overall [1]. The only other camprimulgid in Wyoming is Common Poorwill

(*Phalaenoptilus nuttallii*) [2, 3], which can be distinguished from Common Nighthawk by its smaller size, the presence of rictal bristles, and the lack of white wing patches [1]. The nasal *peent* call of Common Nighthawk is distinctive.

Distribution & Range:
The breeding range of Common Nighthawk is nearly continuous throughout North and Central America with the exception of Alaska; northernmost Canada; and southern California, Nevada, and Arizona. Breeding range throughout Central America is less understood, but the species is known to breed as far south as Panama. Similarly, wintering range remains poorly defined, but the species has been documented from Ecuador, Peru, and Brazil to Argentina, Paraguay, and Uruguay. The species has even been detected in western Europe on several occasions [1]. Common Nighthawk has been documented in all of Wyoming's 28 latitude/longitude degree blocks, with confirmed breeding occurring in all degree blocks [3].

Habitat:
Common Nighthawk uses a variety of nesting habitats, including logged, slash-burned, and open forests and clearings; grasslands and prairies; sagebrush; and rock outcrops [1]. In Wyoming, Common Nighthawk is most common below 2,600 m in elevation, and nests in low-elevation prairies in the east and open Ponderosa Pine (*Pinus ponderosa*) forests on ridges and mesas throughout the state [2]. Eggs are laid on the ground in the open or near logs, boulders, grass clumps, shrubs, or in sandy gravel patches. Eggs may even be laid on flat gravel roofs in urban areas. Common Nighthawk does not construct nests, but may use specific substrate materials, including gravel, sand, bare rock, wood chips, forest duff, leaves, needles, tar paper, cinders, moss, dandelions, and lichens [1]. Males spend much of the day during the breeding season at day roosts. In general, day roosts are typically located in tall trees with low canopy height on north-facing slopes in open forests, including Lodgepole Pine (*P. contorta*) and Quaking Aspen (*Populus tremuloides*). Males may be faithful to day roosts, returning to the same location on the same branch on multiple occasions [4]. Habitat use during migration and overwinter is poorly known.

Phenology:
Common Nighthawk is crepuscular. The species has one of the longest migrations of any North American bird. Individuals leave their wintering grounds in South America from March through mid-April and begin arriving in the southern United States in early April, with northerly populations reported as late as early June in Idaho, California, Oregon, and British Columbia, Canada [1]. The earliest reported Common Nighthawk observation in Wyoming is 16 May, although most reports are from late May [2]. Females typically arrive at breeding sites 1–7 days before males [5]. In Canada, eggs are laid in mid-May and hatch throughout July [1]. In Wyoming, eggs have been observed as early as mid-June [2]. In Idaho, incubation is 18 days and spans mid-June to mid-July [5]. Typically only 1 clutch is laid per year, although 2 clutches may be possible in the southern portion of the breeding range. Clutch size is almost always 2, and only the female incubates. Nestlings are semi-precocial, can fly by 17–18 days after hatching, are able to forage on their own by 25 days, and are fully independent shortly thereafter. Common Nighthawk is gregarious during fall migration, reaching groups of up to 1,000 individuals, and typically leaves its breeding grounds in July. In the western United States, migration peaks between mid-August and mid-September [1]. In Wyoming, migrant groups are first seen in late July and peak in mid- to late August. The latest observation of Common Nighthawk in the state is 15 October [2].

Diet:
The diet of Common Nighthawk is entirely composed of flying insects, which are caught on the wing at dusk and dawn. Common Nighthawk may gather in large groups to feed over water, above the forest canopy, and near artificial lighting [1]. Although nearly any flying insect will be taken when available, major prey items include queen ants (Hymenoptera), beetles (Coleoptera), caddisflies (Trichoptera), moths (Lepidoptera), and true bugs (Homoptera); flies (Diptera) tend to be avoided [1, 6]. Ants and grasshoppers (Orthoptera) may occasionally be taken on the ground, especially during inclement weather [5]. The availability of insect prey may be a primary driver in the timing of migration events. Common Nighthawk drinks water in flight by skimming the surface of lakes, streams, and watering troughs [1].

CONSERVATION CONCERNS

Abundance:
Continental: CONTINENTAL
Wyoming: ABUNDANT
Using North American Breeding Bird Survey (BBS) data, the Partners in Flight (PIF) Science Committee estimated the global population of Common Nighthawk to be 16 million birds [7]. Approximately 3.3% of the global population, or around 500,000 birds, is estimated to breed in Wyoming [8]. The statewide rank of ABUNDANT is based on the large area of the state known to be occupied in any given season, and the large coverage of suitable habitat within that area. Within suitable habitat in the occupied area, Common Nighthawk also appears to be abundant because it inhabits much of the preferred habitat within its range, and the species or its sign is typically encountered while using survey techniques that could be expected to indicate its presence [3]. Estimates of Common Nighthawk density (number of birds per square km) and population size for Wyoming are available from the Integrated Monitoring in Bird Conservation Regions (IMBCR) program for the years 2009–2015 [9].

Population Trends:
Historic: UNKNOWN
Recent: MODERATE DECLINE
Common Nighthawk population trend data from the Wyoming BBS suggest a moderate, but statistically insignificant, decline of 0.77% annually from 1968–2013 (*N* = 120 routes, 95% CI: -1.98 to 0.42) [10]. Western Region BBS trend data indicate that Common Nighthawk experienced a statistically significant annual declines of 2.30% from 1968–2013 (*N* = 844 routes, 95% CI: -3.11 to -1.75) [10].

Intrinsic Vulnerability:
LOW VULNERABILITY
Common Nighthawk is a generalist, both in nesting habitats and prey use. The species is not likely to be limited by low mobility or dispersal ability, since they complete one of the longest avian migrations in North America [1]. With only 2 eggs per year [1], Common Nighthawk has relatively low fecundity, although nest success can be high (e.g., 79% in New Jersey) [11]. Other life history characteristics do not predispose the species to declines from changes in environmental conditions.

Extrinsic Stressors:
SLIGHTLY STRESSED

PIF assigns Common Nighthawk a threat level of 3, indicating that the species is expected to display a slight to moderate decline in the future suitability of breeding conditions. The factors that may contribute to this decline are variable but, for Common Nighthawk, likely include a moderate vulnerability to human activities and land-use trends and a low productivity due to single broods [7]. However, the impact of anthropogenic land-use changes on Common Nighthawks is not straightforward. Flat, gravel roofs may provide important habitat in urban areas [12], and the transition away from these types of roof surfaces may remove nesting habitat [1], although natural habitats may still be preferred when available [13]. Alternatively, some land-use changes, including logging and burning, may increase availability of nesting habitat. Increases in pesticide use may impact the insect prey consumed by Common Nighthawk, but the presence of artificial lighting attracts and condenses insect prey, thus creating foraging habitat [1]. The availability of roost sites may be particularly important [4], and individuals, particularly males, are highly susceptible to collisions with vehicles when roosting on gravel roads [1, 14].

KEY ACTIVITIES IN WYOMING

The Wyoming Game and Fish Department classifies Common Nighthawk as a Species of Greatest Conservation Need (SGCN). Current statewide efforts for monitoring annual detections and population trends of Common Nighthawk in Wyoming include the BBS program conducted on 108 established routes since 1968 [10], and the multi-partner IMBCR program initiated in 2009 [9]. Trend data are available on the United States Geological Survey BBS website [10], and occupancy, density, population estimates, and decision support tools are available through the Rocky Mountain Avian Data Center [9].

ECOLOGICAL INFORMATION NEEDS

Continued monitoring of population trends are needed and will be accomplished through the IMBCR and BBS programs. Targeted management that addresses causes of population declines needs to be applied.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Common Nighthawk is classified as a SGCN in Wyoming due to moderate population declines. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming. The first is the long-term BBS started in Wyoming in 1968 with 108 established routes [10]. Species must be detected on at least 14 routes for data analyses to be significant for tracking population status and trend over time. The IMBCR program was established in 2009 in Wyoming with many state, federal, and nongovernmental organization partners that contribute funding, field personnel, technical assistance, or in-kind services. Data analyses produce density, occupancy, and population estimates at various scales; present habitat associations; and provide decision support tools for managers [9]. Both monitoring programs have detected moderate population declines in Common Nighthawk. Best management practices or key management recommendations to benefit Common Nighthawk include limiting insecticide application in nesting and foraging areas to ensure an adequate prey base of flying insects exists for this species (and other insectivores) and reducing loss of open wooded habitats.

CONTRIBUTORS

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Figure 1: Adult Common Nighthawk in Natrona County, Wyoming. (Photo courtesy of Pete Arnold)

Figure 2: North American range of *Chordeiles minor*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

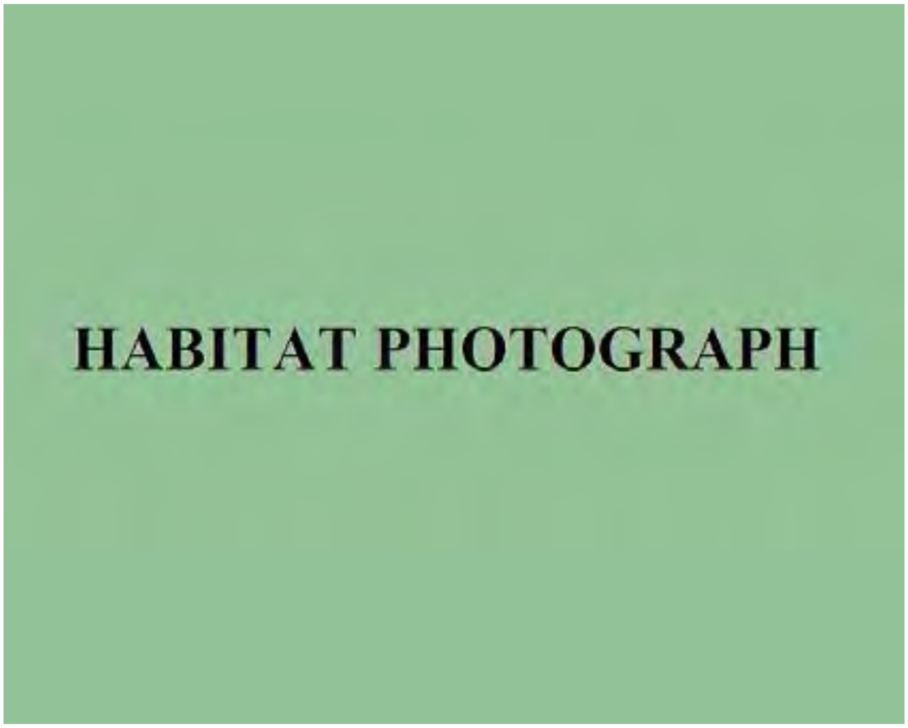

Figure 3: Photo not available.

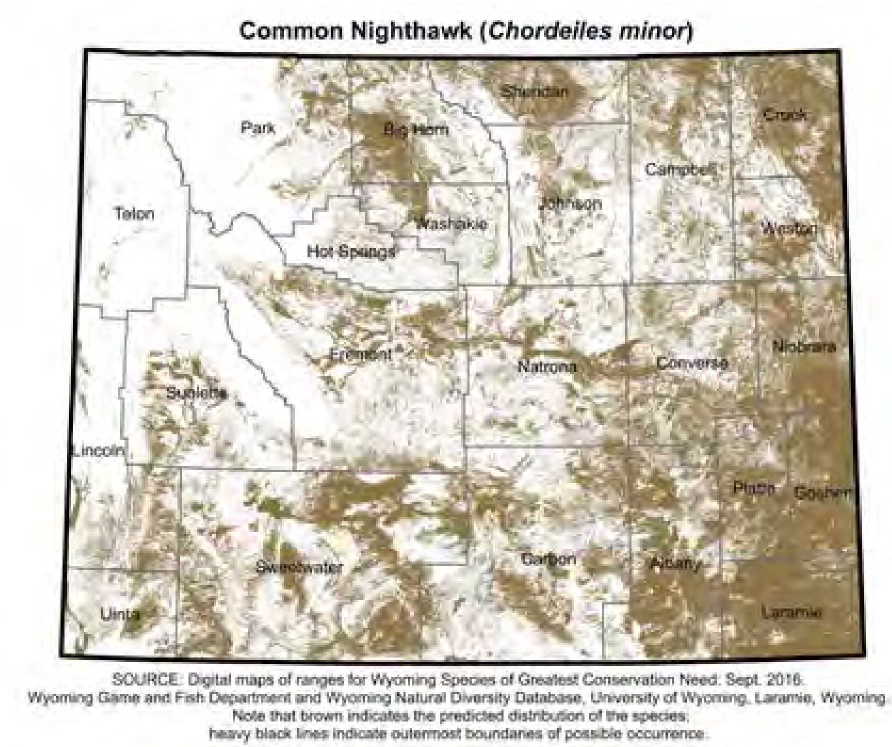

Figure 4: Range and predicted distribution of *Chordeiles minor* in Wyoming.

Figure 5: A foraging Common Nighthawk in Walden, Colorado. (Photo courtesy of Bill Schmoker)

Common Yellowthroat
Geothlypis trichas

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS4 (Bc), Tier III
WYNDD: G5, S5
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 9

STATUS AND RANK COMMENTS
Common Yellowthroat (*Geothlypis trichas*) does not have any additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY
Taxonomy:
Subspecies designations for Common Yellowthroat are perplexing and debated among taxonomic authorities due to the complicated nature of the species' geographic variation, individual variation within subspecies that obscure subspeciation differentiation, and poorly described subspecies that render them invalid [1]. Therefore, descriptions and ranges of Common Yellowthroat subspecies are disputed, especially in western North America [2, 3]. Thirteen subspecies are included in the Birds of North America species account for Common Yellowthroat; two of these subspecies occur in Wyoming [1]. *G. t. campicola* is the main subspecies that occurs in Wyoming. *G. t. occidentalis* may also be found in extreme southwestern Wyoming during the breeding season [1].

Description:
Common Yellowthroat is a medium-sized (length 11–13 cm, mass 9–10 g), compact, wood-warbler [1]. Common Yellowthroat is identifiable in the field, although coloration varies by geography and subspecies. Dunn and Garrett (1997) describe the male as having plain olive upperparts, wings, and tail; a bright yellow chin, throat, upper breast, and undertail coverts; a whitish belly; dusky colored flanks; a broad black mask that extends across the eyes and face, from the forehead and lower auricular area to the sides of the neck; and a narrow whitish-grayish band the separates the mask from the crown and nape [4]. The female Common Yellowthroat is similar to the male, although the female lacks the black mask and whitish-grayish band and instead has plain olive coloration in that area, and has paler yellow coloration on the underparts [4].

Juveniles are similar to adult females, although juvenile males have a faint black mask [4]. Common Yellowthroat is unlikely to be confused with any other species within its Wyoming distribution, especially during the breeding season, as similar species are either migrants or have accidental occurrence in the state.

Distribution & Range:
Common Yellowthroat breeds throughout most of Canada and Alaska south into the United States from the eastern to the western coasts south throughout most of Florida to the Gulf Coast and into eastern Texas and the Texas Panhandle of Texas, in eastern and northern Oklahoma, across the west to southern New Mexico, southern Arizona, and southern California [1]. Common Yellowthroat has been documented in all of Wyoming's 28 latitude/longitude degree blocks, with breeding confirmed in 16 degree blocks and circumstantial evidence of breeding noted in 10 degree blocks [5]. Common Yellowthroat is a summer resident in Wyoming and winters from the southern United States south through Mexico, Baja California, Central America, northern South American, and most of the West Indies [1].

Habitat:
Across its range, Common Yellowthroat is found in a variety of habitats, although it typically occurs in dense vegetation associated with marshes, thickets, and shrubby areas [1]. In Wyoming, the species breeds below 2,438 m in dense willow (*Salix* spp.) and other shrubby habitats along the edges of ponds, lakes, and riparian areas, and in emergent bulrush (*Scirpus* spp., *Schoenoplectus* spp., etc.) and cattail (*Typha* spp.) vegetation along the edges of marshes [5, 6]. No quantitative studies have been conducted to provide additional detail or specific habitat associations across the species' range.

Phenology:
Common Yellowthroat arrives in Wyoming in early May, and begins to depart breeding grounds by late August, with peak autumn migration occurring in September and the latest autumn date recorded as October 16th [6]. The species is a nocturnal, short- to long-distance migrant, although some populations are only partial migrants or fully sedentary [1]. Males arrive on their breeding grounds in the spring before females [7, 8]. Both adult and juvenile Common Yellowthroats depart in the autumn at approximately the same time [9] for the extreme southern portion of the United States and the Neotropics [1]. Common Yellowthroat is known to produce two broods per year in some parts of its range, but more information is needed to determine if second broods are common throughout most of its range [1]. Common Yellowthroat clutches usually contain 4 eggs, but can range from 1–6 eggs [1]. Incubation lasts for 12 days, and fledglings leave the nest 10 days after hatching [10].

Diet:
Common Yellowthroat feeds primarily on insects and spiders taken from the ground and in low vegetation [10, 11]. Foraging specifics are not available from Wyoming, but in Arizona the species was noted to forage from 0 to 6.2 m above the ground [11]. The primary foraging method used is gleaning from leaves, bark, or the ground [10-12]. Other foraging methods can include hover glean, sally-hover, sally-strike, hawk, and flutter-chase [10, 13].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD

Wyoming: COMMON
Using North American Breeding Bird Survey (BBS) data, the Partners in Flight Science Committee estimated the global population of Common Yellowthroat to be 87 million birds [14]. Approximately 0.20% of the global population, or around 200,000 birds, is estimated to breed in Wyoming [15]. However this estimate should be viewed with caution. Estimates of Common Yellowthroat density (number of birds per square km) and population size in Wyoming are available from the Integrated Monitoring in Bird Conservation Regions (IMBCR) program for the years 2009–2015, although data from only two years have a percent coefficient of variation of estimates that are considered robust, so must be interpreted with caution until data from additional years are included [16]. The statewide rank of COMMON is based on the relatively large area of the state known to be occupied in any given season, and the large coverage of suitable habitat within that area. Within suitable habitat in the occupied area, Common Yellowthroat also appears to be common and is usually encountered during surveys that could be expected to indicate its presence [5]. Estimates of Common Yellowthroat density (number of birds per square km) and population size in Wyoming are available from the Integrated Monitoring in Bird Conservation Regions (IMBCR) program for the years 2009–2015, although sample sizes are small so data must be interpreted with caution [16].

Population Trends:
Historic: UNKNOWN
Recent: MODERATE DECLINE
Common Yellowthroat population trend data from the BBS are available from 1968–2013 and suggest a moderate decline. However, results have been determined to fall within a credibility category containing data with 'deficiencies' due to low relative abundance and number of routes with Common Yellowthroat detections, so also must be interpreted with caution [17].

Intrinsic Vulnerability:
LOW VULNERABILITY
Although abundant and widespread, Common Yellowthroat uses specific habitat types year-round. For nesting habitat in Wyoming, and also at migration stopover and wintering areas, Common Yellowthroat is associated with dense shrubby and grassland habitats often along the edges of ponds, lakes, and riparian areas, and in emergent bulrush and cattail vegetation along the edges of marshes [1, 6]. Loss of such habitat resulting from climate change and urban or agricultural development could affect local and regional breeding populations. As a long distance night migrant, collisions with towers, buildings, and other infrastructure have been reported, and can involve several hundred birds at a time [1].

Extrinsic Stressors:
MODERATELY STRESSED
The declining trend documented by BBS data for Wyoming's population suggests that stressors exist for this population, but none have been directly studied in the state. Moderate to severe drought in Wyoming has been documented since 1999, with intensity varying from year to year and within different regions [18]. Natural wetlands continue to decline both in number and area from historic levels [19]. Loss of wetlands from draining, flood-control measures, and development also may affect populations. Conversion of Conservation Reserve Program lands back to crops could also affect certain populations [20]. Direct disturbance by human activity was blamed for loss of eggs and young in Michigan and Minnesota [7]. There has been a dramatic increase in the infrastructure associated with energy production in Wyoming, which supplies more energy to

other states than any other state in the nation [21]. Increasing numbers of power lines, wind farms, drilling rigs, and other structures, especially those with lights, present risks for night migrants [22, 23]. Extensive use of pesticides to control mosquitoes and other insects could result in both direct mortality and greatly decreased prey availability [24]. Similarly, poisoning by carbofuran near a cornfield has been reported, but few data exist on the risk to this species from pesticides or other contaminants and toxins [1]. Common Yellowthroat is one of the three most common cowbird (*Molothrus* spp.) hosts [10].

KEY ACTIVITIES IN WYOMING

Common Yellowthroat is listed as a Species of Greatest Conservation Need (SGCN) in Wyoming by the Wyoming Game and Fish Department due to concerns over wetland habitat loss or degradation from drought and climate change, and moderate population declines as suggested by data from on-going monitoring programs. Current statewide efforts for monitoring annual detections and population trends of Common Yellowthroat in Wyoming include the BBS program conducted on 108 established routes since 1968 [17], and the multi-partner IMBCR program initiated in 2009 [16]. Trend data are available on the United States Geologic Survey BBS website [17], and occupancy, density, population estimates, and decision support tools are available through the Rocky Mountain Avian Data Center [16]. Across its range, Common Yellowthroat has not been the focal species of any specific conservation or management actions. This species is likely to benefit from management practices directed to less common species or those with restricted habitat requirements [1].

ECOLOGICAL INFORMATION NEEDS

Knowledge of how Common Yellowthroat responds to drought and climate change is poorly understood. More exact information on population trends is needed and will continue to be refined through the IMBCR and BBS programs. Although Common Yellowthroat is abundant and has widespread occurrence across its range, few studies have been conducted on the species' breeding biology or behavior, and none of the studies have been long-term [1].

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Common Yellowthroat is classified as a SGCN in Wyoming due to moderate population declines and severe habitat impacts that can occur from drought and climate change. Two separate but compatible survey programs are in place to monitor Common Yellowthroat populations. The first is the long-term BBS started in Wyoming in 1968 with 108 established routes [17]. Species must be detected on at least 14 routes for data analyses to be significant for tracking population status and trend over time. The IMBCR program was established in 2009 in Wyoming with many state, federal, and nongovernmental organization partners that contribute funding, field personnel, technical assistance, or in-kind services. Data analyses produce density, occupancy, and population estimates at various scales, and provide decision support tools for managers [16]. Best management practices to benefit Common Yellowthroat include maintaining dense shrubs and diverse vegetation heights in wetland and riparian habitats, using rotational livestock grazing during the nesting season to rest wetland and riparian areas from cowbird concentrations and brood parasitism, and minimizing insecticide use in wetland and riparian habitats [25].

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Figure 1: Adult male Common Yellowthroat in Sweetwater County, Wyoming. (Photo courtesy of Tom Koerner, USFWS)

Figure 2: North American range of *Geothlypis trichas*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

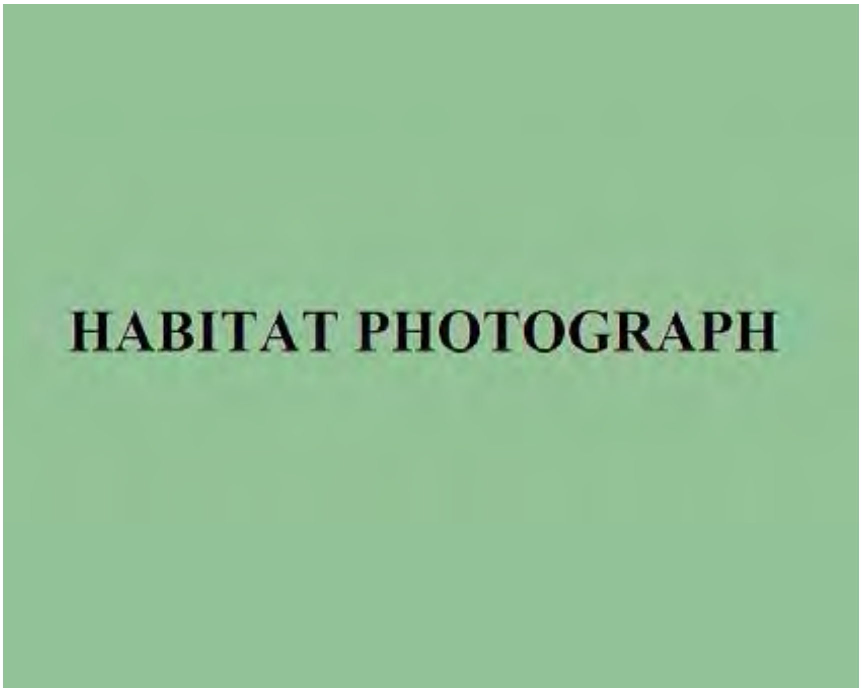

Figure 3: Photo not available.

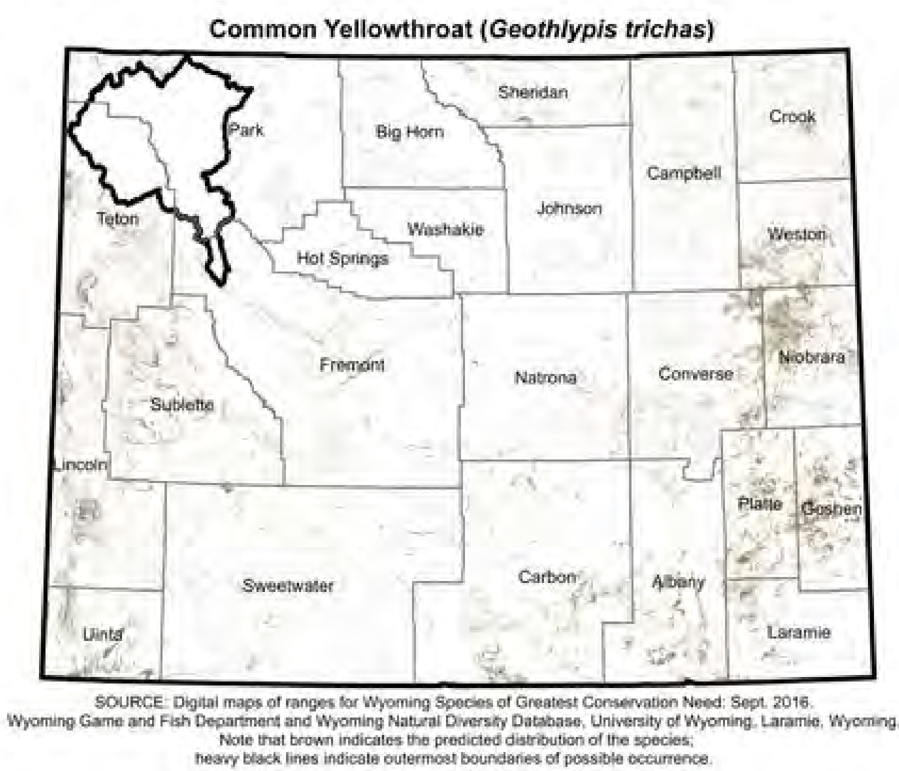

Figure 4: Range and predicted distribution of *Geothlypis trichas* in Wyoming.

Dickcissel

Spiza americana

Regulatory Status

USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

Conservation Ranks

USFWS: Bird of Conservation Concern
WGFD: NSSU (U), Tier II
WYNDD: G5, S1
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 10

Status and Rank Comments

Dickcissel (*Spiza americana*) has no additional regulatory status or conservation rank considerations beyond those listed above.

Natural History

Taxonomy:
There are currently no recognized subspecies of Dickcissel [1].

Description:
Identification of Dickcissel is possible in the field. This species is sexually dimorphic in both size (males average 10–20% larger than females) and plumage [2]. Adults weigh 23–29 g, range in length from 14–16 cm, and have a wingspan of approximately 25 cm [2, 3]. Adult males have a gray head with yellow eyebrows and malars, rufous shoulders, a distinct V-shaped black throat patch, yellow breast, light-gray belly, dark eyes, and gray bill and legs [2, 3]. Males are unlikely to be confused with any other species in their range [2]. Females have similar coloration but duller plumage overall, and noticeably lack the black throat patch [2, 3]. Although similar in size and appearance to some sparrow species, female Dickcissels can be distinguished by their longer bill and pale yellow eyebrows, malars, and breast.

Distribution & Range:
Wyoming lies outside and to the west of the core breeding range of Dickcissel, which is centered over the prairie grasslands of the Great Plains [2]. However, the species is known for its random movements into grassland environments well outside of its primary breeding range, which can lead to extreme and unpredictable annual fluctuations in distribution and abundance in those areas [2]. Eastern Wyoming is within the far western edge of this "sporadic" breeding boundary, and Dickcissel is both a migrant and summer resident in the state [4, 5]. The species has been documented in 19 of Wyoming's 28 latitude/longitude degree blocks, but only 2 degree blocks

include confirmed observations as accepted by the Wyoming Bird Records Committee (WBRC) [5]. Confirmed breeding has been document in 3 degree blocks, all in eastern and northeastern Wyoming [5]. Dickcissel winters in central Venezuela and less commonly in southern mainland Mexico, central America, and far northern South America [2].

Habitat:
Dickcissel is a grassland obligate species that breeds primarily in open prairie grasslands [2]. Ideal habitat characteristics for this species include 90–100% vegetation cover consisting of > 50% forbs, 25–150 cm vegetation height, and 5–15 cm of ground litter [2]. Males sing from elevated vegetation to attract females to their territory, so grassland habitats with a high density (> 10 per ha) of potential perch locations are preferred [2]. Dickcissel will also use restored and managed grasslands [6-13]; a variety of agricultural landscapes including agricultural buffers [14-17]; grassland fragments in urbanized landscapes [18]; and even marginal grassy habitat bordering streams, fences, and roads [2]. In Wyoming, Dickcissel breeds in northwestern Great Plains grasslands and irrigated hayfields in the northeastern corner of the state [4, 5]. Nests are constructed solely by females, typically deep within dense ground vegetation or occasionally in low trees or shrubs [2]. Most nest sites are well-concealed and almost completely sheltered by overhanging vegetation, which provides important natural shade to nestlings [2]. Thick-walled cup nests are made from the stems and leaves of forbs and grasses, with fine plant material and animal hair as a lining [2].

Phenology:
Spring arrival of migrating and breeding Dickcissels in Wyoming is unknown due to low detections [4], and little is known about the specific nesting and breeding habits of this species in the state. The earliest Dickcissel has been reported in Wyoming is 20 April in Sweetwater County [4]. The timing of nest initiation is variable across the breeding distribution, but males can be observed singing at known breeding locations in Wyoming as early as late May [4]. As a species that exhibits resource-defense polygyny, males with high quality territories (i.e., those with more desirable nesting sites) will attract more mates than males with lower quality territories [2]. Clutches average 4 eggs with a range of 3–6 eggs [2]. Dickcissel typically has one brood per season [2]. The timing of fall migration from Wyoming to wintering grounds is unknown, but the latest Dickcissel has been reported in the state is 7 September [4].

Diet:
Dickcissel is omnivorous during the breeding season, consuming a variety of arthropods and plant materials [2]. In the non-breeding season they become granivorous, feeding almost entirely on grass seeds [2].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
In 2013, Partners in Flight estimated that Dickcissel had a global population of approximately 20 million individuals and a Wyoming population of about 9,000 [19]. However, this state abundance estimate is likely very high, and should be viewed with caution, since this species was detected on just 7% of surveyed Breeding Bird Survey (BBS) routes in the state from 1998–2007 [19]. The statewide abundance rank of VERY RARE is based on the rather small area of the state known to be occupied in any given season and the small coverage of suitable habitat within that area. Dickcissel appears to be uncommon even within suitable habitat in the occupied area, occurring

at relatively low density and requiring intensive survey efforts to detect [5]. From 1968–2015, annual Wyoming BBS detections of Dickcissel ranged from 0 to 41 (average = 3), with 1 recorded in 2015 [20]. Only 2 Dickcissels have been detected during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [21].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Robust population trends are not available for Dickcissel in Wyoming because the species is infrequently detected during monitoring efforts. Survey-wide trend data from the North American BBS indicate that Dickcissel numbers experienced a statistically significant annual decline of 0.62% from 1966–2013 and a non-significant annual decline of 0.06% from 2003–2013 [22].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Dickcissel has moderate intrinsic vulnerability in Wyoming because it is restricted to a narrow range of habitats, occurs at low density in the state, and has nesting behaviors that may leave the species susceptible to nest lost. As a peripheral, grassland obligate species, Dickcissel is likely to be affected by any natural or anthropogenic stressors that negatively impact prairie grassland environments in Wyoming. Dickcissel nests are typically close to the ground in dense vegetation, which makes them vulnerable to natural and anthropogenic ground disturbance, especially in agricultural landscapes.

Extrinsic Stressors:
MODERATELY STRESSED
Habitat loss, degradation, and disturbance could negatively impact Dickcissel in Wyoming. Prairie grassland habitats in the state are vulnerable to development for energy, infrastructure, and agriculture; invasive plant species such as Cheatgrass (*Bromus tectorum*) and Canada Thistle (*Cirsium arvense*); anthropogenic disturbance from off-road recreational activities; altered fire and grazing regimes; and drought and climate change [5]. Dickcissel has not demonstrated displacement or decreased nest success in the presence of wind energy development in Texas [23, 24]. When breeding in agricultural landscapes, this species is highly susceptible to nest loss from early-season mowing practices [2, 4, 25]. Responses of Dickcissel to burning, grazing, and other grassland management activities appear to be varied across its distribution and have not been studied in Wyoming [6, 11-15, 26-30]. Dickcissel nests are parasitized, sometimes preferentially, by Brown-headed Cowbird (*Molothrus ater*) in other parts of its breeding range [9, 31, 32].

KEY ACTIVITIES IN WYOMING

Dickcissel is classified as a Species of Greatest Conservation Need by the Wyoming Game and Fish Department, and as a Level II Priority Bird Species requiring monitoring in the Wyoming Bird Conservation Plan [33]. Current statewide activities for monitoring annual detections and population trends for Dickcissel in Wyoming include the BBS program conducted on 108 established routes since 1968 [22], and the multi-agency IMBCR program initiated in 2009 [21]. However, the extremely limited existing data are not robust enough to support estimates of Dickcissel occupancy, density, or population trend. There are currently no research projects designed specifically for Dickcissel in Wyoming. Observations of this species are reported to the Wyoming Game and Fish Department and vetted through the WBRC. Dickcissel is a species for which the WBRC requests documentation on first latitude/longitude degree block sightings and all nesting observations [34].

ECOLOGICAL INFORMATION NEEDS

Nothing is known about the timing of migration or the breeding phenology of Dickcissel in Wyoming. This peripheral and transient species would benefit from research to determine its detailed breeding distribution, range of habitat use, and reproductive success in the state. It is not known if Dickcissel is benefiting from cropland to grassland conversion through the Conservation Reserve Program (CRP) in Wyoming, although the species has been shown to use CRP and restored habitat in other parts of its range [9, 10, 13, 14, 16, 27]. Research is needed to determine if current harvesting practices are impacting Dickcissels that nest in cultivated hayfields in eastern Wyoming [4].

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Dickcissel is classified as a SGCN in Wyoming due to insufficient information on breeding, distribution, population status and trends, and impacts of habitat loss and degradation on grassland habitats [35]. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [22] and the multi-partner IMBCR [21]. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, survey efforts do not tend to detect Dickcissel at adequate levels, suggesting targeted, species-specific monitoring efforts are needed. Best management practices to benefit Dickcissel include managing for large expanses of grassland habitats that have dense grass, a heavy cover of forbs, and thick litter depth; limiting high intensity fire regimes and livestock grazing; rotating livestock grazing; delaying spring mowing; avoiding nighttime and annual mowing; using a flush bar on mowers; implementing mowing and prescribed in the fall to avoid the nesting season; and minimizing insecticide use to maintain a food source for Dickcissel [33]. Key recommendations for Dickcissel include limiting habitat conversions of large expanses of existing grasslands; minimizing conflicts during the breeding season with energy extraction and development, recreation, and landowners; and reducing disturbance (e.g., haying, burning, moderate to heavy grazing) during the breeding season [33, 35].

CONTRIBUTORS

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Figure 1: Adult male Dickcissel in Yuma County, Colorado. (Photo courtesy of Bill Schmoker)

Figure 2: North American distribution of *Spiza americana*, which also breeds and summers sporadically east and west of the breeding distribution shown above. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

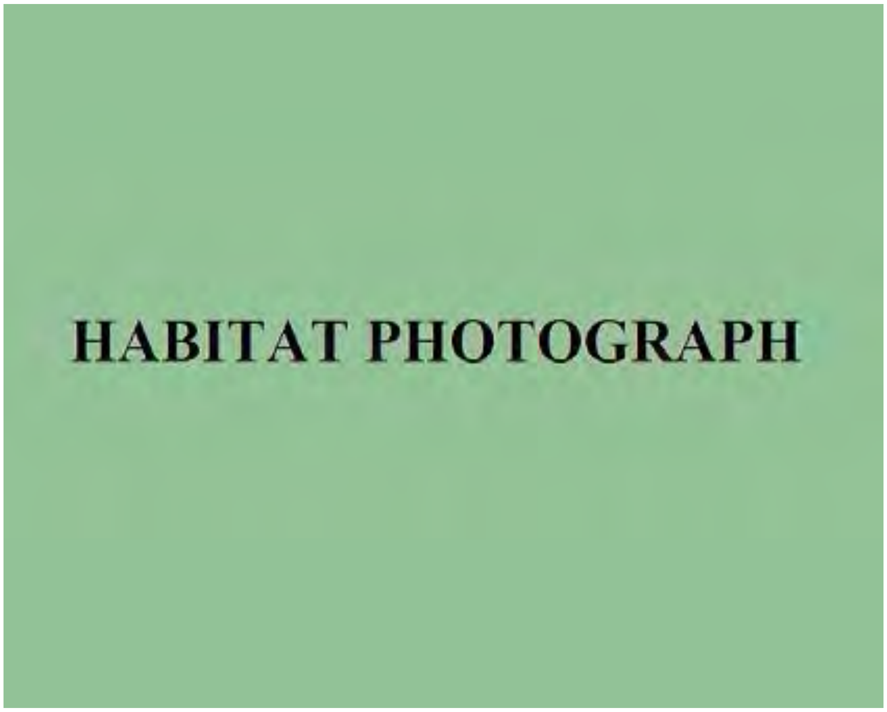

Figure 3: Photo not available.

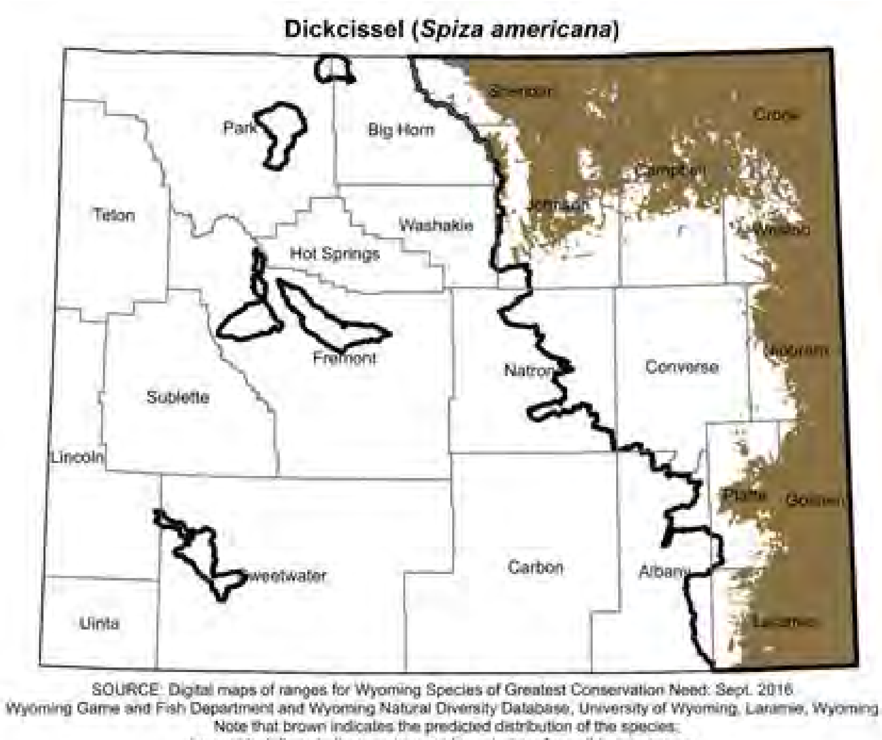

Figure 4: Range and predicted distribution of *Spiza americana* in Wyoming.

Ferruginous Hawk

Buteo regalis

REGULATORY STATUS

USFWS: Listing Not Warranted; Migratory Bird
USFS R2: Sensitive
USFS R4: No special status
Wyoming BLM: Sensitive
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: Bird of Conservation Concern
WGFD: NSS4 (Cb), Tier II
WYNDD: G4, S4S5B/S3N
Wyoming Contribution: MEDIUM
IUCN: Least Concern
PIF Continental Concern Score: 11

STATUS AND RANK COMMENTS

Ferruginous Hawk (*Buteo regalis*) was petitioned for protection under the Federal Endangered Species Act in 1991 but was denied listing based on lack of evidence [1]. The Wyoming Natural Diversity Database has assigned Ferruginous Hawk a state breeding conservation rank ranging from S4 (Apparently Secure) to S5 (Secure) because of uncertainty about the abundance and population trends of the species in Wyoming. Additionally, Ferruginous Hawk is assigned a different state conservation rank in the non-breeding season due to much lower abundance and proportion of area occupied in the state in the winter.

NATURAL HISTORY

Taxonomy:

Ferruginous Hawk is monotypic. No subspecies are currently recognized [2].

Description:

Identification of Ferruginous Hawk is possible in the field. Ferruginous Hawk is the largest North American hawk in the genus *Buteo*, with a wingspan of about 142 cm and measuring 56–69 cm from bill to tail [2, 3]. Both sexes are large and heavy with broad, long, pointed wings and have a large head and bill, long gape, and robust chest; however, females are slightly larger and notably heavier than males [2]. Plumage is identical between sexes but varies between light and dark morph individuals. Light morphs comprise 90% of all individuals, but dark morphs are present range-wide [2, 3]. Light morph individuals have white primary, secondary, and tail feathers. The breast and belly are white with rufous speckling on the belly. The back is rufous. Upper secondary feathers are darker grey while upper primaries are light. Leg feathers are dark rufous and form a characteristic “V” when in flight. Some dark morph birds can have white primary, secondary, and tail feathers, but the head, leg feathers, back, breast, and belly are uniformly dark with rufous highlights [2, 3]. Ferruginous Hawk is most similar in appearance to Red-tailed Hawk

(*B. jamaicensis*) and Swainson's Hawk (*B. swainsoni*). Red-tailed Hawk differs from Ferruginous Hawk in that it has a dark band on its belly, dark patagial marks on the leading edge of the underside of the wing, and adults have a red tail. Swainson's Hawk differs from Ferruginous Hawk in flight in that it has dark flight feathers on the trailing edge of the wing.

Distribution & Range:
Ferruginous Hawk is widely distributed across the western United States. Wyoming is centrally located within the breeding range of Ferruginous Hawk. Ferruginous Hawk winters in southwestern United States and Northern Mexico [2, 4]. Southern Wyoming represents the northern periphery of the species' winter range [4]; however, numbers of Ferruginous Hawk wintering in Wyoming are likely very low. Range contractions have been observed in parts of Canada where grasslands have been converted for agriculture [5].

Habitat:
Ferruginous Hawk occupies open lower-elevation grassland, shrubsteppe, and desert habitats and tends to avoid croplands, forests, and narrow canyons [2, 4]. In Wyoming, the species is most abundant in these habitats in south-central Wyoming during the breeding season [6, 7]. Nest sites vary and can be directly on the ground or on elevated features such as boulders, creek banks, knolls, cliffs, buttes, hoodoos, large shrubs, isolated trees, anthropogenic structures, and artificial nesting substrate. Nesting substrates used in Wyoming include trees and shrubs, artificial nesting platforms, windmills, power poles, and energy development structures [8]. Habitat use in summer and winter are similar. However, in winter, Ferruginous Hawk concentrates in grasslands with prairie dog (*Cynomys* spp.) colonies [2, 4].

Phenology:
Ferruginous Hawk adults migrate north from wintering grounds in March and April. Younger individuals migrate later than adults [2]. Nests are initiated from mid-April to mid-May with eggs hatching 32–33 days after being laid. Fledglings leave the nest between 38–50 days after hatching [2]. Migration by fledglings the first fall is characterized by extensive, wide-ranging movements until arriving on wintering ground in mid-October [9]. Ferruginous Hawk can make two distinct migrations with movements first to fall ranges which have high prey availability and then south to wintering grounds later [2, 9]. Although Ferruginous Hawk is found in portions of Wyoming year round, the species is very rare in winter and the majority of individuals breeding in Wyoming migrate south for the winter.

Diet:
In Wyoming, Ferruginous Hawk feed primarily on ground squirrels (*Urocitellus* spp.), lagomorphs (*Sylvilagus* spp., *Lepus* spp.) and prairie dogs [2, 4, 10]. Additional prey items include small mammals, birds, reptiles, and large invertebrates [4, 5].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: UNCOMMON
Based on results from Breeding Bird Survey (BBS) data, Partners in Flight estimated the Wyoming population of Ferruginous Hawk to be 11,000 [11]. The global population is estimated to be 80,000 birds [11]. During the breeding season, Ferruginous Hawk is considered fairly common and widespread across suitable habitat in Wyoming [6]. In 2011, the Wyoming Game and Fish

Department (WGFD) estimated 1,107 nesting pairs of Ferruginous Hawk in a large study area in Wyoming with a density of 94.7 pairs per km [4, 12]. In winter, Ferruginous Hawk is likely very rare in the state [4, 6].

Population Trends:
Historic: MODERATE DECLINE
Recent: STABLE
Ferruginous Hawk population trend data from BBS routes in Wyoming from 1968–2013 suggest the state population is likely stable, however, results are not conclusive due to limited number of detections [13]. Across its range, Ferruginous Hawk is generally believed to be declining; however, the magnitude and direction of trends vary among states and regions making overall estimation of trends difficult [4, 5, 14, 15]. The most recent study found nesting density in Wyoming to be similar or slightly lower compared to previous estimates across the range of this species [12].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Ferruginous Hawk is sensitive to disturbances during nesting and disruptions or continued disturbances often lead to nest abandonment, especially during incubation [2, 7, 16]. Urban and exurban development, and energy exploration and development all increase potential disturbances and subsequent nest desertion by nesting Ferruginous Hawk [17]. In some locations, Ferruginous Hawk density is thought to be limited by presence of suitable nesting substrate [2, 4]. Although the species will nest on the ground and on rock features, nest success is lower at these sites due to their accessibility to mammalian predators [18]. Prey availability also influences Ferruginous Hawk abundance and nest success. Hawks nesting in areas with abundant prairie dog colonies produced significantly more fledglings per nesting attempt than those in areas without prairie dogs [17]. In Alberta, Canada, reduction in ground squirrel numbers is believed to have resulted in a 4.5-fold decline in nesting density [15]. Re-occupancy of nesting territories in Wyoming was associated with ground squirrel abundance in some years [7, 10]. Severe storms during the brood-rearing period in Wyoming resulted in reduced productivity [8].

Extrinsic Stressors:
MODERATELY STRESSED
The foremost historical and current threat to Ferruginous Hawk is loss of suitable breeding habitat to agricultural conversion, urbanization, and energy development [2, 7, 16]. In Wyoming, exploration and development of natural gas, oil, and wind energy resources have increased throughout the range of Ferruginous Hawk [4, 19]. However, population-level responses of Ferruginous Hawk to energy development activities are complex. The effects of oil and gas activities on nest site selection and nest success may vary with spatial scale, well density, available nesting substrate, prey abundance, and potentially climate (drought) [7, 8, 10, 16, 20, 21]. Increased disturbance, road networks, and human presence associated with energy development and urbanization present significant threats to Ferruginous Hawk including increased morality of young birds [4, 7, 17, 22, 23]. Because Ferruginous Hawk populations can be strongly influenced by prey abundance, reduction in prey populations due to poisoning, shooting, habitat conversion, and disease could negatively impact Ferruginous Hawk. Healthy shrub-steppe nesting habitat is important as hawks were found to produce more young on average in territories that had greater than 20% shrub cover [8].

KEY ACTIVITIES IN WYOMING

Cooperative monitoring efforts by state and federal land management agencies have been initiated in response to land use changes in the state [24]. WGFD completed a study initiated in 2010 examining Ferruginous Hawk population trends in relation to the progression of wind energy development projects in south-central Wyoming [25]. Results suggest no apparent effects of wind energy on nest occupancy or production. However, long term or cumulative impacts are still unknown [25]. WGFD and the United States Forest Service Rocky Mountain Research Station began a study in 2010 to examine effects of energy development and other environmental factors on Ferruginous Hawk productivity, occupancy, and nesting density [8, 10, 24]. Occupancy was not found to be strongly related to density of oil and natural gas development, but this was likely confounded by focusing only on recently occupied territories in the post-development construction period and also by the successful use of artificial nest platforms by Ferruginous Hawks [7, 10]. Occupancy showed a strong positive relationship to ground squirrel abundance and a negative relationship to sagebrush (*Artemisia* spp.) cover [7, 10]. GPS locations are still being collected on 8 pairs of Ferruginous Hawks nesting in energy development areas [23].

ECOLOGICAL INFORMATION NEEDS

Knowledge of population trends for Ferruginous Hawk is needed in Wyoming. Research is needed to examine the extent to which the species overwinters in Wyoming. Long term and cumulative impacts from energy development and urban and exurban development appear complex and poorly understood. Ferruginous Hawk would benefit from continued studies on the effects of energy development activities on population demographics and habitat use by this species in Wyoming. Recent work by Wallace and colleagues [8, 10] provide an excellent baseline for conducting further long-term monitoring for this species. Studies on primary factors driving trends in prey populations of ground squirrels and lagomorphs also would be valuable. Additionally, the ecology and potential limiting factors or threats to Ferruginous Hawk on wintering grounds is poorly understood.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Susan M. Patla. Rapid development of energy resources in Ferruginous Hawk nesting habitat in Wyoming remains of primary concern for this species [23]. A recent study based on aerial surveys of randomly selected townships in 2010 and 2011 resulted in finding 105 nesting territories [7, 8, 10]. In addition, GPS transmitters from 8 pairs of hawks that nest in oil/gas fields are still providing location information [23]. Resource selection models from this study indicate that Ferruginous Hawks select nest areas with lower topographic roughness, more bare ground and shorter relative shrub heights [10]. The study did not identify disturbance associated with energy development to be an important predictor of habitat selection in Wyoming, but was conducted post-energy development construction and focused only on recently occupied territories [10]. Where birds initially select territories and if they become tolerant of disturbance needs to be tested using a before/after longer-term impact study [10]. In addition, infrastructure associated with development such as additional perch sites and artificial nesting structures may provide some benefits for nesting birds. There is likely a non-linear relationship between habitat suitability and the level of energy development also and fields with dense development may show a decline in nesting pairs over time [23]. Future publications from this study will include a study of movements in both the breeding and winter seasons, resource selection in the winter, genetic structure compared to other populations, and mapping of potential prey at the landscape scale [23]. A long-term monitoring plan will also be developed in cooperation with agency partners. Longer-term monitoring and additional studies based on the valuable non-biased data set of nest sites obtained in 2010 and 2011 will help clarify the relative importance of different environmental factors related to occupancy, productivity and survival. It may take years or many generations to determine how disturbance might affect populations of a long-lived species such as the Ferruginous Hawk [10]. In addition, longer-term studies are needed on environmental factors related to prey abundance given rapidly changing climate conditions and increasing development in Ferruginous Hawk habitat.

CONTRIBUTORS

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Figure 1: Adult light morph Ferruginous Hawk in Boulder County, Colorado. (Photo courtesy of Bill Schmoker)

Figure 2: North American range of *Buteo regalis*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Grassland habitat in Thunder Basin National Grassland, Wyoming. (Photo courtesy of Michael T. Wickens)

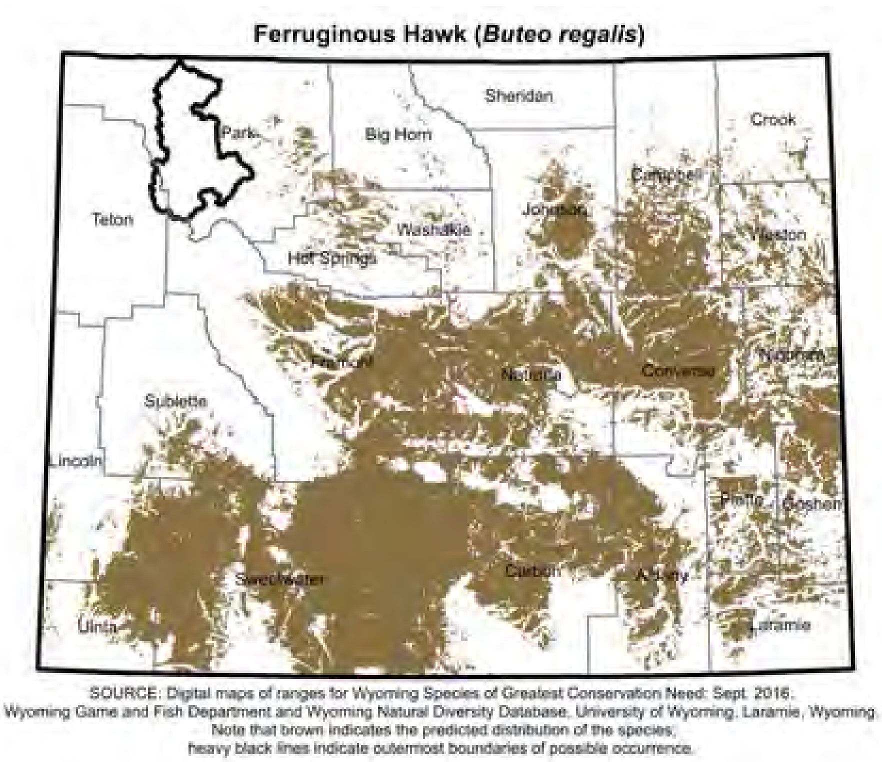

Figure 4: Range and predicted distribution of *Buteo regalis* in Wyoming.

Figure 5: Adult light morph Ferruginous Hawk in flight in Albany County, Wyoming. (Photo courtesy of Shawn Billerman)

Flammulated Owl

Psiloscops flammeolus

Regulatory Status

USFWS: Migratory Bird
USFS R2: Sensitive
USFS R4: Sensitive
Wyoming BLM: No special status
State of Wyoming: Protected Bird

Conservation Ranks

USFWS: Bird of Conservation Concern
WGFD: NSSU (U), Tier III
WYNDD: G4, S1
    Wyoming Contribution: MEDIUM
IUCN: Least Concern
PIF Continental Concern Score: 15

Status and Rank Comments

Flammulated Owl (*Psiloscops flammeolus*) does not have any additional regulatory status or conservation rank considerations in the United States beyond those listed above. Canada has designated the small population that occurs in British Columbia as a Species of Special Concern [1].

Natural History

Taxonomy:

This insectivorous owl, formerly in the genus *Otus*, was recently assigned to *Psiloscops* based on genetic work that indicates it is not closely related to other species of *Otus*, but is instead a sister to species of *Megascops* [2]. Up to six subspecies of Flammulated Owl have been described, but recent genetic analysis of 14 localities throughout its distribution showed high levels of genetic diversity and gene flow among all populations except one in northeastern Mexico [3-5]. Most authors now treat the species as monotypic.

Description:

Identification of Flammulated Owl is possible in the field. Flammulated Owl can be identified from other sympatric owl species by its tiny size; dark eyes in all age classes; densely feathered tarsi; and small, delicate feet [4-6]. The sexes are similar in appearance, but males average slightly smaller than females [4]. The wings are long and pointed, and the tail is short. Its ear tufts are short and usually flattened, forming corners on the rectangular-shaped head. The grayish-white facial disk is speckled with black and rimmed with dark brown, with rufous around the eyes, ears and throat. Upperparts and crown are gray-brown and heavily vermiculated with varying amounts of rufous. There is a partial collar of white spots around the base of the neck. The flight feathers are dark gray-brown with buffy spots on the outer primaries and buffy-gray mottled bars on the inner primaries and secondaries. No distinct color phases or morphs are recognized, but feather coloration varies geographically [4]. Owls in the Great Basin and Rocky Mountains are the darkest gray, while those to the north, west, and south have redder feather fringes and finer markings. These variations in plumage color and pattern may represent local adaptations to match tree bark as a form of crypsis.

Distribution & Range:
Flammulated Owl is considered a rare summer resident in Wyoming with only one documented breeding population in the Sierra Madre Mountains in Carbon County [7-9]. The species has also been documented in Fremont and Teton Counties, and a single detection from the Black Hills of South Dakota suggests that Flammulated Owl may also occur in northeastern Wyoming [5]. The continental breeding distribution is comprised of disjunct pockets of habitat varying in size in higher elevation western mountains from southern British Columbia into Mexico, including Washington, Oregon, California, Nevada, Idaho, Montana, and Wyoming [5]. It is more widespread in the mountains of Colorado, New Mexico, and Arizona, and is also thought to occur in western Texas and in a number of mountains ranges in Mexico south to Oaxaca [10]. In Idaho, Flammulated Owl has been recorded in the southern part of the state, including the Owyhee Mountains, Sawtooth National Forest, and the Caribou-Targhee National Forest close to the Wyoming border [11]. Flammulated Owl is thought to make long-distance migrations to Mexico, Guatemala, and El Salvador but its winter range is poorly documented and complicated by a mixture of migrants and year-round residents in southern locations [4].

Habitat:
Flammulated Owl has specialized habitat requirements. The species breeds in open, dry, mature and old-growth conifer forest often found on south or east facing slopes, with an oak (*Quercus* spp.) or aspen (*Populus* spp.) component, herbaceous or grass understory, and pockets of dense brushy understory [3, 5]. In the Sierra Madre Mountains of south central Wyoming, and in eastern Idaho, breeding pairs occupied mature stands of mixed-conifers and Quaking Aspen (*P. tremuloides*) from 2,134 to 2,743 m in elevation [7, 11]. In Colorado, a long term study found that Flammulated Owl productivity and occupancy were positively correlated with mature, open stands of Ponderosa Pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*) habitat, and negatively correlated with young, dense stands of Douglas-fir [12]. Most nests are found in Ponderosa Pine and Douglas-fir habitats, and to a lesser extent Jeffrey (*Pinus jeffreyi*), Washoe (*P. washoensis*), and Limber Pine (*P. flexilis*), and White (*Abies concolor*) and Subalpine Fir (*A. lasiocarpa*). In Idaho, vocalizing owls were also detected in some juniper-sagebrush (*Juniperus* spp.-*Artemisia* spp.) habitat [11]. As a secondary cavity nester, Flammulated Owl relies on cavities made by Northern Flicker (*Colaptes auratus*) or sapsuckers (*Sphyrapicus* spp.) for nesting.

Phenology:
Flammulated Owl returns to nesting areas in North America from southern wintering grounds between late April and mid-May, with males arriving 1–2 weeks earlier than females [13]. Males call during the courtship period from May to mid-June from high perches in the nest area with low, deep, resonant hoots. Mean date for clutch completion in Colorado ranged from May 29–June 7 [13]. In Oregon, incubated eggs were found from June 8 to July 3 [14]. Females lay up to 4 eggs, with clutches of 2–3 most common. Incubation lasts 21–24 days. Young owls fledge 22–25 days after hatching, and broods divide up to follow either the male or female adult. Young began to disperse in late August. Fall migration flights begin in mid-August in Idaho and Nevada, peak in mid-September, and are over by the end of October [5].

Diet:
The main foods of Flammulated Owl include nocturnal arthropods, especially owlet and geometrid moths (Noctuidae and Geometridae), crickets and grasshoppers (Orthoptera), and beetles (Coleoptera) [4]. In Colorado, noctuid and geometrid moths appear to be the only flying prey available to Flammulated Owl during the cold spring nights [13].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD BUT PATCHY
Wyoming: VERY RARE
Using North American Breeding Bird Survey data, the Partners in Flight (PIF) Science Committee estimated the global population of Flammulated Owl to be 20,000 birds [15]. Currently, no population estimates exist for Wyoming [16]. The statewide rank of VERY RARE is based on the rather small area of the state known to be occupied in any given season, and the small coverage of suitable habitat within that area. Even within suitable habitat in the occupied area, Flammulated Owl appears to be rare, as it occupies only a small percentage of preferred habitat within its range and may not be readily detected during surveys expected to indicate its presence [8]. However, there have been few surveys for this species in Wyoming. Survey results from Teton County, Wyoming in 2016 suggest that Flammulated Owl may be more common, at least in some years and areas, than previously thought [8, 17].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Population trends for Flammulated Owl in Wyoming are unknown. The species is assumed to have suffered population declines in the late 19th and the 20th centuries due to large-scale logging and suppression of natural fire regimes in old-growth Ponderosa Pine forests. However, the extent of this population decline and suspected subsequent recovery is unknown. Flammulated Owl appears to be more widespread and abundant than once believed, but population growth rates are not known [5].

Intrinsic Vulnerability:
HIGH VULNERABILITY
Flammulated Owl is a habitat specialist with a low annual rate of reproduction (considered a "K-selected" species with high longevity and low reproductive output), making it vulnerable to extrinsic factors that might cause decreases in longevity or fecundity [5].

Extrinsic Stressors:
MODERATELY STRESSED
Stressors to Flammulated Owl include outright habitat destruction; removal of large snags; decreases in arthropod populations as a result of pesticides, pollution or climate change; intense, large-scale wildfires; and deforestation in both winter and summer ranges. Fuel reduction and aspen restoration projects that remove large snags and live mature/old-growth aspen and conifer trees over extensive areas could cause local extirpations of Flammulated Owl. Firewood cutting can eliminate large snags needed for cavity nesting. Use of carbonyl-based insecticides kills moths that may be critical prey for Flammulated Owl, especially during the early breeding season, as many moths are cold-tolerant. Effects of climate change could result in a disparity

between breeding phenology and peak prey abundance on breeding grounds for this long-distance migrant [4].

KEY ACTIVITIES IN WYOMING

Flammulated Owl is classified as a Species of Greatest Conservation Need (SGCN) by the Wyoming Game and Fish Department (WGFD). This species is unlikely to be detected by statewide avian monitoring programs, or by surveys for other species of forest owls which are completed in March-April prior to the arrival of Flammulated Owl to its breeding sites. On July 9, 2005, a survey effort by Rocky Mountain Bird Observatory (now Bird Conservancy of the Rockies) and Audubon Wyoming (now Audubon Rockies) documented 10 singing males and found one occupied cavity nest in the Sierra Madre Range in Carbon County. One week later, a fledgling was photographed in that same area, thus confirming Wyoming's first breeding record for the species [7-9]. The Western Working Group of PIF designed Flammulated Owl a priority species and developed an action plan calling for a west-wide inventory and a regional monitoring plan [18]. Idaho, California, Colorado, and Utah participated in surveys and Bird Conservancy of the Rockies is to complete global analyses of these data [19]. Surveys were also completed in Montana in 2005 and 2008 [20]. In 2012, the Wyoming Natural Diversity Database (WYNDD) conducted call-back surveys across the Medicine Bow National Forest and detected Flammulated Owl at two sites on the western side of the Sierra Madre Range (I. Abernethy, pers. comm.). Most recently, in 2016 the Teton Raptor Center conducted Flammulated Owl call-back surveys at a total of 160 sites in the Bridger-Teton National Forest, the National Elk Refuge, and on private lands in Teton County [17]. Flammulated Owl was detected at 10% of the sites surveyed, for a total of 18 individual detections.

ECOLOGICAL INFORMATION NEEDS

Knowledge of Flammulated Owl breeding distribution in Wyoming is lacking. There are no data on preferred prey populations, amount of suitable nesting habitat, trends in nesting habitat quality, or migration routes and wintering areas for birds that nest in the state. Information is needed on what forest types and age classes are used for nesting and how demographic performance varies across the species' range. Studies are also needed on how management activities (e.g., timber thinning and harvesting, prescribed fire) affect nesting populations of Flammulated Owl. The effectiveness of nest boxes as a management tool for this species also needs investigation.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Susan M. Patla. Flammulated Owl was designated a SGCN (status unknown) in Wyoming in 2016 [8]. Although Flammulated Owl is designated a Sensitive Species in Regions 2 and 4 of the United States Forest Service (USFS), statewide, systematic surveys of potential Flammulated Owl habitat on Forest Service lands have not been conducted. Future surveys for Flammulated Owl in Wyoming should be based on protocols similar to those developed by the PIF Western Working Group, and used in adjacent states, to collect baseline data and also to contribute towards a regional population assessment [19]. Flammulated Owl can nest in disjunct patches of old-growth, so mapping potential nesting habitat accurately may be difficult given current GIS coverages. The highest likelihood for finding breeding pairs appears to be in aspen/conifer forest habitats in the southern parts of the Bridger-Teton National Forest, including the Jackson area, which are close to known nesting pairs in Idaho [7, 17]. Potential habitat in the Sierra Madre, Medicine Bow, and Laramie Mountains are also areas with high potential for finding owls. A high priority management goal for Flammulated Owl in Wyoming should be to develop a statewide monitoring strategy which would include mapping potential habitat and planning systematic surveys from May to early July statewide [19, 21]. WGFD and WYNDD have begun to develop a State Wildlife Grant proposal to initiate coordinated surveys in 2018 using broadcast call-back surveys and automated recording devices in areas of the state with suitable habitat. Additional management recommendations include: 1) conduct surveys for Flammulated Owl during the breeding season in proposed project areas on USFS and state lands that contain suitable habitat for this species throughout the state; 2) identify and conserve existing pockets of old growth Douglas-fir/mixed conifers/aspen on public and private lands in the mountain ranges of Wyoming; 3) carefully evaluate proposed treatments for insect control on forested lands of Wyoming for possible effects on breeding Flammulated Owls; 4) develop a research project to collect needed information on nesting ecology, habitat selection and prey use once an adequate sample of nest sites has been documented; and 5) test the effectiveness of using nest boxes in sites where tree cavities for nesting are limited.

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Figure 1: Adult Flammulated Owl in Garfield County, Colorado. (Photo courtesy of Bill Schmoker)

Figure 2: North American range of *Psiloscops flammeolus*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

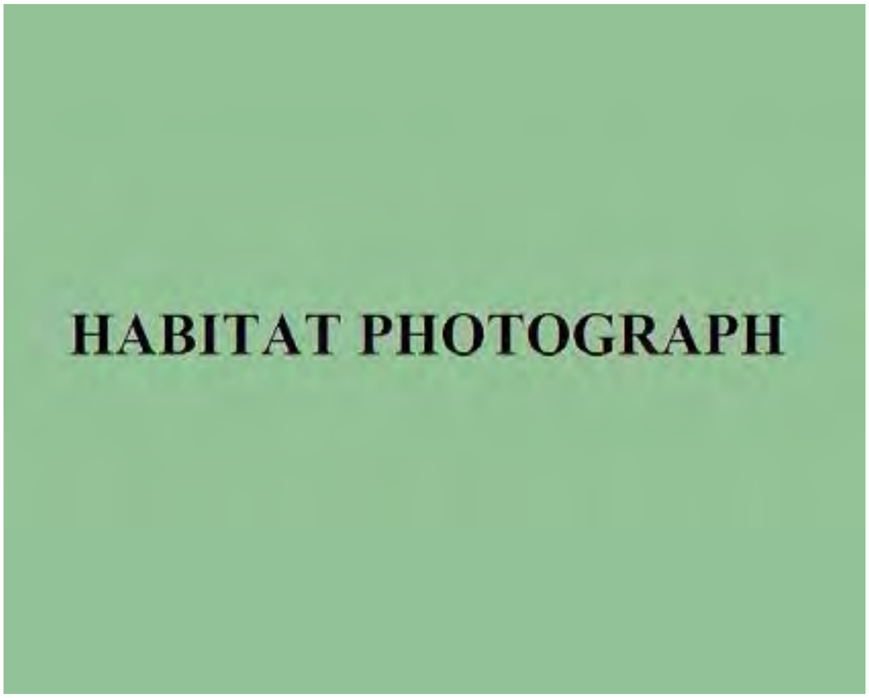

Figure 3: Photo not available.

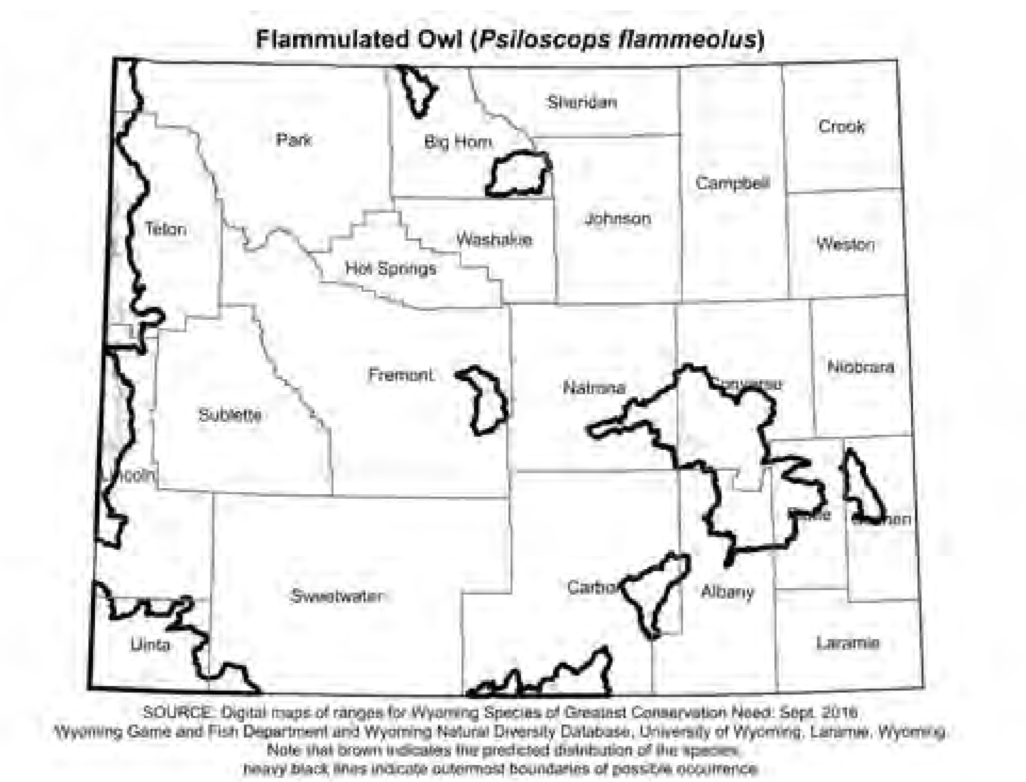

Figure 4: Range and predicted distribution of *Psiloscops flammeolus* in Wyoming.

Forster's Tern
Sterna forsteri

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G5, S1
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: Not ranked

STATUS AND RANK COMMENTS
Forster's Tern (*Sterna forsteri*) has no additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:
Although two North American subspecies have been suggested, there are currently no formally recognized subspecies of Forster's Tern [1, 2].

Description:
Identification of Forster's Tern is possible in the field. It is a medium-sized tern; adults weigh between 130–190 g, range in length from 33–36 cm, and have a wingspan of approximately 79 cm [1, 3]. The sexes are similar in size and appearance [1]. Breeding adults have a solid black cap that extends to the bottom edge of the eye, pale gray back and wings, white to light gray primaries, white underbody, long deeply notched tail, dark brown eyes, orange bill with a black tip, and orange legs and feet [1, 3]. Non-breeding adults have a black bill, dark gray primaries, and the black cap is reduced to black eye patches [1, 3]. Two other species of tern are known to breed in Wyoming: Black Tern (*Chlidonias niger)* and Caspian Tern (*Hydroprogne caspia*) [4, 5]. Forster's Tern resembles Caspian Tern in the breeding season, but Caspian Tern has a thicker red bill with a gray tip and black legs and feet [3].

Distribution & Range:
Forster's Tern is restricted to North America for both the breeding and non-breeding seasons [1]. The breeding distribution of Forster's Tern is widely scattered across Canada and the United States, but the Prairie Potholes Region and the northern Great Basin represent the two largest core areas [1]. Wyoming borders the northeastern edge of the Great Basin, and contains several small peripheral breeding areas [1]. Forster's Tern migrates through the state in the spring and fall

and is a summer resident [4, 5]. Although this species has been observed locally at waterbodies across the state, confirmed breeding has been documented in just 5 of the 28 latitude/longitude degree blocks [5].

Habitat:
Forster's Tern prefers fresh, brackish and saltwater marsh and wetland habitats [1]. Although it is most commonly found in large, open-water marshes with islands of standing emergent or floating vegetation, it will also use peripheral marsh habitat at the edges of lakes, streams, islands, estuaries and coastal beaches [1]. In Wyoming, Forster's Tern breeds primarily in large marshes and lakes, but may use any body of water below elevations of 2,286 m during migration [4]. Forster's Tern nests on a variety of substrates including marshy, sandy and cobblestone shorelines, floating and emergent vegetation, vegetated windrows, and muskrat lodges [1]. The nests themselves can range from an unlined ground scrape to a mound of local marsh plants [1].

Phenology:
In Wyoming, spring arrival of migrating and breeding Forster's Terns typically begins in late April and peaks from mid to late May [4]. Very little is known about the specific nesting and breeding phenology of this species in Wyoming, but nest initiation has been observed as early as late May [4]. Clutch size can range from 1–4 eggs, although clutches of 2 or 3 eggs are most common [1]. Forster's Tern is considered a single-brood species, but will often renest following the loss of the first clutch [1]. Fall migration from Wyoming starts in July and peaks in late August and early September [4].

Diet:
Forster's Tern is primarily piscivorous, consuming a variety of small fish species 1–10 cm in length, as well as some arthropods [1].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
There are no robust estimates of abundance available for Forster's Tern in Wyoming. The statewide abundance rank of VERY RARE is based on the rather small area of the state known to be occupied in any given season, and the small coverage of suitable habitat within that area. However, within suitable habitat in the occupied area, Forster's Tern appears to be common and is usually encountered during surveys that could be expected to indicate its presence [5]. Colonial nesting waterbird surveys conducted from 2002–2006 by the Wyoming Game and Fish Department (WGFD) recorded a range of 33 to 116 individuals annually across all surveyed sites [6-10]. From 1968–2015, annual Wyoming Breeding Bird Survey (BBS) detections of Forster's Tern ranged from 0 to 6, with none recorded in most years [11]. Only 2 Forster's Terns were detected during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [12]. While surveys conducted as part of the BBS and IMBCR programs may occasional detect this species, neither is specifically designed to capture tern observations.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN

Robust population trends are not available for Forster's Tern in Wyoming because the species is infrequently detected during monitoring efforts. North American BBS survey-wide trend data have deficiencies, and should be viewed with caution, but suggest that Forster's Tern numbers declined annually by 1.72% from 1966–2013 and increased annually by 1.82% from 2003–2013 [13]. Neither trend estimate was statistically significant.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Forster's Tern has moderate intrinsic vulnerability in Wyoming due to a narrow range of habitat use, low density of occurrence, colonial nesting behaviors, and inherent risk of bioaccumulation. Forster's Tern abundance and breeding distribution is limited by a preference for large, productive wetlands and marshes. These habitat types are naturally uncommon in Wyoming, which is one of the most arid states in the country [14, 15]. Natural or anthropogenic disturbance to breeding colonies can potentially affect large numbers of nesting individuals and negatively impact local populations of Forster's Tern. As a primarily piscivorous species, Forster's Tern is inherently at risk for physiological and reproductive stress caused by bioaccumulation of environmental contaminants from feeding in polluted aquatic habitats [1, 16-20]. Existing research has examined mercury toxicity in marine habitats or interior saline waterbodies such as the Great Salt Lake, Utah. The extent to which Forster's Tern is exposed to environmental contaminants in freshwater habitats in Wyoming is unknown.

Extrinsic Stressors:
SLIGHTLY STRESSED
Forster's Tern is slightly stressed by extrinsic stressors in Wyoming, where already limited natural wetland habitat is potentially vulnerable to climate change and drought, invasive plant species, and development for infrastructure, energy, and agriculture [14, 15]. Natural wetlands in Wyoming are declining in size and number, with less than 2% of the total state area classified as wetland habitat [14, 15]. Forster's Tern colonies located in close proximity to California Gull (*Larus californicus*) colonies in California were susceptible to high rates of chick mortality from gull predation [21]. The breeding distribution of Forster's Tern in Wyoming overlaps with several gull species, including California Gull [4, 5]; however, predation risk to Forster's Tern chicks at these locations is expected to be nominal.

KEY ACTIVITIES IN WYOMING

Forster's Tern is classified as a Species of Greatest Conservation Need (SGCN) by the WGFD, and as a Level I Priority Bird Species requiring conservation action in the Wyoming Bird Conservation Plan [22]. Current statewide bird monitoring programs are designed for monitoring breeding songbird populations and are unlikely to provide useful information on Forster's Tern. These monitoring programs include the BBS program conducted on 108 established routes since 1968 [13], and the multi-agency IMBCR program initiated in 2009 [12]. Since 1984, WGFD has conducted annual or periodic monitoring at the most important and productive sites for colonial waterbird SGCN to determine species presence and distribution, and to estimate number of nesting pairs. The most recent effort was the culmination of a multi-year cooperative agreement between the WGFD and the United States Fish and Wildlife Service to conduct an intensive survey of all historic, known, potential, and new colonial waterbird breeding sites statewide as part of a western range-wide effort to track population size, trends, and locations of breeding colonial waterbirds in the western United States [23, 24]. In 2014, an online Atlas of western colonial waterbird nesting sites was produced with data collected and submitted by participating states [25]. Every three to five years, WGFD personnel visit known colonial waterbird nesting sites outside of Yellowstone National Park to evaluate water level conditions, determine species present at each site, and estimate the number of nesting pairs of colonial waterbirds. There are currently no research projects designed specifically for Forster's Tern in Wyoming.

ECOLOGICAL INFORMATION NEEDS

In Wyoming, Forster's Tern would benefit from research to determine its detailed distribution, the location and habitat characteristics of all current breeding locations, and the annual abundance of migrating and breeding adults. Beyond approximate arrival and departure dates, very little is known about migratory pathways, or the phenology of local breeders in Wyoming. Nothing is known about nest success, predation risk, fledgling survival, or risk of exposure to aquatic contaminants at the nine known breeding locations in the state. Wyoming's wetland and marsh habitats are scarce and inherently vulnerable, and current and future anthropogenic and natural stressors should be identified to ensure the persistence of breeding habitat for Forster's Tern.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. The colonial nature of Forster's Terns and other waterbirds makes these species particularly vulnerable across their range to loss or degradation of nesting sites, stochastic weather events such as drought and flooding, changing land use practices, pollution, and climate change. In Wyoming, Forster's Tern is classified as a Species of Greatest Conservation Need due to limited suitable aquatic or wetland breeding habitat, sensitivity to human disturbance during the breeding season, and susceptibility of nests to fluctuating water levels [14]. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [13] and IMBCR [12] programs. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, colonial waterbirds are one of the species groups that warrant a targeted, species-specific survey method approach to obtain these data. WGFD conducted inventories of nesting colonial waterbirds, including Forster's Tern, from 1984–1986 [26, 27]. In 1990, WGFD summarized all information presently known on colonial nesting waterbirds in Wyoming [28]. Since 1984, WGFD has conducted annual or periodic monitoring at the most important and productive sites for colonial waterbird Species of Greatest Conservation Need. Results have shown Forster's Tern nesting at nine sites in Wyoming; Ocean Lake near Riverton, Cokeville Meadows National Wildlife Refuge near Cokeville, and five sites within the Laramie Plains Basin near Laramie [5]. Due to their sensitivity to human disturbance during the nesting season, the survey technique used for colonial waterbirds is minimally invasive and provides only an estimate of the number of breeding pairs and coarse habitat associations of each waterbird species present in the colony. Actual nests, eggs, or young are not located or counted to prevent colony disruption and reduce predation risk. From 2009–2012, WGFD and the USFWS cooperated to conduct a rigorous survey of all historic, known, potential, and new colonial waterbird breeding sites statewide as part of a western range-wide effort to track population size, trends, and locations of breeding colonial waterbirds in the western United States [23, 24]. A total of 90 sites were evaluated in Wyoming; 86 potential colonial waterbird nesting sites and 4 known nesting sites. A lack of adequate emergent vegetation to provide secure nesting areas for colonial waterbirds was noted at most potential sites visited. An online Atlas of western colonial waterbird nesting sites was produced with data collected and submitted by participating states [25]. Best management practices to benefit Forster's Tern include maintaining large, high quality wetland complexes; keeping water levels stable during the nesting season; installing artificial nest platforms where needed; protecting any colony site used by Forster's Tern; keeping human disturbance to a minimum during the breeding season, and monitoring colony sites every three years to determine Forster's Tern presence and estimate number of nesting pairs [14, 22].

Contributors

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Figure 1: A flying Forster's Tern in breeding plumage in Walden, Colorado. (Photo courtesy of Bill Schmoker)

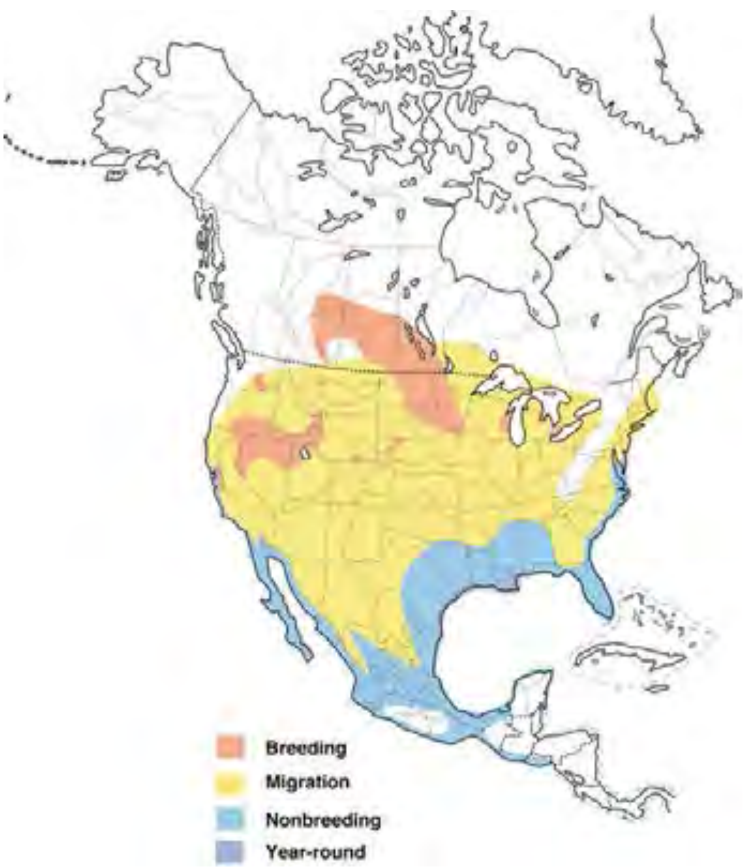

Figure 2: North American range of *Sterna forsteri*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

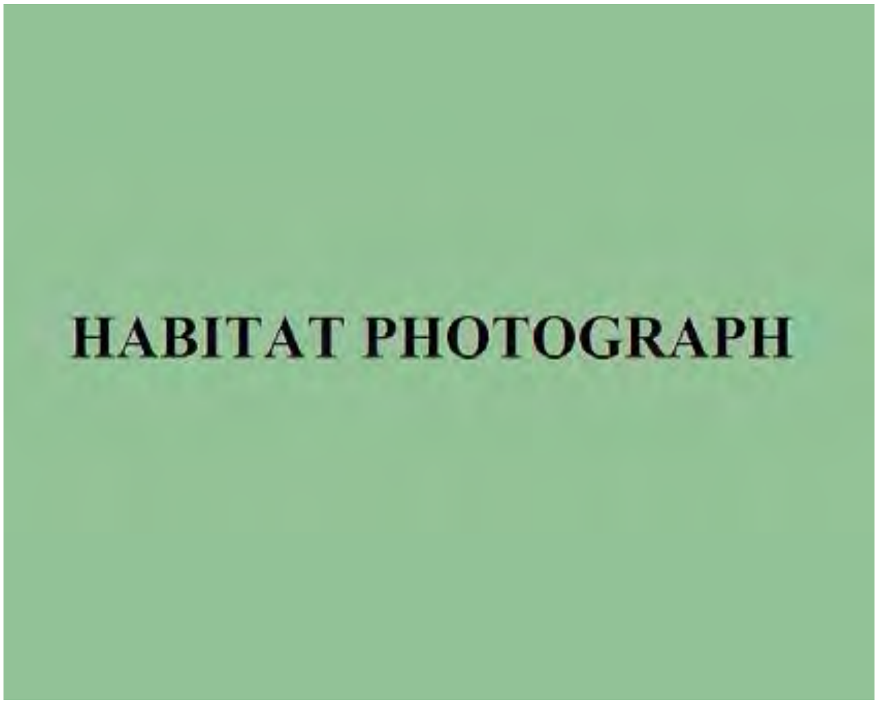

Figure 3: Photo not available.

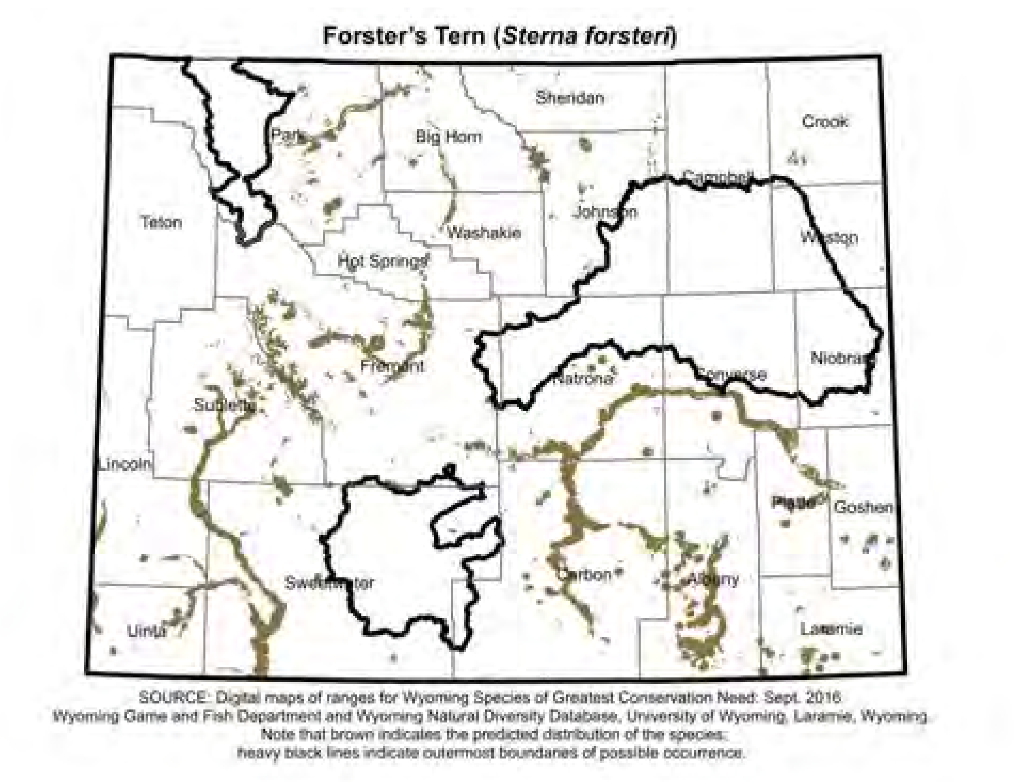

Figure 4: Range and predicted distribution of *Sterna forsteri* in Wyoming.

Franklin's Gull

Leucophaeus pipixcan

REGULATORY STATUS

USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: No special status
WGFD: NSSU (U), Tier II
WYNDD: G4G5, S1
    Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: Not ranked

STATUS AND RANK COMMENTS

Franklin's Gull (*Leucophaeus pipixcan*) has no additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:

Following the reclassification of the genus *Larus* in 2008, Franklin's Gull (formerly *Larus pipixcan*) was moved to the genus *Leucophaeus* [1]. There are currently no recognized subspecies of Franklin's Gull [2, 3].

Description:

Identification of Franklin's Gull is possible in the field. It is a small gull; adults weigh between 250–325 g, range in length from 33–36 cm, and have wingspans of 85–95 cm [2]. The sexes are similar in size and appearance [2]. In the breeding season, Franklin's Gull has a solid black head, thick white arcs above and below the eyes, dark gray back and wings, black primaries with white tips, white underbody that may be tinted pink, black eyes, dark red bill, and dark red to reddish-black legs and feet [2, 4]. The distinct white eye arcs remain in the non-breeding season, but the black head fades to a partial hood, and the bill, legs, and feet darken to mostly black [2, 4]. Two other species of gull are classified as summer residents in Wyoming and are known to breed in the state: Ring-billed Gull (*Larus delawarensis*) and California Gull (*Larus californicus*) [5, 6]. Franklin's Gull can easily be distinguished from both Ring-billed Gull and California Gull in the breeding season by its black head [4].

Distribution & Range:

The core breeding distribution of Franklin's Gull is in the Prairie Potholes Region (PPR) of Canada and the United States, extending through parts of Alberta, Saskatchewan, and the Northwest Territories and south to northern Montana and northeastern South Dakota [2]. Wyoming lies well south of the PPR, but the western edge of the state borders several of the small peripheral Franklin's Gull breeding areas scattered throughout the northwestern United States [2]. Franklin's Gull migrates through Wyoming in the spring and fall and is a summer resident [5, 6]. This species has been observed at waterbodies across the state; however, confirmed or suspected breeding has been documented in just 3 of the 28 latitude/longitude degree blocks, all in far-western Wyoming [6]. Franklin's Gull winters south of the equator on the western coast of South America [2].

Habitat:
Franklin's Gull breeds in large, inland, freshwater prairie wetlands and marshes with emergent vegetation interspersed with areas of open water [2]. In Wyoming, Franklin's Gull breeds and forages in marshes, wetlands, and lakes below 2,500 m, but will also forage in agricultural fields [5-7]. Both sexes participate in the construction and daily maintenance of the nest, which is typically a floating platform of wet vegetation positioned within sparse emergent vegetation. New plant material is added to the nest every day throughout the breeding season to ensure it stays above the surface of the water [2, 7]. This species most commonly winters in marine coastal habitat, from the littoral zone to as far as 50 km offshore, and in bays and estuaries [2].

Phenology:
In Wyoming, spring arrival of migrating and breeding Franklin's Gulls starts in early April and peaks in the middle of May [5], but very little is known about the specific nesting and breeding habits of this species in the state. Franklin's Gull nests in colonies, and males solicit females from established territories [2]. Clutches of approximately 3 eggs are initiated about a week after the start of nest construction, and eggs likely hatch between late May and early or mid-June [2]. Franklin's Gull is a single-brood species [2]. In Wyoming, fall migration to wintering grounds peaks in early September, with most migrants and residents leaving the state by early October [5].

Diet:
Franklin's Gull is a year-round generalist, feeding on a variety of terrestrial and aquatic foods depending on season and availability, including insects, earthworms, larvae, seeds, plant matter, rodents, fish, crabs, snails, other invertebrates, and refuse from garbage dumps and fisheries [2, 7].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
There are no robust estimates of abundance available for Franklin's Gull in Wyoming. The species has a statewide abundance rank of VERY RARE but appears to be common within suitable environments in the occupied area [6]. Colonial nesting waterbird surveys conducted from 2002–2006 by the Wyoming Game and Fish Department (WGFD) recorded a range of 0 to 5 individuals annually across all surveyed sites [8-12]. From 1968–2015, annual Wyoming Breeding Bird Survey (BBS) detections of Franklin's Gull ranged from 0 to 136, with none recorded in most years [13]. Only 1 Franklin's Gull was detected during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [14]. While surveys conducted as part of the BBS and IMBCR programs may occasional detect this species, neither is specifically designed to capture gull observations.

Population Trends:
Historic: LARGE DECLINE
Recent: UNKNOWN
Robust population trends are not available for Franklin's Gull in Wyoming because the species is infrequently detected during monitoring efforts. The species has faced large historic declines across its continental distribution. Survey-wide trend data from the North American BBS indicate that Franklin's Gull numbers experienced a statistically significant annual decline of 3.96% from 1966–2013 and a non-significant annual decline of 0.87% from 2003–2013 [15]. In the PPR, Franklin's Gull numbers declined annually by 1.49% from 1966–2013 and increased annually by 1.01% from 2003–2013; however, neither trend estimate was statistically significant [15].

Intrinsic Vulnerability:
HIGH VULNERABILITY
Franklin's Gull has high intrinsic vulnerability in Wyoming due to low abundance, a narrow range of breeding habitat requirements, and colonial nesting and nest-building behaviors that potentially leave the species susceptible to disturbance. The distribution of Franklin's Gull is limited by a preference for productive wetlands and marshes, which are relatively uncommon in the state [7, 16]. Natural or anthropogenic disturbance to Forster's Tern breeding colonies can potentially affect large numbers of nesting individuals and negatively impact local populations. In addition, the floating nests of this species are vulnerable to damage or loss from surface disturbance and fluctuating water levels, which commonly occur on water bodies in Wyoming [2].

Extrinsic Stressors:
MODERATELY STRESSED
Franklin's Gull is moderately stressed by extrinsic stressors in Wyoming, where already limited natural wetland habitat is potentially vulnerable to climate change and drought, invasive plant species, and development for infrastructure, energy, and agriculture [7, 16, 17]. Drought can render previously productive migration, breeding, and foraging sites unsuitable through the contraction or complete loss of wetland habitat and changes to the structure and availability of emergent aquatic vegetation [18, 19]. Early in the breeding season, anthropogenic disturbance can cause Franklin's Gull to abandon nests or even entire colonies [7]. The species may experience bioaccumulation of some environmental contaminants from feeding on fish and aquatic invertebrates in polluted habitats [2, 7].

KEY ACTIVITIES IN WYOMING
Franklin's Gull is classified as a Species of Greatest Conservation Need (SGCN) by the WGFD, and as a Level I Priority Bird Species requiring conservation action in the Wyoming Bird Conservation Plan [7]. Current statewide bird monitoring programs are designed for monitoring breeding songbird populations and are unlikely to provide useful information on Franklin's Gull. These monitoring programs include the BBS program conducted on 108 established routes since 1968 [15], and the multi-agency IMBCR program initiated in 2009 [14]. Since 1984, WGFD has conducted annual or periodic monitoring at the most important and productive sites for colonial waterbird SGCN to determine species presence and distribution, and to estimate number of nesting pairs. The most recent effort was the culmination of a multi-year cooperative agreement between the WGFD and the United States Fish and Wildlife Service to conduct an intensive survey of all historic, known, potential, and new colonial waterbird breeding sites statewide as part of a western range-wide effort to track population size, trends, and locations of breeding

colonial waterbirds in the western United States [20, 21]. In 2014, an online Atlas of western colonial waterbird nesting sites was produced with data collected and submitted by participating states [22]. Every three to five years, WGFD personnel visit known colonial waterbird nesting sites outside of Yellowstone National Park to evaluate water level conditions, determine species present at each site, and estimate the number of nesting pairs of colonial waterbirds. There are currently no research projects designed specifically for Franklin's Gull in Wyoming.

ECOLOGICAL INFORMATION NEEDS

In Wyoming, Franklin's Gull would benefit from research to determine its detailed distribution, the location and habitat characteristics of current breeding colonies, and the annual abundance of migrating and breeding adults. Beyond approximate arrival and departure dates, very little is known about migratory pathways, or the specific breeding habits of local breeders in Wyoming. Nothing is known about nest success or fledgling survival at the few known breeding locations in the state. Due to the scarcity and inherent vulnerability of Wyoming's wetland and marsh habitats, it would be valuable to identify current and future anthropogenic and natural stressors to ensure the persistence of breeding habitat for Franklin's Gull.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Zachary J. Walker. Franklin's Gull is classified as a SGCN in Wyoming due to varying annual availability and suitability of breeding sites and sensitivity to human disturbance during the nesting period. Colonial water bird surveys are conducted within the state, but existing data are not robust enough to support estimates of occupancy, density, or population trend. Targeted, species-specific survey methods may be warranted. Best management practices or key management recommendations to benefit Franklin's Gull include protection of suitable wetland complexes, protection of all Franklin's Gull breeding colonies, avoidance of disturbing nest sites from April through August, and maintenance of stable water levels throughout the nesting season at breeding locations [7, 16].

CONTRIBUTORS

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Figure 1: Adult Franklin's Gull in breeding plumage in Corpus Christi, Texas. (Photo courtesy of Bill Schmoker)

Figure 2: North American range of *Leucophaeus pipixcan*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

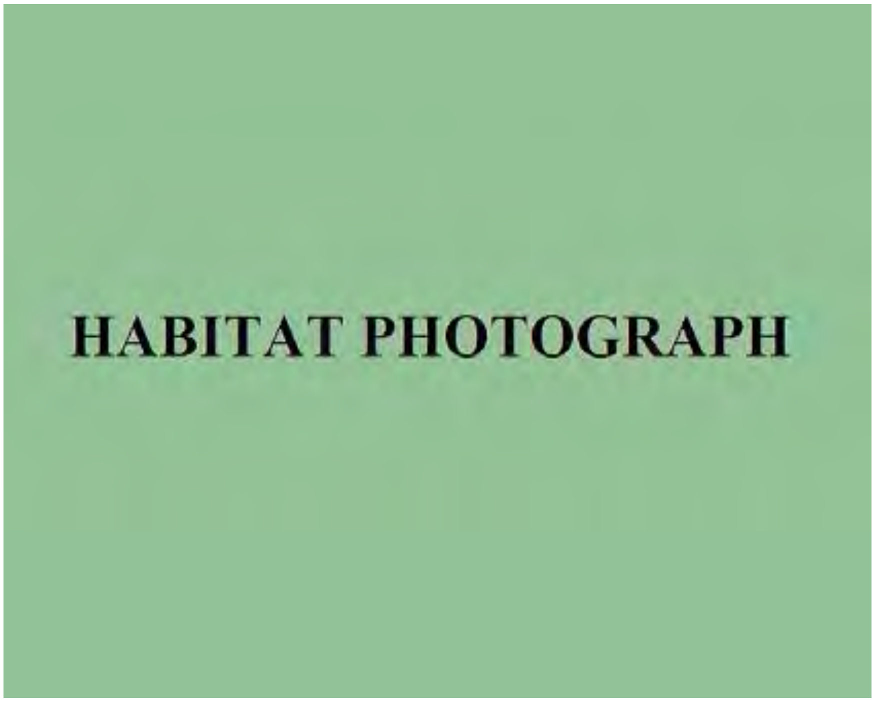

Figure 3: Photo not available.

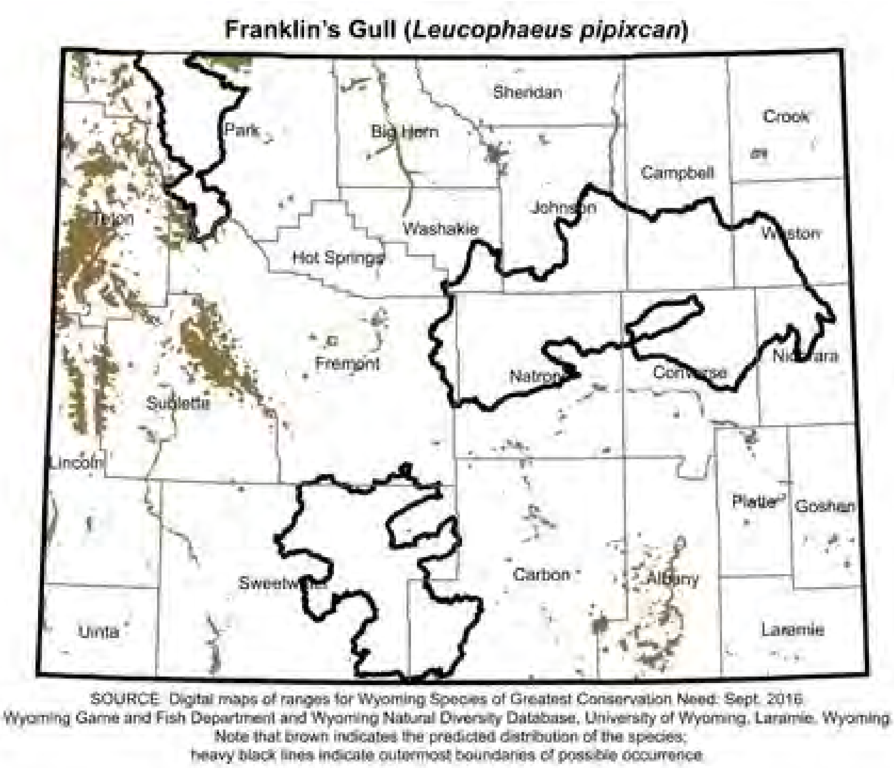

Figure 4: Range and predicted distribution of *Leucophaeus pipixcan* in Wyoming.

Figure 5: A flying Franklin's Gull in Red Rock Lakes National Wildlife Refuge, Montana. (Photo courtesy of Elizabeth Boehm)

Golden Eagle
Aquila chrysaetos

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: Bird of Conservation Concern
WGFD: NSS4 (Bc), Tier II
WYNDD: G5, S5B/S4S5N
Wyoming Contribution: MEDIUM
IUCN: Least Concern
PIF Continental Concern Score: 10

STATUS AND RANK COMMENTS
Golden Eagle (*Aquila chrysaetos*) is protected by the Bald and Golden Eagle Protection Act of 1940, as amended [1]. Golden Eagle has been assigned different state conservation ranks by the Wyoming Natural Diversity Database for the breeding and non-breeding seasons because of potential differences in distribution and abundance of the species among seasons. Additionally, the species has been assigned a range of state conservation ranks for the nonbreeding season because of uncertainties regarding distribution, abundance, and threats to Golden Eagle during this season.

NATURAL HISTORY
Taxonomy:
Five or six subspecies of Golden Eagle are recognized worldwide. Only one subspecies is found in North America: *A. c. canadensis*. The remaining subspecies occur in Eurasia. It is uncertain if individuals from northeast Asia constitute a unique subspecies [2].

Description:
Identification of Golden Eagle is possible in the field. Golden Eagle is the second largest North American raptor, and the largest found in Wyoming. The species has a wingspan of over 2 m and stands up to 1 m tall when perched [3]. Males and females are identical in plumage, although females are larger in size. Adults have dark brown plumage overall, a gold tinted crown and nape, yellow legs, and yellow bill with a black tip [3]. Golden Eagle takes up to five years to reach full adult plumage, but all age classes are similar in overall appearance. Juvenile and sub-adult birds have a broad white band across the base of the tail and white patches on the underwing that vary in size among individuals, but generally become smaller with age [4]. In Wyoming, the only other very large soaring raptor is Bald Eagle (*Haliaeetus leucocephalus*). Adult Bald Eagle has an all-white head and tail, while Golden Eagle is dark overall. Juvenile and sub-adult Bald Eagle

has more extensive white on the underside of the wings and tail than any age class of Golden Eagle, and white patches on the underwing of Golden Eagle are restricted to the base of the flight feathers [3].

Distribution & Range:
Golden Eagle is broadly distributed across the Northern Hemisphere worldwide. In North America, the species is generally found west of the 100th meridian during the breeding season, with a scattered breeding distribution in the northern and eastern arctic. Wyoming is in the center of the species' western range, and Golden Eagle occurs across the state year round. Golden Eagle has been documented as breeding in all of Wyoming's 28 latitude/longitude degree blocks [5]. Individuals breeding at more northern latitudes migrate south during the non-breeding season and winter throughout the breeding range in the western U.S. and Mexico, including Wyoming [2]. Historically, Golden Eagle bred across North America, but portions of its historical distribution are not currently occupied [2].

Habitat:
In Wyoming, Golden Eagle occurs throughout the state in a wide variety of habitats including sagebrush steppe, desert shrubland, prairie grassland, juniper woodland edges, lower elevation riparian areas, and mountainous cliff habitat in high elevation areas [5, 6]. The species generally nests on cliff faces and rock outcrops in open habitats [2], but also nests on trees [7], river banks [8], and manmade structures [9]. Proximity to foraging habitat appears to be an important factor in nest site selection [9, 10]. Nesting territories often include multiple alternative nests that are likely to be reused and can be occupied over a century if undisturbed [11]. Wyoming represented the largest concentration of high-suitability habitat for Golden Eagle during late summer in the western United States due to the prevalence of undisturbed landscapes with high wind speeds, moderate aridity, and relatively little forest cover [12]. During migration and the non-breeding season, the species uses similar habitats as during the breeding season, as well as wetlands and reservoir areas [2]. Winter distribution of Golden Eagle in Wyoming likely shifts to lower elevations, as short-distance migrants move downslope from high-elevation mountainous terrain.

Phenology:
In Wyoming, the breeding population of Golden Eagle is considered non-migratory [13]. Territory establishment is initiated in early February, courtship begins in early March, and young have fledged by the end of July [14]. Incubation lasts 41–45 days, and hatching occurs between early March and late June. Young fledge from the nest between 45 and 84 days of age [2]. Young stay with the parents for 1–6 months after fledging. In the Laramie Basin, Schmalzried [15] documented egg laying between 23 March and 4 April, hatching from 2 May to 31 May, and fledging from 15 July to 7 August. In southcentral Wyoming, Millsap [16] documented an earlier phenology, with laying from 11 March to 4 April, hatching from 7 April to 18 May, and fledging from 12 June to 11 July. Golden Eagles in the northern part of the range in North America migrate south in September and October [2, 17]. Passage of Golden Eagle through Wyoming occurs during September and October, and likely continues into November [13, 18]. Large concentrations of migrant eagles can occur throughout the winter months depending on prey availability such as carrion, leporids, and waterfowl [14, 19 20].

Diet:
The diet of Golden Eagle in Wyoming is composed primarily of leporids (family leporidae: jackrabbits, *Lepus* spp.; and cottontail rabbits, *Sylvilagus* spp.), secondarily of sciurids (family sciuridae: ground squirrels, *Urocitellus* spp.; and prairie dogs, *Cynomys* spp.), and also includes

fawns of pronghorn (*Antilocapra americana*), various other mammals, and birds [21]. The species' diet varies with habitat and season, with carrion consumed more frequently during winter [2, 21].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: COMMON
Using North American Breeding Bird Survey (BBS) data, the Partners in Flight Science Committee estimated the global population of Golden Eagle to be 300,000 birds [22], with 12,000 birds (4.3% of the global population) occurring in Wyoming during the breeding season [23]. The most recent population estimate for Golden Eagle in the United States including Alaska was approximately 39,000–40,000 in 2014 [24]. Results from surveys in Wyoming from 1973–1978 estimated statewide abundance of 4,174 nesting pairs and average density of 60 km^2/nesting pair, excluding approximately 20% of the state classified as marginal habitat [8]; however, this study may have overestimated the population size because it did not use design-based sampling and extrapolated from study areas with high-quality habitat [6]. A recent study from 2010–2011 reported a considerably lower density of 165.9 km^2/nesting pair of Golden Eagle within the breeding range of Ferruginous Hawk in Wyoming (approximately 50% of the state) [25]. The influx of migrants increases the population size in Wyoming during winter, although abundance fluctuates with prey availability [14]. Winter season aerial surveys conducted during January of 1972 and 1973 suggested abundance of 11,965 and 10,554 Golden Eagle, respectively [19]. The statewide rank of COMMON is based on the relatively large area of the state known to be occupied in any given season, and the large coverage of suitable habitat within that area.

Population Trends:
Historic: MODERATE DECLINE
Recent: STABLE
The population of Golden Eagle in the western United States is thought to be stable or possibly declining [26]. The annual aerial transect survey conducted across portions of thirteen western states, including Wyoming, did not show any statistically significant population trends for juveniles or all age-classes between 2006 and 2015 [27]. Models integrating data from the aerial survey and the BBS suggested populations were stable during 1968–2014 [26], while demographic models developed by U.S. Fish and Wildlife Service (USFWS) project a gradual decline in the future [24]. Apparent long-term stability of golden eagle populations across the western U.S. still allows for divergent trends in abundance and other demographic rates at local and regional scales. For example, two studies in Wyoming reported declines in the number of occupied nests: the number of occupied nesting territories within a 3,215-km^2 study area near Medicine Bow declined from 50 in 1978, to an average of 28.5 from 1997–2000, and 27 in 2009 [28]. Similarly, the number of occupied Golden Eagle nests in a 783-km^2 study area north of Baggs declined from 16 in 1993, to 0 in 1994, and 3 in 2008 [29]. A recent status review of Golden Eagle in Wyoming suggested that a severe statewide decline in nesting eagles and leporids occurred in 1993 and the abundance of nesting eagles in low elevation areas has stabilized at lower levels since then [6]. Abundance of nesting pairs in mountainous habitats in western Wyoming, however, appears to have remained stable or increased since the late 1970s [6].

Intrinsic Vulnerability:
MODERATE VULNERABILITY

Golden Eagle has moderate intrinsic vulnerability in Wyoming because of its slow life history strategy and relatively low density. Golden Eagle does not reach sexual maturity until 4–5 years of age, has relatively low fecundity, and a long life expectancy [2]. Reproductive output fluctuates with prey abundance – especially of leporids in Wyoming – and females may not lay eggs during low prey years [6]. Golden Eagle populations are, therefore, sensitive to changes in adult and sub-adult survival, and any factors that increase mortality rates of these age classes could trigger population declines [24]. Additionally, the species occurs at low density and has a large breeding season home range (up to 89 km^2) [8] and even more extensive winter home range (e.g., minimum of 5,420.5 km^2) [30].

<u>Extrinsic Stressors</u>:
SLIGHTLY STRESSED
Human activities are the leading cause of mortality for Golden Eagle [2]. Golden Eagle experiences high rates of fatality at wind energy facilities and is thought to be one of the most vulnerable species to wind energy development [31-33]. Other anthropogenic sources of mortality include collisions with fences and vehicles [2], electrocution on power lines [34, 35], shooting[35, 36], trapping [2], poisoning and contaminants such as lead and mercury [37-39]. Human disturbance of Golden Eagle nests may lead to reduced productivity: for example, territories in areas with significant increases in off-highway vehicle use were less productive than those with little or no motorized recreation [40]. Declines in prey populations resulting from drought, wildfire, or disease can cause declines in nesting populations [6, 41].

<u>KEY ACTIVITIES IN WYOMING</u>

Golden Eagle has been federally protected under the "Bald and Golden Eagle Protection Act," and subsequent amendments, since 1940. This act prohibits the "take" of Golden Eagles and Bald Eagles, which also includes parts, nests, and eggs of the species. This act also provides year-round protection for nest sites that may be affected by human activities [1]. Although Golden Eagle was not designated a state species of conservation concern until 2016, Wyoming Game and Fish Department (WGFD) initiated nest occupancy and productivity surveys for this species in 1978–1982 and has since collected data on nesting eagles in various areas of the state [6, 28, 42]. In 1996, the WGFD and the Bureau of Land Management began long term raptor nest surveys in Wyoming to provide an inventory of nest locations focused in areas with potential oil and gas development [42]. A more focused study in 2009 examined the population trend of nesting raptors, including Golden Eagle, in response to wind energy development over a 10-year period in Carbon and Albany counties [28]. A large-scale study was initiated in 2010 to evaluate the effects of energy development on both Ferruginous Hawk and Golden Eagle abundance, nesting density, occupancy, and reproduction in lowland areas of Wyoming based on aerial line transect surveys of 99 randomly selected townships [25]. Data on Golden Eagle have been summarized in a preliminary status review for the state [6]. Data on abundance and population trends have also been collected in Wyoming as part of a long-term regional monitoring effort in the western U.S. based on line-transect distance sampling [26, 27, 43]; results of this survey are summarized for Bird Conservation Regions and estimates specific to the state of Wyoming are not available. An intensive demographic study in the Bighorn Basin has provided valuable information on reproductive rates and diet of Golden Eagle in this area of the state [44]. Overall, the nesting population in Wyoming appears to be stable [27] following a decrease in the number of nesting pairs in lowland areas of the state in 1993 related to a large drop in leporid prey populations [6]. Other ongoing monitoring efforts that provide data on occurrence, abundance, or trend of Golden

Eagle in Wyoming include counts of migrating raptors conducted annually since 2002 at Commissary Ridge in southwestern Wyoming [18], BBS surveys [23], and point counts from the Integrated Monitoring in Bird Conservation Regions program [45]. Some Golden Eagles are captured in Wyoming for falconry, and the WGFD monitors annual harvest [46, 47].

ECOLOGICAL INFORMATION NEEDS

Recent research on Golden Eagle has helped determine relatively reliable estimates of abundance and trend for populations in Wyoming and the western U.S. [6, 25, 43, 44]. Although the breeding population currently appears to be stable, given uncertain effects of increasing energy development on this species [32, 48], a key need is to design and implement a long-term monitoring program [6]. Knowledge is lacking on major factors that drive population trend year round, including habitat modification, contaminants (heavy metals and anti-coagulant rodenticides, such as Rozal), disease (West Nile virus), and direct and indirect effects of energy development [2, 49]. Data are also lacking on winter ecology and distribution, migration concentration areas, and juvenile dispersal patterns [48]. Long-term monitoring and research on key prey species (i.e., leporids) is also needed to understand year-to-year fluctuations and long-term trends in Golden Eagle populations [6].

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona and Susan M. Patla. A priority for Golden Eagle management identified in a recent status review of the species in Wyoming is to develop a design-based monitoring program using existing data sets that include randomly selected nesting territories [6]. A recent evaluation of results from a landscape scale study to determine abundance and density of nesting pairs suggested fixed-winged surveys are more cost effective than helicopters for surveying large areas of the state with relatively smooth terrain [25]. Work is underway to determine if preferred habitats have been adequately sampled in the past and to develop a state-wide monitoring strategy [50]. In May 2015, a Raptor Symposium was held in Campbell County to address issues concerning energy development and raptors in eastern Wyoming. Topics of discussion included developing a centralized raptor survey database [51]. Efforts to form a Wyoming Golden Eagle Working Group were initiated in 2015 and the group held its first meeting in November 2016, including participants from federal and state agencies, the USFWS Western Golden Eagle Team (WGET), researchers, and NGOs. Some of the major objectives developed by the group include information sharing, coordination of efforts, review of conservation strategies and management plans, identification of data gaps, and reaching out to include a broader spectrum of participants [49]. The USFWS formed the WGET in 2013 to address energy-related conservation needs of Golden Eagles by developing landscape-scale conservation strategies. Conservation strategies are currently being developed for the Wyoming Basin and Northwestern Great Plains ecoregions in Wyoming [52]. A web site will be developed by WGET to provide information and reports on this regional effort. Predictive spatial models have recently been developed of nesting occurrence in relation to areas of the state suitable for wind energy development [48] and additional data products being developed by WGET include models of habitat suitability for nesting and winter seasons [52]. The authors recommend using these models to identify important target areas for conservation in the state.

CONTRIBUTORS

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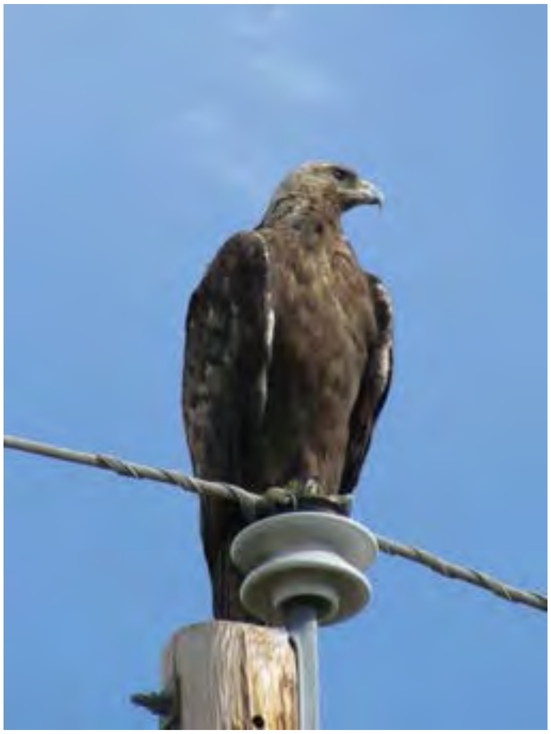

Figure 1: Golden Eagle in southwest Wyoming. (Photo courtesy of Kaylan A. Hubbard)

Figure 2: North American range of *Aquila chrysaetos*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Golden Eagle nesting habitat in the Bighorn Basin near Leiter, Montana. (Photo courtesy of Erik Jansen)

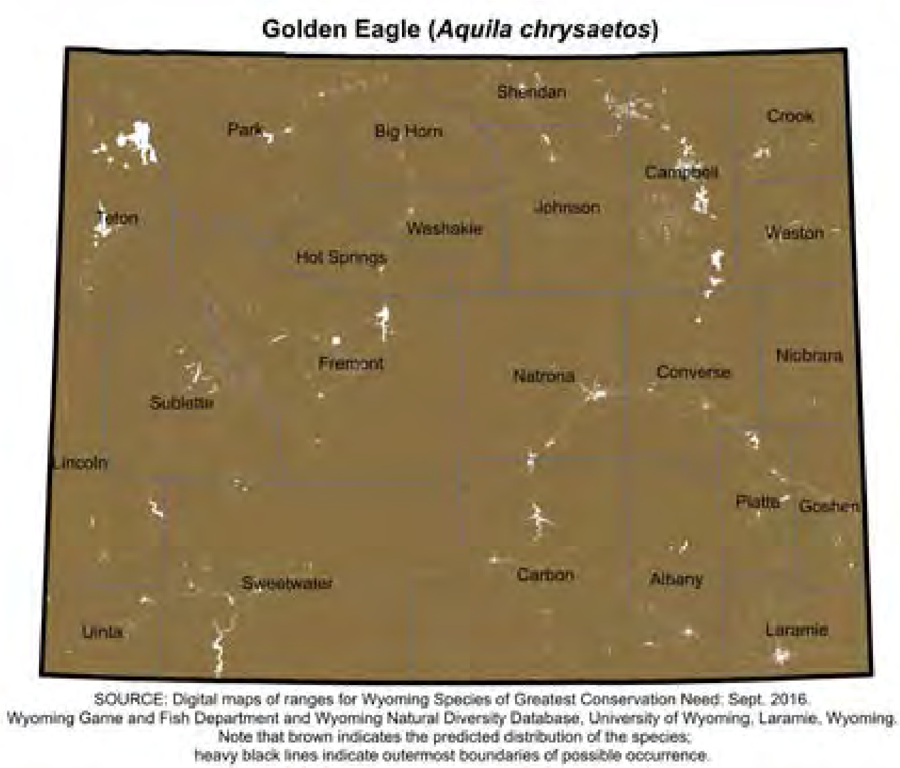

Figure 4: Range and predicted distribution of *Aquila chrysaetos* in Wyoming.

Figure 5: Golden Eagle in flight in Albany County, Wyoming. (Photo courtesy of Shawn Billerman)

Grasshopper Sparrow

Ammodramus savannarum

REGULATORY STATUS

USFWS: Migratory Bird
USFS R2: Sensitive
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: Bird of Conservation Concern
WGFD: NSS4 (Bc), Tier II
WYNDD: G5, S4
Wyoming Contribution: MEDIUM
IUCN: Least Concern
PIF Continental Concern Score: 12

STATUS AND RANK COMMENTS

Grasshopper Sparrow (*Ammodramus savannarum*) has no additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:

There are eleven or twelve recognized subspecies of Grasshopper Sparrow. Of the four subspecies that breed in North America, only *A. s. perpallidus* is found in Wyoming [1, 2].

Description:

Identification of Grasshopper Sparrow is possible in the field. The species is similar in size and shape to most sparrows, about 11 cm long. Males, females, and juveniles are identical in appearance. The species has a small, flat head with a pale stripe through the darkish crown, combined with an unstreaked breast and orange-yellow lores and faint whitish eye-ring. Savannah Sparrow (*Passerculus sandwichensis*) is similar in both appearance and habitat use. However, the Savannah Sparrow has a streaked breast. Other sparrows in the genus *Ammodramus* may be found in Wyoming during migration, but the Grasshopper Sparrow is the only species with an unmarked, plain breast. Other sparrow genera in Wyoming are larger, and lack the flat head of the Grasshopper Sparrow [3].

Distribution & Range:

Grasshopper Sparrow is distributed across North America during the breeding season. Generally, the species is found east of the continental divide, but also in basins west of the divide. Wyoming is at the western edge of most of the continental distribution of the species. Grasshopper Sparrow has been observed in 24 of Wyoming’s 28 latitude/longitude degree blocks, with confirmed or suspected breeding documented in 15 degree blocks [4]. The species migrates out of Wyoming for the winter to the southern United States, Mexico, and Central America. Despite major population declines, breeding and winter ranges have remained widespread, and no range contractions have been documented [1, 5].

Habitat:
Grasshopper Sparrow uses a broad array of open grassland habitat types. Habitat is characterized by a patch size of at least 8 ha and vegetation averaging 30cm in height with at least 50% grass cover. Additional characteristics include patches of bare ground among clumped vegetation, and sparse shrub cover [5]. Herbaceous vegetation provides nest material and concealment [5]. In Wyoming, the species breeds in any suitable habitat [5]. Quality habitat can be found in the shortgrass prairies found in the eastern portion of the state, including Thunder Basin National Grassland [6]. Habitat use during migration and winter is similar to the breeding season [1, 5].

Phenology:
Grasshopper Sparrow arrives in Wyoming in early to mid-May [7]. Pair formation, nest construction, and egg laying occur a short time after females arrive on the breeding grounds, generally 2–3 days after males. Incubation lasts 11–13 days, and fledging occurs when young are 6–9 days old. Fledglings likely become independent at about 2 weeks after leaving the nest [1]. Fall migration in Wyoming begins in August, and most birds are gone by September [7].

Diet:
On the breeding grounds, Grasshopper Sparrow primarily feeds upon grasshoppers (order Orthoptera), as well as seeds and other insects. In winter, the species primarily eats seeds, mostly from grasses and sedges [1].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: COMMON
Using North American Breeding Bird Survey (BBS) data, the Partners in Flight Science Committee estimated the global population of Grasshopper Sparrow to be 31 million birds [8]. Approximately 2.6% of the global population, or around 800,000 birds, is estimated to breed in Wyoming [9]; however, this state estimate is likely high and should be viewed with caution. The statewide rank of COMMON is based on the relatively large area of the state known to be occupied in any given season, and the large coverage of suitable habitat within that area. Within suitable habitat in the occupied area, Grasshopper Sparrow also appears to be common and is usually encountered during surveys that could be expected to indicate its presence [10]. From 1968–2015, annual Wyoming BBS detections of Grasshopper Sparrow ranged from 0 to 406 (average = 89), with 107 recorded in 2015 [11]. Annual detections of Grasshopper Sparrow ranged from 71 to 238 during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [12]. Estimated mean density across this same time period was 2.87 birds per km^2 (standard deviation 1.48, standard error 0.56) in suitable habitats in Wyoming [12].

Population Trends:
Historic: LARGE DECLINE
Recent: MODERATE DECLINE
Survey-wide trend data from the North American BBS indicate that Grasshopper Sparrow numbers experienced statistically significant annual decreases of 2.83% from 1966–2013 and

1.93% from 2003–2013 [13]. Wyoming BBS trend data indicate that Grasshopper Sparrow increased by 0.87% annually from 1968–2013 and declined by 0.77% annually from 2003–2013; however, neither state estimate was statistically significant [13].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Grasshopper Sparrow has a somewhat restricted habitat preference which makes the species moderately vulnerable. In Wyoming, Grasshopper Sparrow is generally restricted to native shortgrass prairie [5]. Across the species' range, the minimum habitat patch size the species requires varies from 8 ha to over 100 ha. Patch size requirements vary with habitat and geographic location. Additionally, smaller patches have lower abundance and breeding success than larger patches [5, 14]. The species is subject to Brown-headed Cowbird (*Molothrus ater*) parasitism, which can reduce breeding success [1].

Extrinsic Stressors:
MODERATELY STRESSED
Due to human impacts to habitat of Grasshopper Sparrow in Wyoming, the species is moderately threatened. Conversion of native prairie habitat to agricultural or other habitat types is an ongoing threat to Grasshopper Sparrow [5]. Habitat fragmentation from natural resource, agricultural, and urban development is also an ongoing threat to the species [5]. Breeding success and productivity are lower in areas with high proportions of edge habitat, as well as in grazed or mowed areas [15-17]. Grasshopper Sparrow males perform a low aerial display during courtship [1], so wind power development in nesting areas may be problematic [18].

KEY ACTIVITIES IN WYOMING

Grasshopper Sparrow is listed as a Species of Greatest Conservation Need (SGCN) in Wyoming by the Wyoming Game and Fish Department (WGFD), and as a Level II Priority Bird Species requiring monitoring in the Wyoming Bird Conservation Plan [18]. Current statewide activities for monitoring annual detections and population trends for Grasshopper Sparrow in Wyoming include the BBS program conducted on 108 established routes since 1968, and the multi-partner IMBCR program initiated in 2009. Trend data are available on the U.S. Geological Survey BBS website [13], and occupancy, density, population estimates, and decision support tools are available through the Rocky Mountain Avian Data Center [12]. BBS surveys are conducted annually in Wyoming, and detect Grasshopper Sparrow in sufficient numbers to provide population estimates and trends for the state [13, 19]. The IMBCR program detects Grasshopper Sparrow in Wyoming, and surveys have occurred annually since 2009 [12]. Additionally, WGFD initiated a targeted grassland SGCN monitoring program in 2015 for Mountain Plover, Upland Sandpiper, Long-billed Curlew, and Burrowing Owl [20]. While Grasshopper Sparrow is not a target species, all individuals detected are recorded and documented in the WGFD species database.

ECOLOGICAL INFORMATION NEEDS

Demographics of Grasshopper Sparrow specific to Wyoming are poorly understood. Specific habitat requirements in Wyoming, especially patch size requirements, are unknown. The extent natural resource development impacts the species in Wyoming are unknown. Effects of land management practices are largely unknown [5]. The effects of climate change on Grasshopper Sparrow is unknown.

Management in Wyoming

This section authored solely by WGFD; Andrea C. Orabona. The Grasshopper Sparrow is classified as a SGCN in Wyoming. Although populations are stable in the state, the species is vulnerable to severe habitat impacts that can occur from increased industrialization, habitat degradation, and conversion of grasslands [18]. Two separate but compatible survey programs are in place to monitor Brewer's Sparrow populations. The first is the long-term BBS started in Wyoming in 1968 with 108 established routes [13]. Species must be detected on at least 14 routes for data analyses to be significant for tracking population status and trend over time. The IMBCR program was established in 2009 in Wyoming with many state, federal, and nongovernmental organization partners that contribute funding, field personnel, technical assistance, or in-kind services. Data analyses produce density, occupancy, and population estimates at various scales and provide decision support tools for managers [12]. Best management practices to benefit Grasshopper Sparrows include continued monitoring, as well as maintaining large tracts of intact grassland habitats with dense grass of heights up to 46 cm, heavy forb cover, thick litter depth, 1–2% bare ground overall, minimal (5% or less) shrub cover, and singing perches [18, 21]. While high intensity livestock grazing can be detrimental to Grasshopper Sparrow, low to moderate rotational grazing, light fall burning, delayed spring mowing, and minimal insecticide use can be used as habitat management tools [18].

Contributors

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Figure 1: Singing Grasshopper Sparrow in Morgan County, Colorado. (Photo courtesy of Bill Schmoker)

Figure 2: North American range of *Ammodramus savannarum*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Grasshopper Sparrow habitat in Thunder Basin National Grassland. (Photo courtesy of Michael T. Wickens)

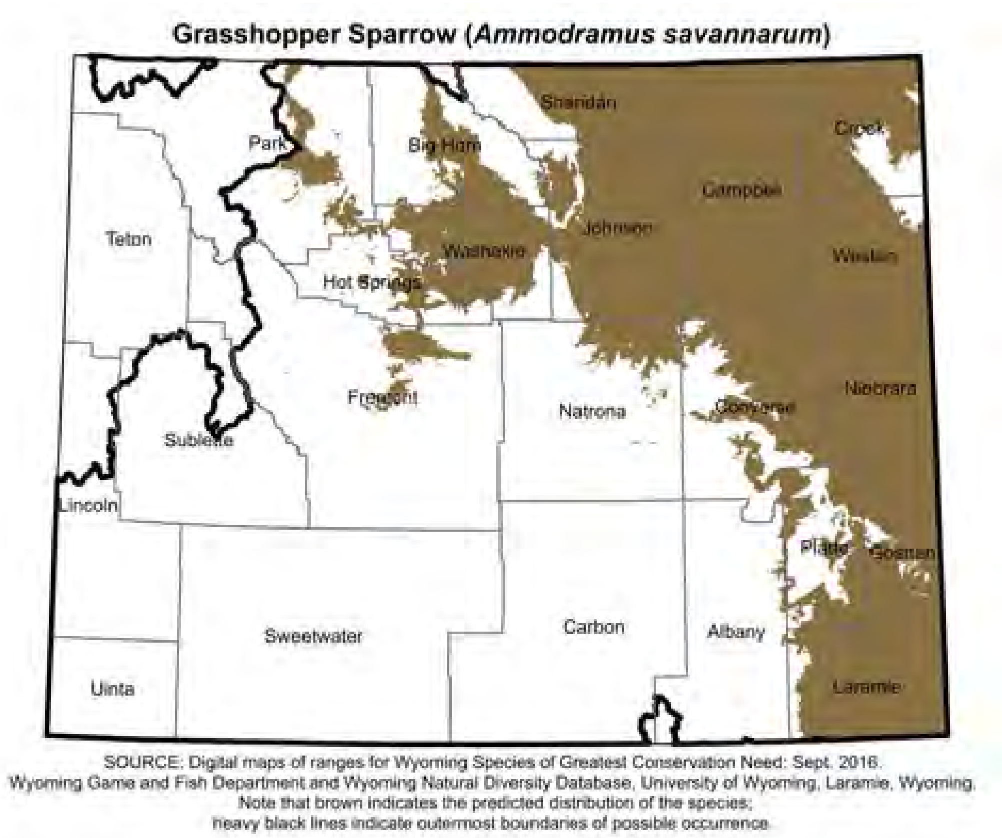

Figure 4: Range and predicted distribution of *Ammodramus savannarum* in Wyoming.

Figure 5: Grasshopper Sparrow Nest, Chestertown, Maryland. (Photo courtesy of Archer F. Larned)

Gray Vireo

Vireo vicinior

REGULATORY STATUS

USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: Bird of Conservation Concern
WGFD: NSSU (U), Tier II
WYNDD: G5, S1
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 14

STATUS AND RANK COMMENTS

Gray Vireo (*Vireo vicinior*) has no additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:

Vireos are monophyletic, with all species belonging to the genus *Vireo*. No subspecies of Gray Vireo are currently recognized [1].

Description:

Gray Vireo is a medium sized vireo. The sexes are monomorphic in both plumage color and pattern, but the bill, wings, and tail of males are slightly larger than females [1]. Males are 130–148 mm long and weigh 11.5–13.5 g. Adult Gray Vireos have dull gray cheeks and upperparts; white lores; a complete, thin, white eye ring; blackish bill; lighter gray chin, throat, and chest; white abdomen and undertail coverts; dark grayish-black wings; one whitish wing bar; and white edges on the outer rectrices [1]. The plumage of juvenile Gray Vireos is more brownish and the wing bars are more distinct [2]. Similar sympatric species in Wyoming include Bell's Vireo (*V. bellii*) and Plumbeous Vireo (*V. plumbeus*); however, these species have incomplete eye rings, two wing bars, and shorter tails [3]. Gray Vireo may also be distinguished from some other vireo species by its behavior of cocking and flicking its long tail, similar to gnatcatchers (*Polioptila* spp.), although several other vireo species (e.g., Plumbeous Vireo) also exhibit this behavior [4].

Distribution & Range:

During the breeding season, Gray Vireo is found primarily in montane regions and adjacent arid scrubland in the southwestern United States and northern Baja California, Mexico [5, 6]. The species winters in parts of Texas, Arizona, and Mexico, although more information on the wintering range is needed [1]. In Wyoming, Gray Vireo has been found in the southwestern corner of the state in areas where Utah Juniper (*Juniperus osteosperma*) occurs [7, 8]. Observations of Gray Vireo have only been documented and confirmed as accepted by the Wyoming Bird Records Committee (WBRC) in 2 of Wyoming's 28 latitude/longitude degree blocks, both in Sweetwater County [7-11]. To date, there are no confirmed breeding records for Gray Vireo in Wyoming [8]. However, 3 to 4 different individuals were first reported in southwestern Wyoming from 26 June to 27 July 1982, with a singing male documented from 2 to 6 June 1982 [9].

Habitat:
Gray Vireo is associated with arid shrubland and scrub habitats during all seasons, but occurs at higher elevations during the breeding season [1]. The species is considered a thicket forager [12]. In Wyoming, the species is restricted to mature Utah Juniper woodlands with moderate canopy closure and ample amount of Mountain Mahogany (*Cercocarpus montanus*) or other deciduous shrubs in the understory or in nearby clearings [8-10]. No Gray Vireo nests have been described from Wyoming, but elsewhere nests are supported by a horizontal fork among the branches of shrubs or small trees, and suspended 0.9–3.7 m above the ground [10].

Phenology:
Gray Vireo is a short-distance migrant, leaving its wintering grounds from late February to mid-April [1]. Two separate spring observations of Gray Vireo in Wyoming were both reported on 29 May in different years [7, 8, 11]. Males are reported to arrive on their breeding grounds a few days before females, with pair formation completed within a day of the arrival of females, and nest building initiated 1–2 days following pair formation [1]. Typically, 4 eggs are laid (range 3–5), one each day for 4 days or until the clutch has been competed [1, 4, 13]. Eggs are incubated for 13–14 days, and nestlings fledge 13–14 days after hatching [1]. There are no reports from Wyoming of Gray Vireo fall migration; however, the species is known to leave Colorado and southern California by the second week of August [14, 15].

Diet:
Gray Vireo is primarily insectivorous, although it may also become frugivorous on its wintering grounds [1]. Gray Vireo consumes a variety of arthropods from the Orders Orthoptera (grasshoppers), Homoptera (cicadas), and Lepidoptera (caterpillars). It takes prey from leaves, twigs, and branches of small trees and shrubs; from trunks of small trees; and from the ground [16]. Most prey is taken by gleaning, stalking, and hawk-capturing (70%), with 25% taken by flycatching and 5% by pouncing [17, 18]. Gray Vireo forages from the ground up to 9 m above the ground, with most foraging occurring at 1–4 m [17, 18].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD BUT PATCHY
Wyoming: VERY RARE
Using Breeding Bird Survey (BBS) data, the Partners in Flight Science Committee estimated the global population of Gray Vireo to be 400,000 birds [19]. Currently, there are no robust population estimates for Gray Vireo in Wyoming. The statewide rank of VERY RARE is based on the rather small area of the state known to be occupied in any given season, and the small coverage of suitable habitat within that area. However, within suitable habitat in the occupied area, Gray Vireo appears to be rare, as it occupies only a small percentage of preferred habitat within its range and may not be readily detected during surveys expected to indicate its presence [8].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends of Gray Vireo are not known in Wyoming due to limited distribution in the state and low detection rates during monitoring. Currently, there are no robust North American BBS trend data for Gray Vireo in Wyoming. BBS trend data for Gray Vireo in Utah from 1968–2013 suggest a slight annual population decline (-0.44%, *N* = 37 routes, 95% CI -4.04–3.34) [20]. However, these data fall within a credibility category with 'deficiencies' due to low relative abundance and number of routes with Gray Vireo detections [20].

Intrinsic Vulnerability:
HIGH VULNERABILITY
Gray Vireo has somewhat specialized habitat requirements, especially in Wyoming where it is restricted to a narrow area of Utah Juniper in extreme southern Sweetwater County [8-10]. Other life history characteristics may predispose the species to declines from changes in environmental conditions (e.g., fire suppression, climate change).

Extrinsic Stressors:
MODERATELY STRESSED
Gray Vireo requires mature junipers (> 100 years) for nesting, and a shrubby understory and shrub/juniper habitat interspersion for foraging [10]. Threats to preferred habitat include extensive tree removal; soil erosion; isolation from adjacent populations of Gray Vireo in the neighboring states of Utah and Colorado; and a lack of stand rejuvenation [10]. Furthermore, the availability of Utah Juniper habitat remains limited in Wyoming and may be negatively impacted through fragmentation, disruption of historic fire regimes, climate change, energy development, and removal and thinning programs [21, 22]. Therefore, the future availability and suitability of this habitat in Wyoming is uncertain. A lack of information regarding the outcome of disturbance on Utah Juniper habitat can complicate successful management for this species [10]. Although little information is available on specifics, Gray Vireo is a common cowbird (*Molothrus* spp.) host. Most parasitized nests are abandoned within of days of egg-laying by the parasite [1]. In California, Gray Vireo range contraction may be partly due to cowbird parasitism [23, 24]. The introduction of livestock to areas occupied by Gray Vireo may attract cowbirds and cause a local increase in numbers and parasitism rates [1].

KEY ACTIVITIES IN WYOMING

Little work has been done specific to Gray Vireo in Wyoming since it was first noted in the state in 1982 [9, 10]. Initial work and written species accounts on avian Utah Juniper obligate species, including Gray Vireo, occurred in 1988 [10]. However, higher priorities and limited personnel and funding precluded conducting additional work on these species. Gray Vireo is classified as a Species of Greatest Conservation Need (SGCN) in Wyoming due to restricted habitat distribution and a lack of information on the breeding status and population trends in the state. The species is not adequately monitored by current national or regional avian monitoring efforts in Wyoming, including the Integrated Monitoring in Bird Conservation Regions (IMBCR) program initiated in 2009 (0 detections) [25] or the BBS program conducted on 108 established routes since 1968 [20]. Gray Vireo is a species for which the WBRC requests documentation on all sightings. Observations of this species are reported to the Wyoming Game and Fish Department (WGFD) and vetted through the WBRC. In 2016 and 2017, the WGFD will be conducting a project focused on addressing data deficiencies for Utah Juniper obligate species, including Gray

Vireo, in southwestern Wyoming. This project will address a number of objectives, including evaluating species distribution and richness, estimating relative abundance and occupancy rates, and quantifying and evaluating habitat characteristics.

ECOLOGICAL INFORMATION NEEDS

In Wyoming, assessment of the status of Gray Vireo is hampered by a lack of ecological and population data. Additional information is needed on distribution and habitat use, and estimates of abundance and occupancy rates are needed to assess status, monitor populations, and evaluate trends. Research is needed on the effects of habitat alterations and the impact of brood parasitism on Gray Vireo, and to determine distinctive geographic variation in disjunct populations. Traditional state-wide survey efforts do not tend to detect Gray Vireo, suggesting targeted, species-specific monitoring efforts are needed. Because only two confirmed records are available for the species in Wyoming, additional work is needed to determine the frequency of these events in the state, including breeding status. Additionally, the distribution of juniper forests in Wyoming is greater than the distribution of Gray Vireo, and a better understanding of habitat use and requirements at this northernmost range boundary is needed.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Gray Vireo is classified as a SGCN in Wyoming due to unknown population status and trends in the state; a need for robust information on breeding status; limited distribution of required breeding habitat; loss, degradation, and fragmentation of Utah Juniper habitat due to industrial developments; and incompatible management practices. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [20] and IMBCR [25]. While these monitoring programs provide robust estimates of occupancy, density, or population trends for many avian species in Wyoming, survey efforts do not tend to detect Gray Vireo at adequate levels, suggesting targeted, species-specific monitoring efforts are needed. Best management practices to benefit Gray Vireo are similar to those for sympatric Utah Juniper obligate species and include implementing a sufficient monitoring technique; maintaining mature stands of Utah Juniper habitat where Gray Vireo nests, including herbaceous vegetation and shrubs for foraging; implementing prescribed and natural fire management to maintain savannah-like stands of juniper woodlands in areas occupied by Gray Vireo; and coordinating Utah Juniper management to provide a mosaic of juniper woodland conditions [21].

CONTRIBUTORS

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Figure 1: Adult Gray Vireo in Colorado National Monument outside of Grand Junction, Colorado. (Photo courtesy of Shawn Billerman)

Figure 2: North American range of *Vireo vicinior*. This map does not accurately reflect the species' range in Wyoming. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Gray Vireo habitat in southwestern Wyoming, dominated by Utah Juniper. (Photo courtesy of Leah H. Yandow, WGFD)

Figure 4: Range and predicted distribution of *Vireo vicinior* in Wyoming.

Great Blue Heron
Ardea herodias

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS4 (Bc), Tier II
WYNDD: G5, S4
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: Not ranked

STATUS AND RANK COMMENTS
Great Blue Heron (*Ardea herodias*) does not have any additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:
There has been much disagreement about the number of subspecies of Great Blue Heron [1-6]. The most recent assessment is that there are four subspecies in North America, with *A. h. herodias* and *A. h. wardi* being the two most common. These two subspecies are also likely found in Wyoming.

Description:
Great Blue Heron is the largest heron in North America (160 cm tall, 97–137 cm long, 2.1–2.5 kg). It is easily identifiable in the field by its large size, long legs and neck, gray upperparts, white head with a broad blue stripe running from the eyes to the back of the head, and yellowish eyes and bill. Its legs are greenish or brownish. Juveniles have solid gray crowns, whereas adults have white crowns. Both sexes are visually similar, with females averaging slightly smaller [6]. Great Blue Heron is unlikely to be confused with any other heron species in Wyoming.

Distribution & Range:
In Wyoming, Great Blue Heron can be a summer, breeding-only resident or a year-round resident [6]. Great Blue Heron has been documented in all of Wyoming's 28 latitude/longitude degree blocks, with confirmed or circumstantial evidence of breeding occurring in 27 degree blocks [7]. Great Blue Heron winters both inside and outside of Wyoming.

Habitat:
Across its range, important foraging habitat during the breeding season has been reported as shallow coastal marine waters, coastal mangrove swamps, sea beaches, pasture and cultivated fields, prairie, aquaculture ponds, and human-created foraging sites where handouts and fish scraps can be found [6]. In Wyoming, the highest concentration of breeding Great Blue Herons occurs along the major river drainages (i.e., Bighorn, Green, North Platte, Powder, and Snake) [8]. The lowest densities occur in Yellowstone National Park and in arid regions, such as the Great Divide Basin [9]. Breeding elevation has been reported up to 1,100 m in British Columbia and 610 m in Vermont [10], but is necessarily higher in Wyoming (up to 2,438 m) due to the state's overall elevation [9]. In Wyoming, the species typically creates stick nests in colonies in trees, shrubs, artificial structures, or on the ground, near water [6, 9, 11]. To avoid ground predators, Great Blue Heron prefers to nest in swamps or on islands. There is little knowledge of habitat use during migration, but it is assumed to be similar to that of the breeding season [6]. As with migration, there are little data on winter habitat use, but Great Blue Heron is reported to have the widest wintering distribution of any North American heron species [12]. Winter sightings in Wyoming generally occur along open rivers and warm springs [9].

Phenology:
Great Blue Herons that are not year-round residents of Wyoming begin to arrive in the second half of March [9]. Timing of fall dispersal is uncertain, but likely occurs between late August and mid-September [9]. Little data are available for Wyoming, but first brood of the season has been recorded as early as the third week in March in Idaho [13]. Eggs are typically laid in 2-day intervals, sometimes 3-day intervals [14-16]. Incubation period averages 27 days. Young are semi-altricial at hatching, able to walk steadily at 21 days, and able to fly at 7–8 weeks [14, 15, 17-19]. Depending on latitude, Great Blue Heron can re-nest after a failed attempt but typically chooses a new mating partner [6, 20, 21].

Diet:
Great Blue Heron eats a wide variety of organisms including mammals, fish, amphibians, birds, insects, and crustaceans [22, 23]. In some regions, voles are known to be important components in the diet of nestlings [24] and for juveniles [11, 25-27]. Diet composition is likely a function of local prey availability and abundance [25, 28-30]. Death by choking can occur when herons try to consume large prey items [31]. Great Blue Heron digests bones but cast pellets that contain mammal hair. The species obtains all water necessary for survival from its food [6].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: UNCOMMON
The statewide rank of UNCOMMON is based on the limited area of the state known to be occupied in any given season, and the relatively small coverage of suitable habitat within that area. However, within suitable habitat in the occupied area, Great Blue Heron appears to be common and is usually encountered during surveys that could be expected to indicate its presence [7]. Great Blue Heron density (number of birds per square km) and population size estimates for Wyoming are available from the Integrated Monitoring in Bird Conservation Regions (IMBCR) program for the years 2012–2015, although detections are limited so data must be interpreted with caution [32].

Population Trends:
Historic: UNKNOWN
Recent: MODERATE DECLINE to STABLE
Great Blue Heron population trend data from the Breeding Bird Survey (BBS) in Wyoming suggest a slight decline of 0.38 annually (*N* = 78 routes, 95% CI: -1.96–1.13) from 1968–2013 and an annual increase of 0.45 (*N* = 78 routes, 95% CI: -2.80–3.75) from 2003–2013 [33]. However, these trend estimates must be interpreted with caution, since neither is statistically significant and Wyoming falls within a regional credibility category containing data with deficiencies.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Great Blue heron has moderate intrinsic vulnerability in Wyoming due to colonial nesting behaviors that make large numbers of breeding individuals vulnerable to catastrophic weather events [34]. Nests in trees are susceptible to windfall destruction [35], and severe winters that cause sustained ice over aquatic foraging areas can reduce Great Blue Heron prey availability and cause mortality [36].

Extrinsic Stressors:
MODERATELY STRESSED
Potential extrinsic stressors to Great Blue Heron in Wyoming include habitat loss and fragmentation, human disturbance, increasing predator abundance, and climate change. Wetland and woodland habitat loss and fragmentation are a risk to all colonial nesting birds, which simultaneously exposes them to increased human disturbances [34]. Colony disturbance by human activity in Oregon, Colorado, and British Columbia has coincided with a decrease in Great Blue Heron breeding success [35, 37, 38]. Bald Eagle (*Haliaeetus leucocephalus*), an important predator of Great Blue Heron, has been increasing in abundance in Wyoming, which in turn could increase predation pressure on herons in the state [39]. Further, climate change could cause changes in the timing of precipitation events, detrimentally altering water levels in Great Blue Heron foraging areas [21].

KEY ACTIVITIES IN WYOMING

Great Blue Heron is classified as a Species of Greatest Conservation Need (SGCN) by the Wyoming Game and Fish Department (WGFD). Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the North American BBS [33] and the multi-partner IMBCR [32]. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, a targeted, species-specific survey method is needed to obtain these data for Great Blue Heron. Since 1984, WGFD has conducted annual or periodic monitoring at the most important and productive sites for colonial waterbird SGCN to determine species presence and distribution, and to estimate number of nesting pairs. In 2014, a multi-year cooperative agreement between the WGFD and U.S. Fish and Wildlife Service was completed on an intensive survey of all historic, known, potential, and new colonial waterbird breeding sites statewide as part of a western range-wide effort to track population size, trends, and locations of breeding colonial waterbirds in the western United States [40, 41]. An online Atlas of western colonial waterbird nesting sites was produced with data collected and submitted by participating states [42]. However, because Great Blue Heron is known to shift colony locations, the WGFD periodically conducts aerial surveys of all the major drainages in Wyoming to map the most current colony locations.

ECOLOGICAL INFORMATION NEEDS

To ensure management actions reflect actual colony locations, new information will soon be needed on up to date locations of Great Blue Heron colonies, as these are known to shift along drainages over time (A. Orabona, pers. obs.).

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Great Blue Heron is classified as a SGCN in Wyoming due to limited nesting habitat in the state. Riparian lands constitute a small percentage of Wyoming's landscape [43], and less than 2% of the state's total area is classified as wetland habitat [44]; yet the importance of these mesic habitats to avian migration, nesting, and foraging is well documented [45]. While local, state, and federal measures may limit certain impacts in these areas, the cumulative effects of development (e.g., grazing, timber harvesting, recreation), invasive species, and hydrologic regime change (e.g., impoundments, irrigation withdrawals, channel alterations) contribute to the degradation of riparian lands in Wyoming [43]. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the North American BBS [33] and the multi-partner IMBCR [32]. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, survey efforts do not tend to detect Great Blue Heron at adequate levels, suggesting targeted, species-specific monitoring efforts are needed. Approximately every 3–5 years, WGFD conducts aerial Great Blue Heron colony surveys over the state's river drainages with suitable nesting habitat to track locations of occupied heron rookeries.

CONTRIBUTORS

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Figure 1: Adult Great Blue Heron in Ellis County, Kansas. (Photo courtesy of Brian Zinke)

Figure 2: North American range of *Ardea herodias*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

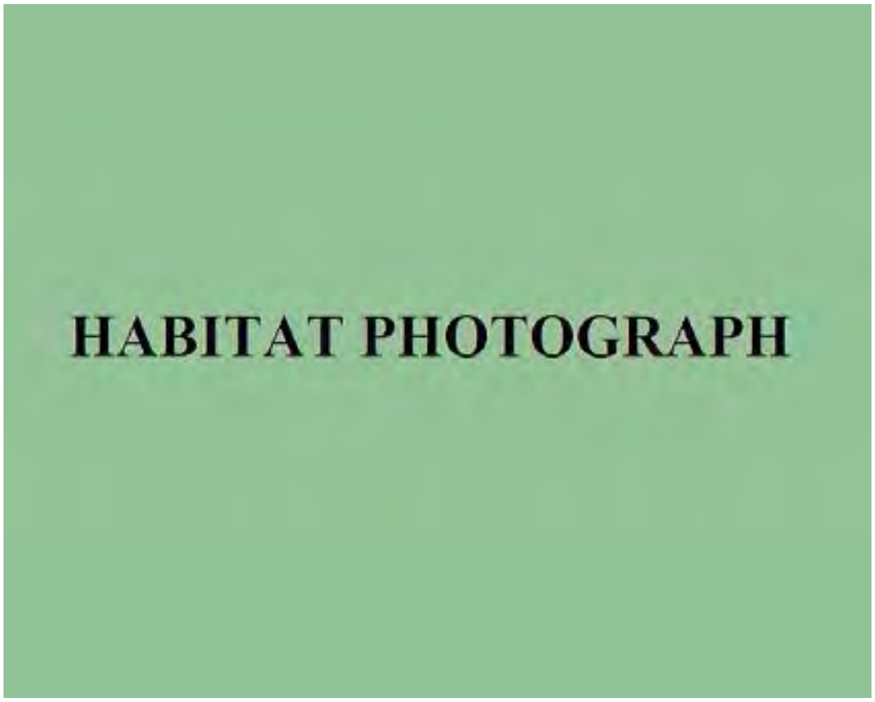

Figure 3: Photo not available.

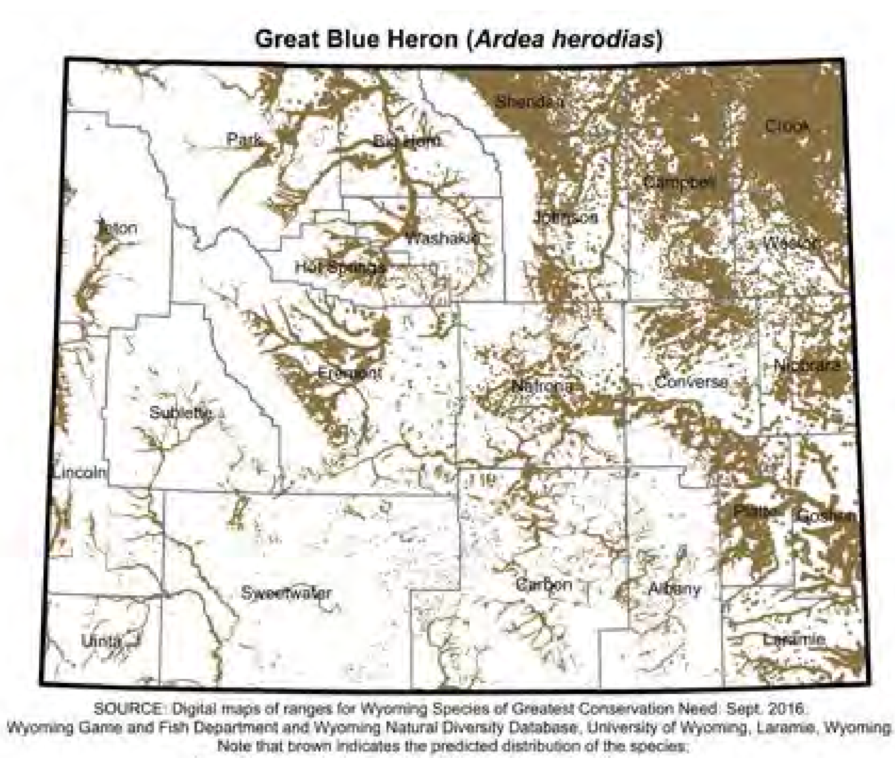

Figure 4: Range and predicted distribution of *Ardea herodias* in Wyoming.

Figure 5: Adult Great Blue Heron in flight in Weld County, Colorado. (Photo courtesy of Bill Schmoker)

Greater Sage-Grouse

Centrocercus urophasianus

REGULATORY STATUS

USFWS: Listing Not Warranted
USFS R2: Sensitive
USFS R4: Sensitive
Wyoming BLM: Sensitive
State of Wyoming: Game Bird (see regulations)

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS4 (Bc), Tier II
WYNDD: G3G4, S4
    Wyoming Contribution: VERY HIGH
IUCN: Near Threatened
PIF Continental Concern Score: 15

STATUS AND RANK COMMENTS

Greater Sage-Grouse (*Centrocercus urophasianus*) has been the subject of major conservation efforts in Wyoming and across its range [1-4]. Anecdotal reports suggest this effort may be the largest ever undertaken for a single species. As a result, many of the threats facing Greater Sage-Grouse are being addressed leading to a "Not Warranted" U.S. Fish and Wildlife Service (USFWS) listing decision in 2015 [1] and a Wyoming Game and Fish Department (WGFD) decision to change the status of the species from NSS2 to NSS4 [5].

NATURAL HISTORY

Taxonomy:

Greater Sage-Grouse (*C. urophasianus*) is genetically distinct from Gunnison Sage-Grouse (*C. minimus*), but the previous delineation of western (*C. u. phaios*) and eastern Greater Sage-Grouse (*C. u. urophasianus*) is not supported genetically [6]. Greater Sage-Grouse occasionally hybridizes with Dusky Grouse (*Dendragapus obscurus*) and Sharp-tailed Grouse (*Tympanuchus phasianellus*).

Description:

Greater Sage-Grouse is the largest North American grouse species. Males are larger than females; males are 1.7–2.9 kg and 65–75 cm long, while females are 1.0–1.8 kg and 50–60 cm long. Plumage is largely dark brown-gray, marked with drab gray and white. The belly is black. The tail is long and pointed and undertail coverts are black with large white spots on the tips. The sides of the male's neck, breast, and upper belly are white and form a ruff. The male has a yellow, fleshy comb above each eye and long filoplumes that arise from the back of the neck. Two patches of yellow skin on the breast are exposed briefly during courtship displays. Females are more cryptic. Immatures resemble adults of their sex but may be distinguished for up to 17 months by retained outermost 2 juvenile primaries [7].

Distribution & Range:
Greater Sage-Grouse currently occupies 56% of its historic North American range, inhabiting portions of 11 states and two Canadian provinces [8]. Of the 192,189 km^2 of potential historic Greater Sage-Grouse range in Wyoming, 173,949 km^2 is currently occupied (91%). This is 70% of the state and 26% of North America's occupied Greater Sage-Grouse range. Wyoming contains 37% of North America's population of Greater Sage-Grouse [9].

Habitat:
Greater Sage-Grouse is a sagebrush obligate species that depends on large areas of contiguous sagebrush [10, 11] that include a variety of semiarid shrub-grassland (shrub steppe) habitats, especially Big Sagebrush (*Artemisia tridentata*) [10, 12-14]. Greater Sage-Grouse distribution is strongly correlated with the distribution of sagebrush habitats [8, 15]. Greater Sage-Grouse is a lekking species [7]. Leks are typically located in openings of relatively low shrub and herbaceous cover within nesting habitat [7]. Nesting habitats are characterized by sagebrush with an understory of native grasses and forbs [7, 13, 15]. Greater Sage-Grouse moves to mesic areas, such as wet meadows, riparian areas, or alfalfa fields in response to summer desiccation of herbaceous vegetation in the uplands [13]. Greater Sage-Grouse depends entirely on sagebrush exposed above the snow for food and cover during winter [7].

Phenology:
Greater Sage-Grouse is a year-round resident of Wyoming. Some sub-populations and individuals may migrate between seasonal habitats [16]. During the spring breeding season, males gather together to perform courtship displays on traditional sites called "leks" [17]. Hens are typically bred on a lek and nest within 8.5 km of the lek [18] in Nests typically hatch in late May or early June in Wyoming. Some hens will renest if their first attempt is unsuccessful [13, 18]. Hens and chicks remain in upland habitats associated with the nest until herbaceous plants become desiccated during the summer and then move to more mesic sites [13, 19]. Fall snowfall triggers movement to winter habitat. Winter habitats are often associated with lekking and nesting habitat, although in some areas Greater Sage-Grouse concentrates on winter habitats away from breeding habitat [16]. Greater Sage-Grouse exhibits strong fidelity to seasonal habitats [11, 20].

Diet:
Sagebrush (*Artemisia* spp.) is essential for Greater Sage-Grouse survival and dominates diet during late autumn, winter, and early spring [10, 21, 22]. Insects are important for juveniles, particularly during first 3 weeks of life; forbs increase in importance as juveniles age [10, 23-26]. Forbs are also important for females during the pre-laying period [27].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: ABUNDANT
Greater Sage-Grouse occupies 668,412 km^2 in North America [8] and173,949 km^2 in Wyoming. Thirty-seven percent of North America's population of Greater Sage-Grouse inhabits Wyoming [9]. In 2015, 85,674 males were counted on 3,559 known leks in the 11 western states [28]. In Wyoming, there are 1,833 known occupied leks in Wyoming and 1,609 (88%) of those were checked in 2015 according to the WGFD Greater Sage-Grouse database (accessed on 8/12/2015). A total of 35,854 males were counted on 1,196 active leks, as defined by the WGFD [29].

Population Trends:
Historic: LARGE DECLINE
Recent: MODERATE DECLINE
Greater Sage-Grouse has declined from historic levels but the scope of that decline is unclear as estimates of Greater Sage-Grouse abundance were mostly anecdotal prior to the implementation of systematic surveys in the 1950s [30]. Overall, the rate of population decline has moderated since the mid-1990s although trends vary locally [20, 28]. Greater Sage-Grouse populations in Wyoming are cyclic [31].

Intrinsic Vulnerability:
HIGH VULNERABILITY
Greater Sage-Grouse is highly to moderately vulnerable to extrinsic threats based on the fact that it is a sagebrush obligate [10, 11], has large home area requirements [11, 14], limited ability to disperse [7, 17], relatively low fecundity [7, 32], predisposed to West Nile virus mortality [33], and sensitive to habitat fragmentation and disturbance [34].

Extrinsic Stressors:
MODERATELY STRESSED
Threats to Greater Sage-Grouse populations in Wyoming and range wide are primarily from degradation, fragmentation, and loss of sagebrush steppe habitats. Sagebrush steppe is considered one of the most threatened ecosystems in North America [35]. Sagebrush habitats in Wyoming have been fragmented by energy development, agricultural activities, transportation corridors and rural residential development. Research conducted in Wyoming has demonstrated the impacts of energy development to sage-grouse [19, 36-38]. Invasive grasses represent another significant threat to sagebrush habitats, primarily from increased fire frequency, which has reduced the amount of sagebrush habitat [14, 17]. Greater Sage-Grouse is also subject to mortality from West Nile virus [33].

KEY ACTIVITIES IN WYOMING
The WGFD and partners increased Greater Sage-Grouse monitoring efforts since the mid-1990s [39]. At the same time, multiple universities and agencies have conducted research on Greater Sage-Grouse in Wyoming [39]. Wyoming implemented its "Core Area Strategy" in 2008, which was most recently updated in 2015 [2]. The Bureau of Land Management (BLM) and U.S. Forest Service (USFS) have incorporated most aspects of the Core Area Strategy into their land use planning decisions [3]. The Natural Resources Conservation Service (NRCS) has implemented its range-wide Greater Sage-Grouse Initiative [4].

ECOLOGICAL INFORMATION NEEDS
Knowledge of Greater Sage-Grouse distribution during winter is lacking. More refined estimates of population size and trend would be useful. Further assessments of Greater Sage-Grouse response to habitat modifications, energy development and climate change are needed.

MANAGEMENT IN WYOMING
This section authored solely by WGFD; Tom Christiansen. Greater Sage-Grouse is classified as a Species of Greatest Conservation Need in Wyoming. The USFWS recently determined that Greater Sage-Grouse is not warranted for Threatened or Endangered Species status [1]. Monitoring includes leks counts and surveys, hunter harvest surveys, age/sex structure based on wings from

harvest birds and habitat quality and condition. Wyoming retains management authority for establishing hunting seasons. Data analyses produce density, occupancy, and population trends at various scales and provide decision support tools for managers. Greater Sage-Grouse has been the subject of much research since the mid-1990s in Wyoming [39]. Local Greater Sage-Grouse Working Groups were establish in 2004. These groups developed conservation plans and have legislative funding to conduct conservation efforts across the state [39]. The governor appointed a Greater Sage-Grouse Implementation Team in 2007. This entity was codified by the legislature in 2015. This group advises the governor on Greater Sage-Grouse policy related to the Wyoming Governor's Greater Sage-Grouse Core Area Protection Policy [2]. This policy, established via an Executive Order, provides a mechanism to reduce human disturbance in areas with large Greater Sage-Grouse populations [2]. The BLM and USFS have incorporated most aspects of the Core Area Strategy into their land use planning decisions [3]. The NRCS has implemented its range-wide Greater Sage-Grouse Initiative [4].

CONTRIBUTORS

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Figure 1: Adult male (left) and female (right) Greater Sage-Grouse. (Photo courtesy of W. Zickefoose)

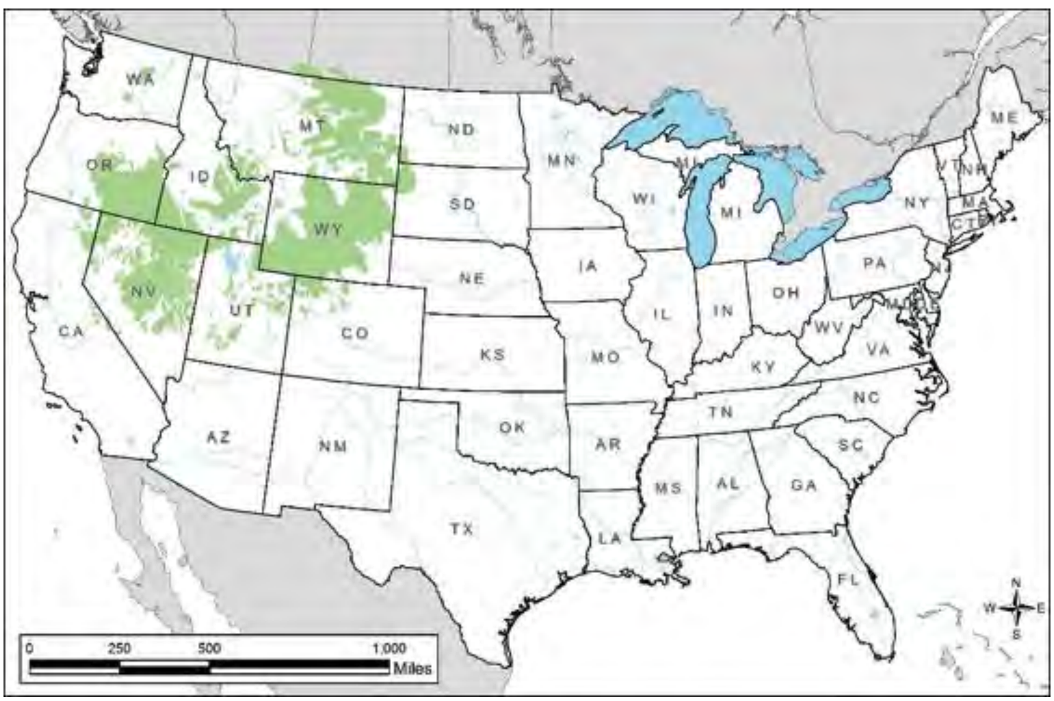

Figure 2: North American range of *Centrocercus urophasianus*. (Map courtesy of Colorado Parks and Wildlife)

Figure 3: Wyoming Big Sagebrush habitat in Sweetwater County, Wyoming. (Photo courtesy of Ian M. Abernethy)

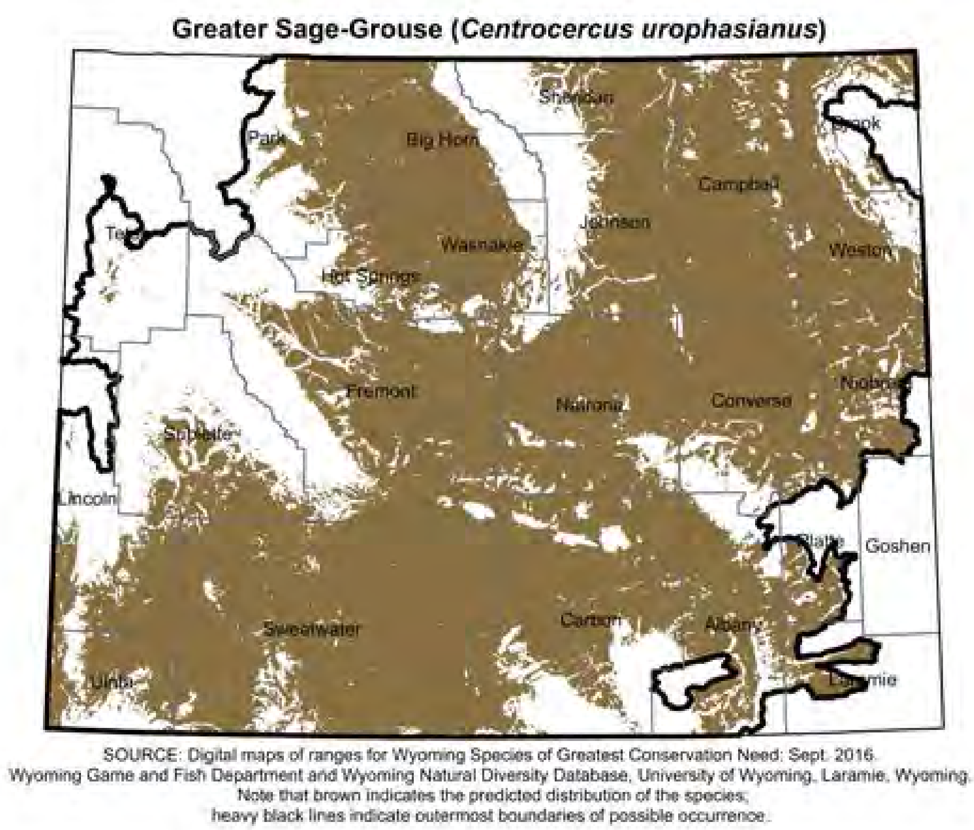

Figure 4: Range and predicted distribution of *Centrocercus urophasianus* in Wyoming.

Great Gray Owl
Strix nebulosa

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: No species status
USFS R4: Sensitive
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: No special status
WGFD: NSSU (U), Tier II
WYNDD: G5, S2
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 11

STATUS AND RANK COMMENTS
Great Gray Owl (*Strix nebulosa*) has no additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY
Taxonomy:
There are currently two recognized subspecies of Great Gray Owl; *S. n. nebulosa* is the only subspecies found in North America, and therefore also in Wyoming [1, 2]. Some researchers suggest that a geographically isolated population in the southern Sierra Nevada Mountains in California should be recognized as a third subspecies [3].

Description:
Identification of Great Gray Owl is possible in the field. It is the largest owl in North America, measuring 61–84 cm tall. Males, females, and juveniles have identical plumage, which is a mixture of brown, gray, and white that appears gray overall [1]. The underparts have heavy vertical streaking. The head is very round with a well-pronounced, lined facial disk; no ear tufts; yellow eyes; and a black chin spot centered between two white patches giving the appearance of a "bowtie" [4]. Where their ranges overlap, Great Horned Owl (*Bubo virginianus*) can easily be distinguished from Great Gray Owl by its conspicuous ear tufts [4].

Distribution & Range:
Globally, Great Gray Owl has a Holarctic distribution and is found across the boreal and taiga forests in North America and Eurasia. In the United States, the species range extends south along the Cascade Range, Sierra Nevada, and Rocky Mountains. The southernmost part of the species range in the Rocky Mountains is in Wyoming and Idaho and possibly northeastern Utah [1, 5, 6]. In Wyoming, the species is known to breed in Yellowstone National Park, the Absaroka Range, the Teton Range, the Wyoming Range (Roberts USFS, pers. comm.), and the Wind River Range.

Unconfirmed reports of the species have occurred in the Bighorn Range, and breeding status in this region is unknown [1, 5, 7, 8]. Great Gray Owl has been observed in 11 of Wyoming's 28 latitude/longitude degree blocks, with confirmed or suspected breeding documented in 4 degree blocks [9]. The species is resident across its range, though local, irregular winter irruptions occur outside the breeding range [1].

Habitat:
In the southern portion of the range of Great Gray Owl, mature deciduous and coniferous forest stands are preferred during the breeding season [5]. This contrasts with the bulk of the species range in the boreal zone, where habitat is taiga forest with interspersed bogs, muskegs, and other open areas [1, 5]. Habitat use in the non-breeding season is identical to the breeding season, though the species will also use more open areas with a few perching structures [5]. In Idaho and Wyoming during the breeding season, the species has been found in forests comprised of Lodgepole Pine (*Pinus contorta*), Douglas Fir (*Pseudotsuga menziesii*), Aspen (*Populus tremuloides*), and cottonwood (*Populus angustifolia*)/spruce (*Picea* spp.) at elevations ranging from 1,524 m to 3,000 m [6, 10]. Nest locations are generally in close proximity to foraging habitat, which includes clearings such as wet meadows and clear cut areas [5, 11-14]. Cottonwood riparian habitat provides important wintering habitat in the Teton Range [6].

Phenology:
In Wyoming, egg laying has been documented from early April to May [6]. Egg laying has been documented in Oregon and California as early as March. Incubation in Wyoming averages 30 days. Young fledge at 26–29 days of age, though they are incapable of sustained gliding flight for two weeks after fledging. The young may be dependent upon parents for up to 3 months [1, 10].

Diet:
Great Gray Owl feeds upon small mammals, especially small rodents [1]. In Wyoming, pocket gophers (*Thomomys* spp.) and voles (*Microtus* spp.) are the primary food [6, 10].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
There are no robust estimates of abundance for Great Gray Owl in Wyoming. The species has a statewide abundance rank of VERY RARE and appears to be rare to uncommon within suitable environments in the occupied area [6, 9]. Great Gray Owl has never been detected during annual surveys for the Wyoming Breeding Bird Survey (BBS) between 1968–2015 [15]. Only 3 Great Gray Owls were detected during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [16]. While surveys conducted as part of the BBS and IMBCR programs may occasionally detect this species, neither is specifically designed to capture owl observations.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends for Great Gray owl in Wyoming are unknown. Although changing availability of small mammals and nesting sites can lead to local fluctuations in abundance, population trends are thought to have remained relatively stable across North

America over the past century [13]. A recent study reported a decline in mean productivity, however, from 3.0 fledglings/nest in the 1980s to 1.7 in 2013–2015 in western Wyoming [6].

Intrinsic Vulnerability:
HIGH VULNERABILITY
Great Gray Owl requires mature forest habitat with high canopy cover including trees with large diameters, alive or dead, near optimal foraging areas for nesting [6]. The species does not construct a nest, but uses existing nests or platforms. Nest structures and optimal locations have been shown to be limiting factors for breeding in some areas [1, 5, 13, 14]. Great Gray Owl does not regularly breed until 3 years of age and typically raises no more than three young a year, resulting in low fecundity. The species requires a large home range, though home ranges may overlap [1, 17]. Prey abundance and availability in both summer and winter drive movements and occurrence and likely influence nesting demographics [10, 13, 18].

Extrinsic Stressors:
MODERATELY STRESSED
Nesting locations for Great Gray Owl are limited, and forestry practices which remove potential nest sites or reduce canopy cover and large diameter trees threaten the species [1, 13, 19]. Strychnine poisoning of pocket gophers, which would reduce the availability of a primary food of Great Gray Owl in Wyoming, may have a harmful effect on the owl [1]. Livestock grazing in montane meadow habitats may negatively impact the species through habitat degradation [20]. Residential development in lower elevation riparian forests could reduce limited wintering habitat [6]. Long-term climate change trends may impact nesting habitat and prey by affecting conifer mortality, frequency of forest fires, snow conditions, and prey density and availability [6].

KEY ACTIVITIES IN WYOMING

The Wyoming Game and Fish Department and the United States Forest Service have performed pre-nesting season call back surveys for Great Gray Owl across a portion of the species' range in Wyoming. These surveys were performed in the Wyoming Range in 2009 and 2010 and in the Shoshone National Forest in 1998, 1999, and 2008–2010. The surveys were also conducted in the Bridger-Teton National Forest in 2001 and 2008–2009 [21-23]. Additionally, more focused surveys are conducted by Forest Service biologists in specific project areas in suitable habitat. Biologists on the Bighorn National Forest have performed owl surveys in that region [8]. These surveys have detected a limited number of territorial owls. A study of Great Gray Owl habitat use and seasonal movement was conducted in the Jackson Hole area in the 2013–2015 breeding seasons [6]. Thirty-six nest attempts were documented across years with a nest density of one nest/2.7 km^2. Nest success ranged from 75% to 83% with 1.5 to 1.9 fledglings/nest produced per year. A total of 33 owls were outfitted with VHF or GPS satellite transmitters. Home ranges of breeding owls (7 females, 3 males) was estimated to be 1.53 km^2 and non-breeding owls 14.4 km^2 during the breeding season, 1 May–31 August. In the 2016 breeding season, automatic recording devises were tested in the same study area to evaluate their potential use for monitoring forest owls (B. Bedrosian, pers. comm.).

ECOLOGICAL INFORMATION NEEDS

Information is lacking on population trend, distribution, nesting density, and abundance of Great Gray Owl across the state outside of the Jackson area. Great Gray Owl is known to select mature forest habitat for nesting, but data are lacking on fine-scale habitat use and selection especially by breeding males as they supply food for incubating females and also feed young in the post-fledging period. Little information exists on survival and dispersal of young owls and how isolated breeding populations may be at the southern extent of the species' range. How climate change and forest management practices affect nesting density, owl survivorship and productivity, and important prey populations also is largely unknown.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Susan M. Patla. Past survey work for Great Gray Owl in Wyoming has focused on Forest Service lands as the owl is a designated Sensitive Species associated with mature conifer forest habitat. Information is lacking on population trend and the overall distribution and abundance of this species in the state outside of the Jackson area. A statewide, long-term monitoring protocol needs to be developed and implemented including the Big Horn Range. Use of automated recording devises should be explored as they may help to reduce costs and eliminate the need to deploy survey crews at night (B. Bedrosian, pers. comm.). Results from a recent intensive, year-round study (2013–2015) found that Great Gray Owl nests were distributed evenly across suitable habitat, but most owls concentrated in winter in a small area in the Snake River riparian corridor south of Jackson highlighting how limited winter habitat may be in Wyoming [6]. Owls nested in similar numbers in both broken-top snags and raptor stick nests with a few pairs nesting in low elevation cottonwood/spruce riparian habitat. Nest sites did not seem to be limiting as artificial nest platforms were rarely used. Snow depth was related to the number of nesting pairs with significantly fewer owl detections and occupied nests in a high snowfall year. Productivity per nest attempt overall was much was much lower compared to earlier studies in the 1980s and 1990s [10, 19]. Additional research that focuses on fine-scale habitat use based on satellite tracking of male breeding adults is recommended to understand how habitat/prey interactions may be limiting density and productivity. Such a study would also help to predict the impacts of future habitat changes (both natural and anthropogenic) on breeding populations and allow managers to develop management strategies to sustain the breeding population.

CONTRIBUTORS

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Figure 1: Great Gray Owl in Sublette County, Wyoming. (Photo courtesy of Shawn Billerman)

Figure 2: North American range of *Strix nebulosa*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Potential habitat of Great Gray Owl in Grand Teton National park, with wetland foraging area near forest. (Photo courtesy of WYNDD)

Figure 4: Range and predicted distribution of *Strix nebulosa* in Wyoming.

Harlequin Duck

Histrionicus histrionicus

REGULATORY STATUS

USFWS: Migratory Game Bird
USFS R2: Sensitive
USFS R4: Sensitive
Wyoming BLM: No special status
State of Wyoming: Game Bird (see regulations); Protected Bird

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G4, S1
    Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: Not ranked

STATUS AND RANK COMMENTS

Harlequin Ducks (*Histrionicus histrionicus*) in the eastern United States were denied listing under the Endangered Species Act (ESA) in 1998, after the United States Fish and Wildlife Service found that the population which winters in the Atlantic Ocean was not in danger of extinction. Harlequin Ducks in Wyoming are part of the western population that winters in the Pacific Ocean, which was not petitioned under the ESA [1].

NATURAL HISTORY

Taxonomy:

There are no recognized subspecies of Harlequin Duck. The eastern (Atlantic) and western (Pacific) populations of the species were historically considered subspecies, and are managed as two separate populations [2].

Description:

Harlequin Duck is identifiable in the field. The species is 33 to 46 cm long, smaller than most other ducks. Males, females, and juveniles are different in plumage. The male has striking plumage, slate blue overall with chestnut flanks, and with various markings of white and chestnut on the head and wings. The adult female is brown overall, with a white belly, a round white spot behind the ear, and variable white patches in front of the eye [2, 3]. Juvenile and immature birds look similar to the female, and males may take up to 3 years to reach full adult plumage [2]. The adult male is not likely to be confused with any other species, but females and juveniles may be confused with female ducks of other species. Harlequin Duck females and juveniles are the only duck species with both a white spot behind the eye and the white in front of the eye [2, 3].

Distribution & Range:
Harlequin Duck is broadly distributed in two different geographic regions. These include the North Atlantic and the North Pacific and their associated watersheds. Individuals in Wyoming are associated with the Pacific population and represent the most eastern extension of that population [2]. The species is only found during the breeding season in northwestern Wyoming, with a few sightings extending as far east as the Bighorn Mountains [4, 5]. It formerly bred in Colorado and California, but has been extirpated from these states. Local extirpations have also occurred in portions of Idaho and Montana [6]. Harlequin Ducks in Wyoming migrate to the Pacific Ocean for the winter [2, 6].

Habitat:
During the breeding season, the Harlequin Duck uses fast flowing streams in subalpine habitats typically surrounded by undisturbed forest [2, 6]. Though habitat preference differs across the species' range, habitat characteristics include wide riparian zones, clear and clean water of low acidity, braided or multi-channel streams with islands, a rocky substrate, and a stream gradient of one to seven percent. In Grand Teton National Park, Harlequin Duck occurs along streams with a mean gradient of < 3% with dense shruby vegetation lining the banks [7]. Harlequin Duck nests on islands in streams and also in dense shrubs adjacent to streams [6, 7]. Suitable habitat in Wyoming is found in Grand Teton and Yellowstone National Parks, and in the Bridger-Teton and Shoshone National Forests [8]. During the winter, the species migrates out of the state to the Pacific coast, where it uses shallow intertidal and subtidal rocky benches and cobble beaches [2].

Phenology:
Pair bonds are formed on the winter grounds as early as October. Migration to inland breeding sites begins in late March, and continues into May [2]. The first birds arrive in Grand Teton National Park from early to mid-May [7]. In Iceland, incubation lasted an average of 28 days (Robertson and Goudie 1999). Hatching in Wyoming occurs in early-late July (S. Patla, pers. comm.) [7]. Fledging occurs 42 to 56 days after hatching [6]. Fall migration begins for males in June and July, while females and young migrate as late as September and October [2]. Two adult males implanted with satellite transmitters in May 2016 in Grand Teton National Park departed for the west coast on July 1 and July 10 and settled at molt sites near the west end of Vancouver Island, British Columbia on July 13 and July 31 (L. Savoy, Biodiversity Research Institute, pers. comm.).

Diet:
On the breeding grounds, Harlequin Duck feeds upon aquatic insects and fish roe. The species feeds upon marine invertebrates on the winter grounds [2].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD BUT DISJUNCT
Wyoming: VERY RARE
A minimum of 70 Harlequin Duck breeding pairs are estimated to occur in Wyoming [9, 10].

Population Trends:
Historic: MODERATE DECLINE
Recent: STABLE

Harlequin Duck populations in Wyoming have probably remained stable in recent years although pairs have not been documented recently on some historic nesting streams in the Teton Range (S. Patla, pers. comm.) [9]. Harlequin Duck numbers in eastern North America experienced large declines during most of the 1900s, stabilizing in the 1990s, and currently may be increasing [2]. In western populations, breeding surveys suggest a stable population, while winter surveys show a declining population [6].

Intrinsic Vulnerability:
HIGH VULNERABILITY
Harlequin Duck is restricted to breeding on clear, relatively fast moving, low gradient streams that are low in acidity, with many channels and islands, and a rocky substrate [6]. Males typically do not breed until at least three years of age, while females may not successfully breed until five years of age [2]. Survival rate of fledglings may be low [11]. The species has strong site fidelity to breeding locations [2, 6]. If the breeding population in Wyoming became extirpated, recolonization of the species in the state would likely not occur.

Extrinsic Stressors:
MODERATELY STRESSED
Human recreation, including hiking, fishing, and boating may cause Harlequin Duck to abandon breeding sites [6]. Recent efforts to open up remote streams for recreational boating in national parks could result in loss of breeding habitat in both Grand Teton and Yellowstone National Parks (S. Patla, pers. comm.). Sport hunting for sea ducks, including Harlequin Duck, occurs in the winter and may have a negative impact on populations [6]. Timber harvest may cause streams to become turbid, and hence unsuitable for nesting [6]. Mining may cause pollution, increased sedimentation, and increased acidity of streams [6]. Forest fires may also result in degraded stream conditions. Livestock grazing in forest habitats can cause sedimentation in streams, trampling of nests, and trampling of vegetation that provides nest cover [6]. Density of raptors has been associated with unoccupied suitable habitat in the eastern population [12]. Aerial surveys of breeding pairs in Wyoming documented fewer ducks in 2007 when water levels were low and higher numbers of Bald Eagles were observed [10]. Based on band recoveries during the winter and on recent satellite tracking data, Wyoming's Harlequin Ducks concentrate in the Strait of Juan de Fuca in Washington state and British Columbia (Puget Sound). This area is at risk from bilge discharge and oil spills [6]. Timing of migration and routes have been documented for only two males from Wyoming so risks during migration between summer and winter habitat remain speculative but likely include shooting, predation, and habitat loss of key stop over sites.

KEY ACTIVITIES IN WYOMING

Monitoring inventories for breeding Harlequin Ducks were initiated in the late 1980s and the 1990s in Grand Teton National Park [7], Targhee National Forest [13, 14], Yellowstone National Park [15], and the Shoshone National Forest [16]. In 2002, WGFD began development of an aerial survey monitoring protocol to provide a statewide estimate of the number of breeding pairs in Wyoming. For the first survey effort, 35 suitable streams and rivers were surveyed during the pre-nesting period in the last two weeks of May and a total of 63 ducks (including 28 breeding pairs) were documented. In August, a follow-up brood survey was also completed in the Teton Wilderness area to confirm successful nesting (five female adults and 13 young of the year) in this previously undocumented nesting area [9]. WGFD completed additional aerial monitoring surveys in 2007, 2008, and 2012 [8, 10, 17]. Based on these survey efforts, WGFD estimates a minimum of 70 breeding pairs in the state that appears to be stable. WGFD also completed a study on factors that affect detectability of Harlequin Duck [18]. Ducks foraged most intensively in the early morning and late afternoon periods in riffles with changing light conditions which made them more difficult to observe in contrast to rest periods when they hauled out on sand bars or in eddies. In 2014, WGFD initiated a project in partnership with Biodiversity Research Institute and Grand Teton National Park to trap and mark breeding pairs in the park [19]. In May 2014, a total of 3 ducks were captured and tagged with color leg bands. In May 2016, two additional pairs were trapped and marked with color leg bands. In addition, the males were implanted with satellite GPS transmitters and the female adults were tagged with geo-locator leg bands as part of a larger regional study in partnership with Environment Canada (S. Patla, pers. comm.). Tagged males left breeding sites in early July 2016 and traveled over 1500 km to Pacific Ocean molting sites near Vancouver Island in British Columbia (S. Patla, pers. comm.). Two additional pairs will be tagged in May 2017.

ECOLOGICAL INFORMATION NEEDS

Demographic information for Harlequin Duck is lacking [6]. The effects of forest management, such as fire, logging, and road development, are unknown [6]. The preferred habitat in Wyoming, and how it differs from unused habitat, is unknown [6]. Information on migration routes and timing as well as winter distribution for the interior Rocky Mountain breeding population is also needed to assess risks during the non-breeding season. For Wyoming, further work is need on distribution during the breeding season to determine the eastward extension of this species, and whether pairs have abandoned former nesting streams that were occupied in the 1980s.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Susan M. Patla. Aerial monitoring to track statewide population trends should continue in coordination with federal parks and national forests every five years at a minimum in four key areas: Teton Wilderness (Bridger-Teton and Shoshone National Forests), north end of Grand Teton National Park/south end Yellowstone National Park, Yellowstone/Larmar Rivers (Yellowstone National Park), and the Clark's Fork River and its tributaries (Shoshone National Forest). Follow up brood surveys in selected areas during survey years are also recommended. In 2016, a regional two-year satellite tracking study was initiated coordinated by Environment Canada. Objectives include tagging a few male Harlequin Ducks in Wyoming, Idaho, Montana, and interior Canada to collect data on migration routes and wintering areas for this eastern extension of the Pacific population. Coordinating population trend surveys within the Intermountain region still remains a key objective so participation in the Harlequin Duck working group (held annually in Montana) should be continued. The lack of observations of breeding pairs in recent years from some streams in Grand Teton National Park and the Caribou-Targhee National Forest requires investigation to determine if increasing human recreation has resulted in loss of nesting habitat. Management of human recreation activity (especially boating) may be required in the future in important nesting areas to preserve high quality habitat. It is recommended that additional surveys be conducted in historic nesting areas after severe wild fires occur to determine if changes in stream quality post fire may also cause pairs to abandon nesting habitat. Confirmation of pairs reported from new areas is needed to document potential additional nesting habitat. Research to help determine how climate change may affect the functioning of mountain streams and Harlequin Duck nest success, productivity, and survival will require focused study of females during the nesting and brood-rearing periods.

CONTRIBUTORS

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Figure 1: Adult male Harlequin Duck (top) in breeding plumage, British Columbia, Canada; Adult female Harlequin Duck (bottom) in winter, West Vancouver, Canada. (Photos courtesy of Tom Middleton (top) and Lanaye Baxter (bottom))

Figure 2: North American range of *Histrionicus histrionicus*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Harlequin Duck habitat at Moose Creek in Grand Teton National Park, Wyoming. (Photo courtesy of Cody Bish)

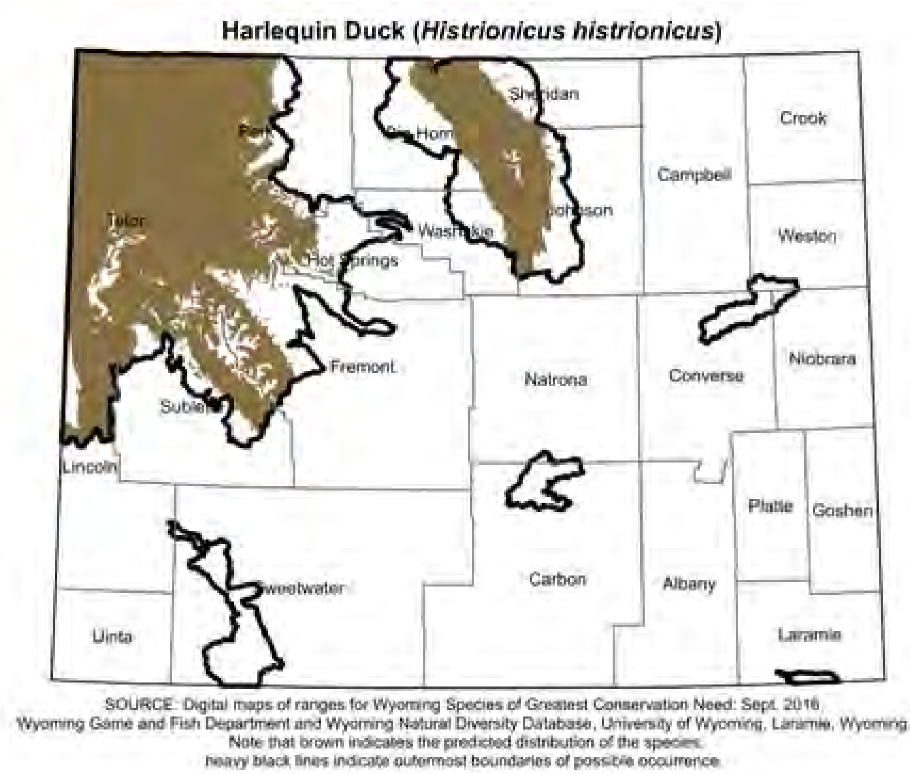

Figure 4: Range and predicted distribution of *Histrionicus histrionicus* in Wyoming.

Juniper Titmouse
Baeolophus ridgwayi

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: Bird of Conservation Concern
WGFD: NSS3 (Bb), Tier II
WYNDD: G5, S1S3
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 12

STATUS AND RANK COMMENTS
The Wyoming Natural Diversity Database has assigned Juniper Titmouse (*Baeolophus ridgwayi*) a state conservation rank ranging from S1 (Critically Imperiled) to S3 (Vulnerable) because of uncertainty about the abundance, proportion of range occupied, and population trends for this species in Wyoming.

NATURAL HISTORY

Taxonomy:
In 1997, Plain Titmouse (*Parus inornatus*) was split into two geographically distinct species based on genetic evidence and differences in ecology, morphology, coloration, and song: Juniper Titmouse (*B. ridgwayi*) and Oak Titmouse (*B. inornatus*) [1, 2]. There are currently two recognized subspecies of Juniper Titmouse, but only *B. r. ridgwayi* is found in Wyoming [2, 3].

Description:
Identification of Juniper Titmouse is possible in the field. Juniper Titmouse has uniform brownish-gray plumage year-round, with breast feathers that are slightly lighter than the back and wings, a short crest, unmarked face, dark gray legs and bill, and black eyes [2, 4]. The sexes are similar in appearance. Adults have a wingspan of approximately 22.9 cm and weigh 13.5–23.1 g, with males averaging slightly larger than females [2, 4]. The plumage coloration of Juniper Titmouse is similar to Bushtit (*Psaltriparus minimus*), but Bushtit lacks a crest and is substantially smaller (i.e., wingspan 15.2 cm and weight 5.3 g) [4].

Distribution & Range:
Juniper Titmouse occurs only in portions of western North America. The species is found year-round from southern Oregon and Idaho to extreme northern Sonora, Mexico [2]. A small isolated population also occurs on the border of New Mexico and Texas in the vicinity of the Guadalupe Mountains [2, 5]. Range overlap with Oak Titmouse is limited to a small area in northern California

[2, 6]. Juniper Titmouse may be physiologically restricted at the northern boundary of its continental distribution by thermoregulatory requirements and metabolic restrictions that limit tolerance to cold [7-9]. Wyoming is peripheral to the core range of Juniper Titmouse [2], but the species is a year-round resident [10, 11]. Juniper Titmouse is most frequently observed in southwestern Wyoming [10, 11]. Confirmed and suspected breeding has been documented in just 4 of the 28 latitude/longitude degree blocks in the state, all in southwestern and southcentral Wyoming [11].

Habitat:
Juniper Titmouse is a juniper and piñon-juniper woodland obligate across its distribution [2, 12]. In Wyoming, Juniper Titmouse occurs in mature Utah Juniper (*Juniperus osteosperma*) woodlands with large trees, high canopy cover, and high densities of senescent trees and dead limbs [10, 13-16]. Presence of Piñon Pine (*Pinus edulis*), although uncommon in Wyoming [17], has also been identified as a strong predictor of Juniper Titmouse habitat use within Wyoming juniper woodlands [14]. Juniper Titmouse nests primarily in existing tree cavities, and will use both natural cavities and cavities created by woodpeckers [2, 11].

Phenology:
Very little is known about the specific breeding habits of Juniper Titmouse in Wyoming. The species is believed to be non-migratory, with the exception of some short-distance movements outside of the breeding season [2, 10]. Juniper Titmouse is a territorial species that forms life-long pair bonds [2, 18]. Both the male and female actively defend their territory throughout the year, even outside the breeding season [2, 18]. Nests are likely initiated in April or May, and clutch size ranges from 4–7 eggs [2]. Females are solely responsible for incubation, which likely lasts 14–16 days [2]. Nests with young have been reported in mid- and late May in southwestern Wyoming [13]. Juniper Titmouse is believed to be a single-brood species [2].

Diet:
Juniper Titmouse feeds primarily on large seeds from trees (e.g., juniper seeds, piñon seeds, acorns, etc.), as well as terrestrial invertebrates and other plant materials [2, 18]. This species hoards seeds, but specific caching behaviors have not been formally documented [2, 18].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
Partners in Flight estimated the global population of Juniper Titmouse at approximately 180,000 in 2013 [19]. There are no robust estimates of abundance available for Juniper Titmouse in Wyoming. The species has a statewide abundance rank of RARE but appears to be uncommon within suitable environments in the occupied area [11]. From 1968–2015, annual Wyoming Breeding Bird Survey (BBS) detections of Juniper Titmouse ranged from 0 to 6, with none recorded in most years [20]. Juniper Titmouse was not detected during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [21]. More targeted surveys in juniper woodland habitat may be necessary to adequately detect Juniper Titmouse in Wyoming.

Population Trends:
Historic: UNKNOWN

Recent: UNKNOWN
Robust population trends are not available for Juniper Titmouse in Wyoming because the species is infrequently detected during monitoring surveys. North American BBS survey-wide trend data have deficiencies, and should be viewed with caution, but suggest that Juniper Titmouse numbers declined annually by 0.23% from 1966–2013 and increased annually by 0.58% from 2003–2013 [22]. Neither trend estimate was statistically significant.

Intrinsic Vulnerability:
HIGH VULNERABILITY
Juniper Titmouse has high intrinsic vulnerability in Wyoming because it is an obligate of mature juniper woodlands for all stages of its life cycle. Only 2.2% of the total land area in Wyoming is classified as juniper woodlands [17], which restricts the distribution and abundance of Juniper Titmouse in the state. In addition, the previously discussed physiological constraints and limited cold intolerance of this species (see Distribution and Range) may limit the potential for range expansion to juniper woodlands in northern Wyoming should loss or degradation of existing habitat occur [10].

Extrinsic Stressors:
MODERATELY STRESSED
Habitat loss, degradation, and disturbance could negatively impact Juniper Titmouse in Wyoming. Piñon and juniper woodlands have been expanding in many areas of the western United States since the mid-1800s [23], and the area of piñon-juniper habitat occupied by Juniper Titmouse could increase by > 25% in parts of its range [24]. However, existing juniper woodlands in Wyoming are potentially vulnerable to changes in fire regime; invasive species such as Cheatgrass (*Bromus tectorum*); drought and climate change; habitat fragmentation; and human disturbance, including juniper removal and thinning programs [17]. In addition, juniper woodlands in southwestern Wyoming are often associated with rocky habitats, which are threatened by potential energy development and exposure to anthropogenic disturbances from recreational activities [17, 25]. Wyoming is predicted to lose a majority of its Utah Juniper woodlands over the next century due to changing climate condition [26]. Currently, it is not known how potential extrinsic stressors may impact Juniper Titmouse in Wyoming.

KEY ACTIVITIES IN WYOMING

Juniper Titmouse is classified as a Species of Greatest Conservation Need (SGCN) by the Wyoming Game and Fish Department (WGFD), and as a Level II Priority Bird Species requiring monitoring in the Wyoming Bird Conservation Plan [27]. Current statewide activities for monitoring annual detections and population trends for Juniper Titmouse in Wyoming include the BBS program conducted on 108 established routes since 1968 [22], and the multi-agency IMBCR program initiated in 2009 [21]. In 2016, the WGFD began a two-year project designed to collect data on the distribution, relative abundance, and habitat use of piñon-juniper obligate species, including Juniper Titmouse, in the woodlands of southwestern Wyoming.

ECOLOGICAL INFORMATION NEEDS

In Wyoming, Juniper Titmouse would benefit from research to determine its detailed distribution and actual abundance. Very little is known about the specific breeding habits of this species in the state, and nothing is known about nest success or fledgling survival. Additional research is needed to examine how current and future anthropogenic and natural threats to Wyoming juniper woodlands could potentially effect Juniper Titmouse populations in the state.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Juniper Titmouse is classified as a SGCN in Wyoming due to a need for robust information on breeding status and population trend in Wyoming; limited distribution of required breeding habitat; loss, degradation, and fragmentation of Utah juniper habitat due to industrial developments; and incompatible management practices [17]. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [22] and IMBCR [21]. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, Juniper Titmouse needs a targeted, species-specific survey method approach to obtain these data. Initial work and written species accounts on avian Utah Juniper obligate species, including Juniper Titmouse, occurred in 1988 [28]. However, higher priorities and limited personnel and funding precluded conducting additional work on these species. Best management practices to benefit Juniper Titmouse include implementing a sufficient monitoring technique; maintaining mature stands of Utah Juniper habitat where Juniper Titmouse nests, including herbaceous vegetation and shrubs for foraging; implementing prescribed and natural fire management to maintain savannah-like stands of juniper woodlands in areas occupied by Juniper Titmouse; coordinating Utah Juniper management to provide a mosaic of juniper woodland conditions [29].

CONTRIBUTORS

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Figure 1: Juniper Titmouse in Flaming Gorge, Sweetwater County, Wyoming. (Photo courtesy of Shawn Billerman)

Figure 2: North American range of Juniper Titmouse (*Baeolophus ridgwayi*) and Oak Titmouse (*B. inornatus*). (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Juniper Titmouse habitat in southwestern Wyoming, dominated by Utah Juniper. (Photo courtesy of Leah H. Yandow, WGFD)

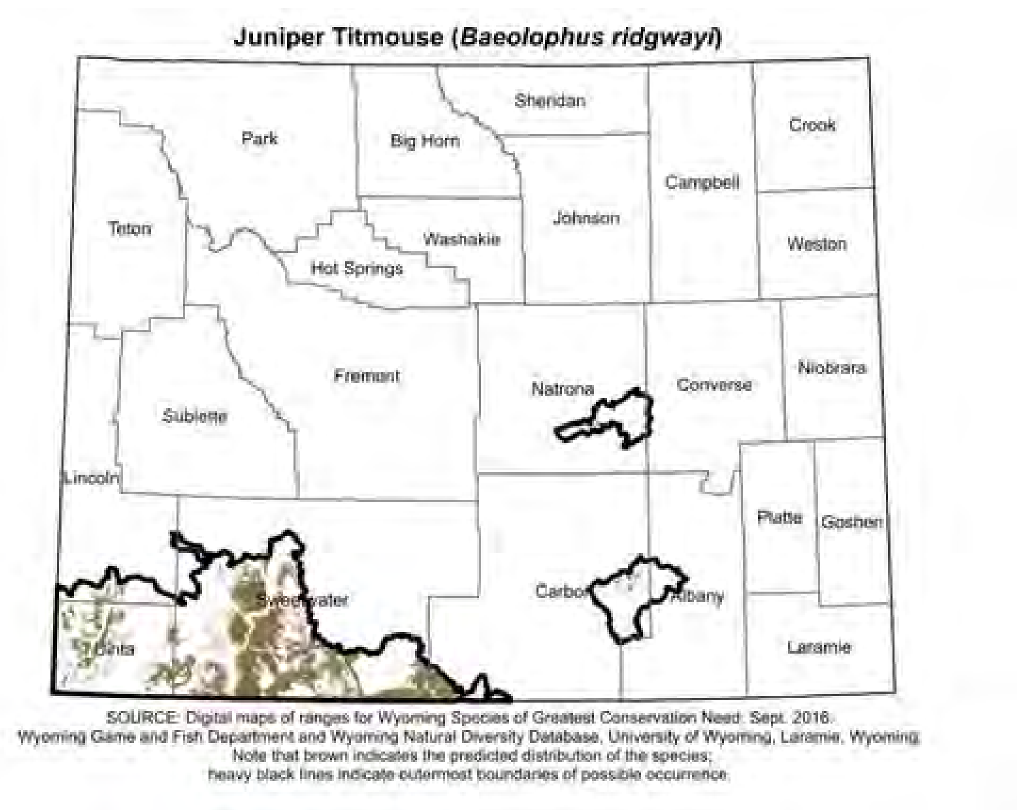

Figure 4: Range and predicted distribution of *Baeolophus ridgwayi* in Wyoming.

Lewis's Woodpecker
Melanerpes lewis

Regulatory Status
USFWS: Migratory Bird
USFS R2: Sensitive
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

Conservation Ranks
USFWS: Species of Conservation Concern
WGFD: NSSU (U), Tier II
WYNDD: G4, S3
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 13

Status and Rank Comments
Lewis's Woodpecker (*Melanerpes lewis*) has no additional regulatory status or conservation rank considerations beyond those listed above.

Natural History
Taxonomy:
There are currently no recognized subspecies of Lewis's Woodpecker [1, 2].

Description:
Identification of Lewis's Woodpecker is possible in the field. Males and females are identical in size and plumage. It is a large woodpecker, 26–28 cm long. The crown, back, wings, and tail are dark green. It has a large red face patch, a broad gray collar, and the belly is extensively pinkish-red [1, 3]. Juvenile birds are darker than adults overall, more brown on the dorsal side, and the face and belly are not as extensively red [1]. In Wyoming, this is the only extensively green and red woodpecker.

Distribution & Range:
Lewis's Woodpecker is patchily distributed across western North America [1]. It is found as far north as British Columbia; west to California; east to Colorado, Wyoming, and western South Dakota; and south to New Mexico and Arizona [1]. It is locally distributed across its range, and is not always found in viable habitat [1]. Populations in Wyoming are migratory, and the species is generally not found in the state in the winter [1]. There have been range contractions along the periphery of the species' range [1].

Habitat:
Lewis's Woodpecker is commonly found in forests dominated by Ponderosa Pine (*Pinus ponderosa*), open riparian woodland dominated by cottonwood (*Populus spp.*), and recently

logged or burned pine forests [1, 4-8]. The species nests in cavities excavated in dead trees. Additionally, the species is associated with habitats that have a brushy understory and a relatively open canopy [1, 5, 9]. Outside of Wyoming, the woodpecker has been found in oak (*Quercus* spp.) woodlands, nut and fruit orchards, Piñon Pine-Juniper (*Pinus cembroides-Juniperus* spp.) woodlands, fir (*Abies* spp.) forests, and agricultural areas such as farms or ranchlands [1]. Ideal habitat in Wyoming can be found in the Bear Lodge Mountains in the Black Hills [10]. The species winters out of Wyoming and is often associated with oak woodlands and commercial orchards [1].

Phenology:
Lewis's Woodpecker is migratory in Wyoming, arriving in early May, and departing after the breeding season from August to October. Initiation of breeding varies with elevation, latitude, and insect abundance. Incubation has been observed from May to June, and lasts for 12–16 days. Fledging occurs at 28–34 days of age, and in Colorado occurred from mid-June to mid-July [1, 8, 11].

Diet:
Lewis's Woodpecker primarily feeds upon insects, acorns, nuts, and fruit [1].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
Lewis's Woodpecker has a statewide abundance rank of RARE and appears to be uncommon within suitable environments in the occupied area [12]. In 2013, Partners in Flight estimated the Wyoming population to be around 1,900 individuals [13]; however, this abundance estimate is based primarily on Breeding Bird Survey (BBS) data and should be viewed with caution due to the low detection rate of this species in the state. From 1968–2015, annual Wyoming BBS detections of Lewis's Woodpecker ranged from 0 to 13 (average = 1), with none recorded in 2015 [14]. A total of 13 Lewis's Woodpeckers were detected during surveys for the Integrated Monitoring in Bird Conservation Regions program between 2009–2015 [15].

Population Trends:
Historic: LARGE DECLINE
Recent: UNKNOWN
Robust population trends are not available for Lewis's Woodpecker in Wyoming because the species is infrequently detected during monitoring efforts. Wyoming trend data from the North American BBS suggest that Lewis's Woodpecker experienced annual increases from 1968–2013 and from 2003–2013, but these state estimates have low credibility and are not statistically significant [16]. Survey-wide BBS trend data indicate that Lewis's Woodpecker numbers experienced a statistically significant annual decline of 3.29% from 1966–2013, and a non-significant annual increase of 0.01% from 2003–2013 [16].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Lewis's Woodpecker is a primary cavity nester and requires standing dead or partly dead trees for nesting. Additionally, snags must be in advanced stages of decay for the species to be able to

excavate a nest cavity [1]. Suitable nesting habitat is becoming increasing scarce. Competition from European Starlings (*Sturnus vulgaris*) for nest cavities may threaten the species [1, 8].

Extrinsic Stressors:
MODERATELY STRESSED
Habitat loss and degradation represent major extrinsic threats to Lewis's Woodpecker. Habitat degradation has primarily occurred from fire suppression and intensive livestock grazing. Habitat loss has occurred throughout the species range, primarily from human development encroaching into breeding habitat on open valley floors and foothills. Strip-mining may cause habitat degradation and loss. Mountain Pine Beetle (*Dendroctonus ponderosae*) affects Ponderosa Pine trees, and it is unknown what effects this will have on the woodpecker. On the wintering grounds, the species is exposed to pesticides and herbicides in agricultural areas. The species forages in commercial nut and fruit orchards, which places it at risk from shooting and trapping [1].

KEY ACTIVITIES IN WYOMING
Lewis's Woodpecker is classified as a Species of Greatest Conservation Need (SGCN) by the Wyoming Game and Fish Department, and as a Level II Priority Bird Species requiring monitoring in the Wyoming Bird Conservation Plan [17]. Current statewide bird monitoring programs are designed for monitoring breeding songbird populations and do not adequately detect Lewis's Woodpecker. These monitoring programs include the BBS program conducted on 108 established routes since 1968 [16], and the multi-agency IMBCR program initiated in 2009 [15]. There are currently no research projects designed specifically for Lewis's Woodpecker in Wyoming.

ECOLOGICAL INFORMATION NEEDS
Specific habitat requirements of Lewis's Woodpecker in Wyoming are poorly understood. Current estimates of abundance and population trends of the species in Wyoming and range wide may not be accurate, and more accurate data are needed [1]. Many aspects of migration are poorly understood including migratory patterns and survival rates during migration [8].

MANAGEMENT IN WYOMING
This section authored solely by WGFD; Zachary J. Walker. Lewis's Woodpecker is classified as a SGCN in Wyoming due to habitat degradation from fire suppression and loss of riparian woodlands. Management activities in the short term should focus on addressing data deficiencies. Research should be developed to examine current population status and population trends within the state. Research should additionally focus on habitat associations and the impact of current management practices. Best management practices for this species include maintenance of cottonwood galleries and other riparian forests, ensuring that large snags are available. Salvage logging should be avoided in mature forests where Lewis's Woodpecker is known to occur. Understory where Lewis's Woodpecker occurs should be managed to ensure insect prey are abundant and available.

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Figure 1: Adult Lewis's Woodpecker in Flagstaff, Arizona. (Photo courtesy of Pam Koch)

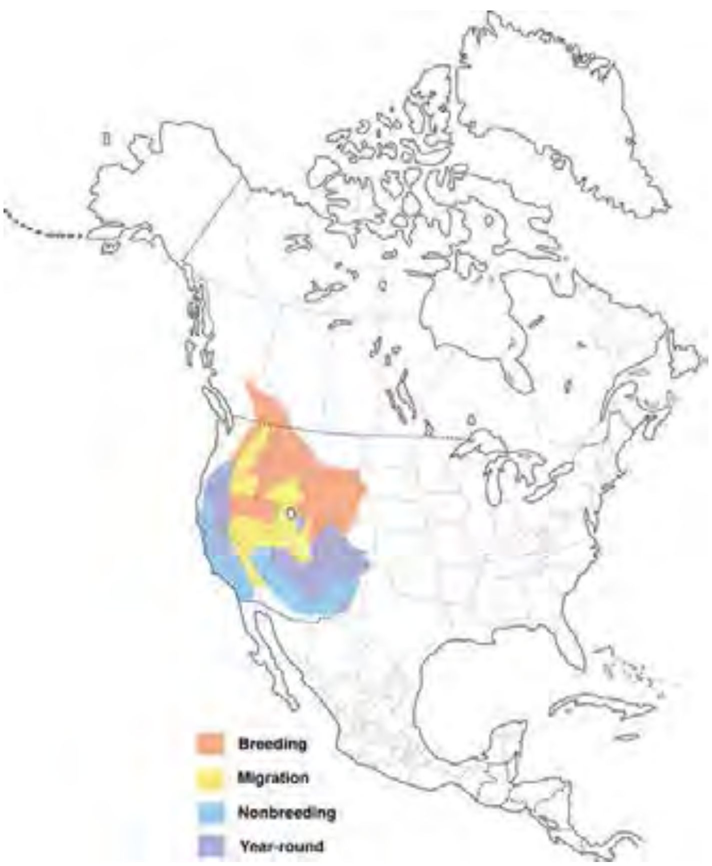

Figure 2: North American range of *Melanerpes lewis*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Lewis's Woodpecker habitat in Coconino National Forest, Arizona, 9 years post-burn. (Photo courtesy of Terri Pope)

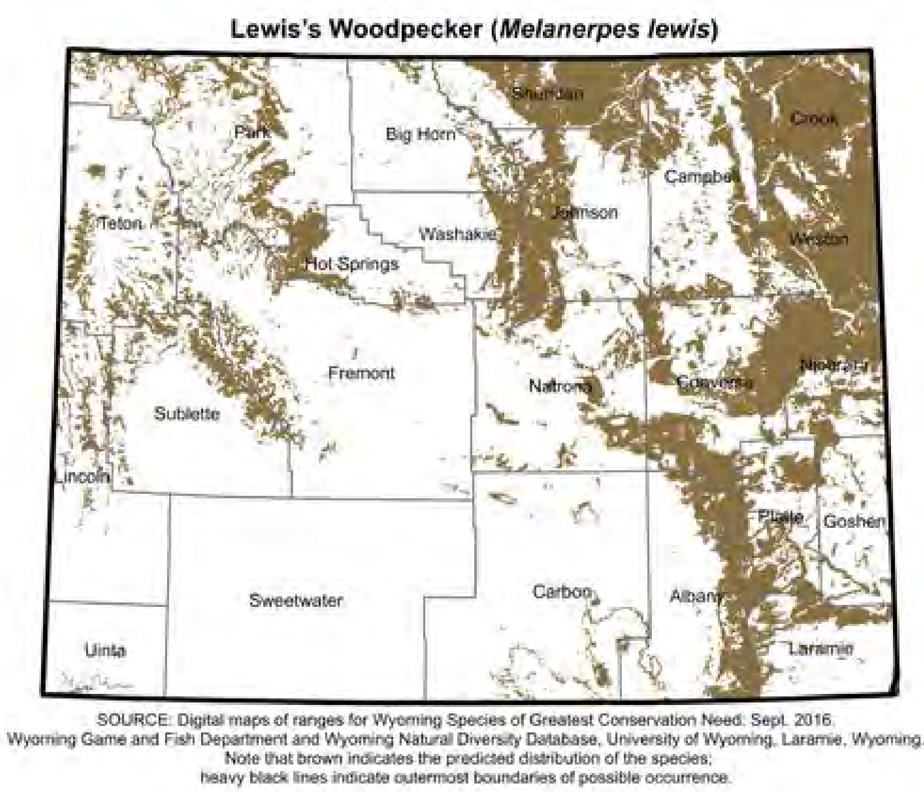

Figure 4: Range and predicted distribution of *Melanerpes lewis* in Wyoming.

Loggerhead Shrike
Lanius ludovicianus

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: Sensitive
USFS R4: No special status
Wyoming BLM: Sensitive
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: Bird of Conservation Concern
WGFD: NSS4 (Bc), Tier II
WYNDD: G4, S4S5
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 11

STATUS AND RANK COMMENTS
The Wyoming Natural Diversity Database has assigned Loggerhead Shrike (*Lanius ludovicianus*) a state conservation rank ranging from S4 (Apparently Secure) to S5 (Secure) because of uncertainty over extrinsic stressors and population trends of the species in Wyoming. Loggerhead Shrike is classified as Sensitive by Region 2 of the U.S. Forest Service and the Wyoming Bureau of Land Management because of significant range-wide declines from historic levels that may impact the future viability of the species; the cause of the declines are currently unknown [1, 2]. Although the species is not classified as Threatened or Endangered, the San Clemente Loggerhead Shrike (*L. l. mearnsi*) is Endangered throughout its range in California [3]. Finally, the International Union for Conservation of Nature and Natural Resources classifies the status of the Loggerhead Shrike as Least Concern [4]; however, population trends are decreasing.

NATURAL HISTORY

Taxonomy:
Loggerhead Shrikes, also known as butcherbirds, and Northern Shrikes (*L. excubitor*) are the only North American species in the family Laniidae. The number and distinctness of subspecies of Loggerhead Shrike varies among reports [5]. For the purposes of this document, we follow Yosef (1996) and recognize 9 subspecies. Only *L. l. excubitorides* is found in Wyoming [6].

Description:
Loggerhead Shrike is a robin-sized passerine identifiable by its gray back, head, and breast; white chin, throat, and belly; black mask; black primaries and secondaries with a white wing patch; black tail with white outer tail coverts; and small, black, slightly hooked bill [5]. Females are smaller than males and tend to have browner primaries. Loggerhead Shrike may be easily confused with Northern Shrike, which overlap throughout their range in Wyoming [6, 7]. However, Northern Shrike is larger and paler with a larger white rump, has a black mask that is narrower

and does not extend above the eye, and is found in deciduous and coniferous woodlands as opposed to the open habitats of Loggerhead Shrike (see below) [5]. Loggerhead Shrike subspecies generally vary in color, bill size, and length of tail and wings.

Distribution & Range:
Loggerhead Shrike is a year-round resident throughout most of its range. Wyoming, however, only provides breeding habitat, and all Loggerhead Shrikes in the state are migratory. Breeding range extends from southern Saskatchewan and Manitoba, Canada, through the central and western United States, the entire southern half of the United States from the Pacific to Atlantic coasts, and the western third of Mexico south to Oaxaca. Wintering range extensively overlaps breeding range, and extends from non-migratory populations in the southern half of the United States at roughly 40° N latitude south throughout all of Mexico to Veracruz and Oaxaca [5]. Loggerhead Shrike has been documented in all of Wyoming's 28 latitude/longitude degree blocks, with confirmed or circumstantial evidence of breeding occurring in all, with the exception of Yellowstone National Park [7].

Habitat:
Loggerhead Shrike tends to use similar habitats throughout both breeding and wintering ranges. In general, Loggerhead Shrike is found in open habitats with short vegetation, especially hay fields and pastures. Other components of habitat include 'pastures with fence rows, old orchards, mowed roadsides, cemeteries, golf courses, agricultural fields, riparian areas, and open woodlands' [5]. Breeding sites include isolated trees and shrubs within this open habitat. The amount of cover provided at nest sites by trees and shrubs tend to be more important than specific species [5]. In the western United States, nests are placed in Russian Olive (*Elaeagnus angustifolia*) [8], Big Sagebrush (*Artemisia tridentata*), Antelope Bitterbrush (*Pursia tridentata*), and Greasewood (*Sarcobatus vermiculatus*) [9]. In sagebrush habitat in Idaho, nests were typically placed low in shrubs (0.8 m above ground in shrubs averaging 1.6 m in height) [9], although subsequent nests tended to be placed higher in trees as individuals re-nested throughout the season [5, 9]. Fence lines and power lines provide important perches for hunting [5].

Phenology:
Loggerhead Shrike returns to its breeding grounds in Wyoming in April [6], and individuals occupy and defend territories and initiate nest-building shortly after arrival [5]. In northern Colorado, egg-laying peaks in late May, incubation lasts for 16 days (range is 15–17 days), and fledging occurs 17 days later [8]. Fledglings are able to fly approximately 1 week after leaving the nest; before that time, both parents continue to provide food. Clutch size is typically 5–6 eggs (range 1–9) and tends to be larger for populations in the northern and western part of the breeding range. Loggerhead Shrike usually produces a single brood, although it may have multiple broods in a season (especially following nest failure) with as many as 3 broods recorded in southern populations [5]. Fall migration likely occurs in August and September in Wyoming; the latest recorded observation of a Loggerhead Shrike in Wyoming was 18 November [6]. Although a handful of Loggerhead Shrikes have been observed in the southern part of the state during Christmas Bird Counts, these remain unverified [6]. Individual *L. l. excubitorides* has been observed overwintering in southern Texas and southern Mexico; no individuals of that subspecies have been observed in the southeastern United States, suggesting migration of Wyoming birds follows a north-south route and does not include movement eastward [5].

Diet:
Loggerhead Shrike is an opportunistic carnivore and takes a variety of prey items including arthropods, reptiles and amphibians, small birds and mammals, and even roadkill and other carrion. Arthropods are main prey items, although vertebrates may become more important during the winter. Shrikes actively hunt and kill prey, using their hooked beaks to sever the spinal cord of vertebrate prey, which they then carry with their beaks or feet. Larger prey items are impaled on thorns or barbed-wire before eating to assist with prey immobilization and manipulation and as a method of food storage [5].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: ABUNDANT
Using North American Breeding Bird Survey (BBS) data, the Partners in Flight Science Committee estimated the global population of Loggerhead Shrike to be 5.8 million birds [10]. Extrapolation suggests approximately 2.2% of the global population, or around 130,000 birds, could breed in Wyoming, but this estimate is likely high and should be viewed with caution [11]. The statewide rank of ABUNDANT is based on the large area of the state known to be occupied in any given season and the large coverage of suitable habitat within that area. Loggerhead Shrike appears to be common within suitable habitat and is usually encountered during surveys that could be expected to indicate its presence [7]. The Integrated Monitoring in Bird Conservation Regions (IMBCR) program is developing data with which to more precisely estimate abundance and densities of Loggerhead Shrike in Wyoming, but robust data are not yet available and will require additional survey years [12].

Population Trends:
Historic: MODERATE DECLINE to STABLE
Recent: MODERATE DECLINE to STABLE
Although there is good evidence for large, long-term population declines elsewhere in the species' range [5], there is no strong reason to suspect historic declines in Wyoming populations. Loggerhead Shrike population trend data from the BBS in Wyoming from 1968–2013 and 2003–2013 suggest annual declines of 0.73% (N = 90 routes, 95% CI: -2.05–0.59) and 0.42% (N = 90 routes, 95% CI: -3.65–3.21), respectively [13]; however, neither trend estimate is statistically significant.

Intrinsic Vulnerability:
LOW VULNERABILITY
Loggerhead Shrike uses a variety of natural and human-developed habitats; consequently, it tends to respond well to human-altered landscapes. High reproductive rates may also allow populations to expand quickly into new areas [5]. Loggerhead Shrike is susceptible to West Nile virus [14, 15], although the impact of the disease at a population level is unknown. As arthropods represent a major prey item, the species may be at particular risk from pesticide [5]. Other life history characteristics do not predispose the species to declines from changes in environmental conditions.

Extrinsic Stressors:
SLIGHTLY STRESSED

Partners in Flight assigns the Loggerhead Shrike a threat level of 3, indicating that the species is expected to display a slight to moderate decline in the future suitability of breeding conditions [10]. The factors that may contribute to this decline are variable, and a number of threats may impact populations throughout portions of the range. Historically, shrikes were the target of removal efforts because of their behavior of impaling prey; however, this direct mortality is not as common currently. Pesticides may reduce availability of insect prey, as well as accumulate in individual Loggerhead Shrikes [5], although the role of these pesticides in population declines is unclear [16]. Perhaps one of the most likely causes of decline, particularly in the eastern portion of the species' range, is from the loss of agriculture, pasture, and hedgerow habitat [5], although it is unknown to what degree this loss is occurring in Wyoming or impacting populations. Habitat loss in winter range may be particularly important, especially for Midwestern populations [17]. However, much of the open habitat on which Loggerhead Shrike depends is created through anthropogenic land use activities (see Habitat section above), and much apparently suitable habitat is still available and unoccupied [5, 18]. Fire in sagebrush habitat may negatively impact density and nest survival, potentially due to the reduction of nesting habitat [19]. Predation and inclement weather are common causes of nest failure [8].

KEY ACTIVITIES IN WYOMING

Loggerhead Shrike is listed as a Species of Greatest Conservation Need (SGCN) in Wyoming by the Wyoming Game and Fish Department and as a Level II Priority Species requiring monitoring action in the Wyoming Bird Conservation Plan [20]. Current statewide efforts for monitoring annual detections and population trends of Loggerhead Shrike in Wyoming include the BBS program conducted on 108 established routes since 1968 [13] and the multi-partner IMBCR program initiated in 2009 [12]. Trend data are available on the U.S. Geological Survey BBS website [13], and occupancy, density, and population estimates, along with other decision support tools, are available through the Rocky Mountain Avian Data Center [12].

ECOLOGICAL INFORMATION NEEDS

Additional information on the effects of pesticides on Loggerhead Shrike in Wyoming would be beneficial. Also, a better understanding of the spatial pattern and timing of arthropod productivity in Wyoming shrublands would provide resource managers some information on how to manage landscapes for the benefit of Loggerhead Shrike.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Loggerhead Shrike is classified as a SGCN in Wyoming due to apparent, slight population declines. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming. The first is the long-term BBS started in Wyoming in 1968 with 108 established routes [13]. Species must be detected on at least 14 routes for data analyses to be significant for tracking population status and trend over time. The IMBCR program was established in 2009 in Wyoming with many state, federal, and nongovernmental organization partners that contribute funding, field personnel, technical assistance, or in-kind services. Data analyses produce density, occupancy, and population estimates at various scales; present habitat associations; and provide decision support tools for managers [12]. Best management practices or key management recommendations to benefit Loggerhead Shrike include maintaining a mosaic of open (5%) to moderate (25%) shrub cover in shrub-steppe landscapes that includes various ages and heights of shrubs; providing a mosaic of short (≤ 10 cm) and taller (> 20 cm) vegetation within the shrub-steppe landscape as ground foraging and nesting areas; protecting known Loggerhead Shrike nest trees from browsing and rubbing damage due to livestock and direct loss due to prescribed burning; allowing at least 50% of annual herbaceous plant growth to remain through the following nesting season to provide cover for nest concealment; preventing large-scale fires, habitat conversions, and additional road construction that will eradicate or diminish large, continuous areas of shrub-steppe and woodland habitats; and minimizing insecticide use in shrub-steppe habitats to maintain a food source for Loggerhead Shrikes (and other insectivores) [20].

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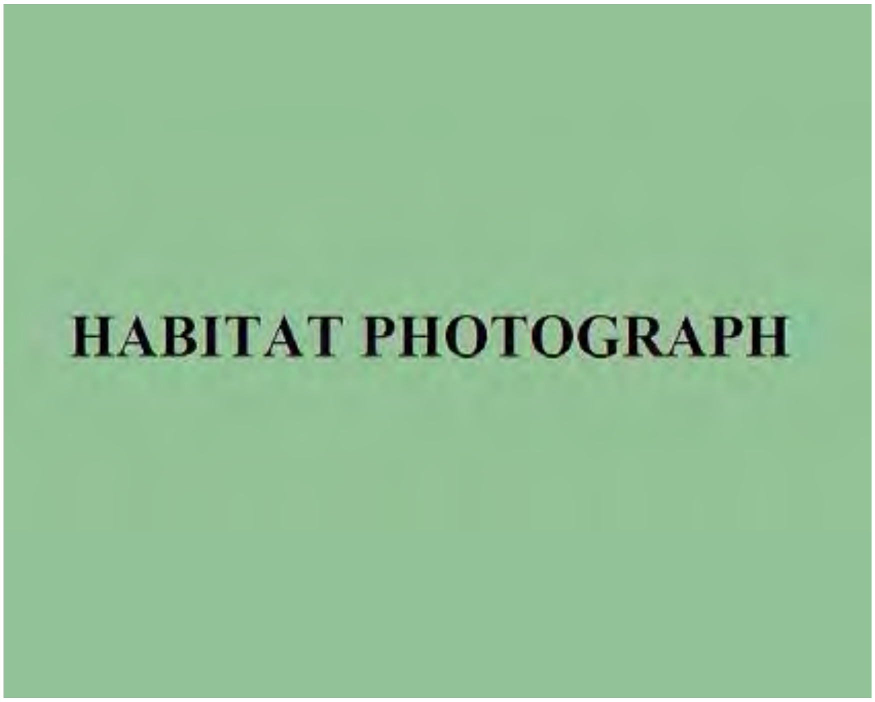
Figure 1: Adult Loggerhead Shrike in Albany County, Wyoming. (Photo courtesy of Shawn Billerman)

Figure 2: North American range of *Lanius ludovicianus*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)



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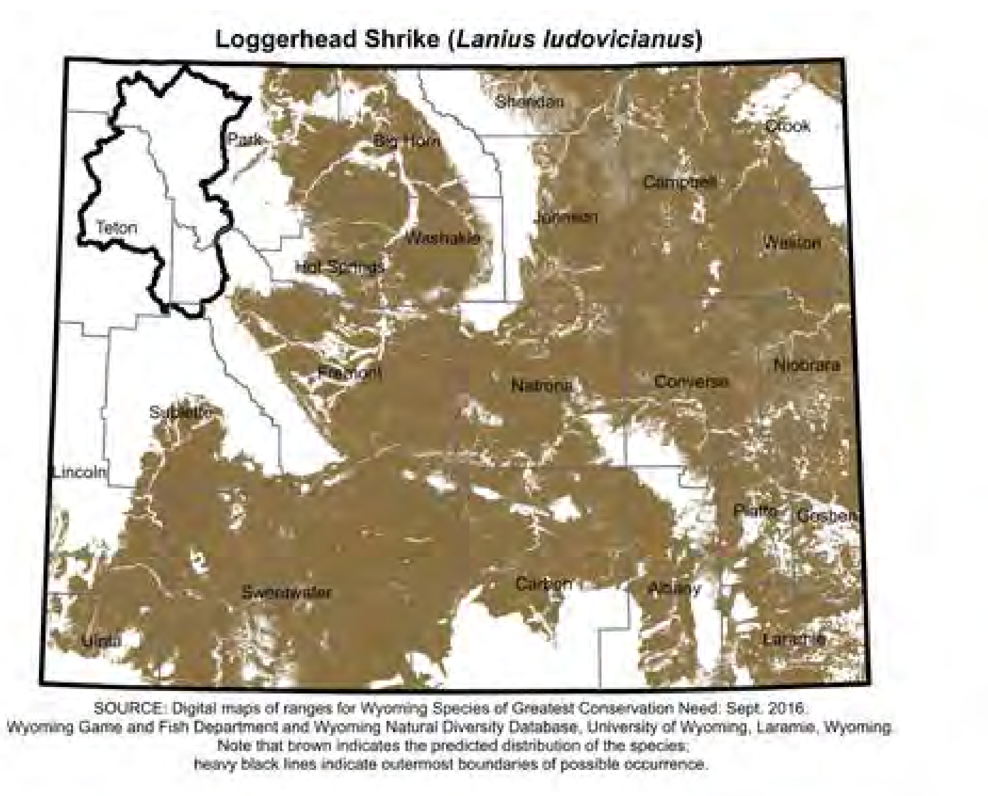

Figure 4: Range and predicted distribution of *Lanius ludovicianus* in Wyoming.

Long-billed Curlew
Numenius americanus

Regulatory Status
USFWS: Migratory Game Bird
USFS R2: Sensitive
USFS R4: No special status
Wyoming BLM: Sensitive
State of Wyoming: Game Bird (see regulations); Protected Bird

Conservation Ranks
USFWS: Bird of Conservation Concern
WGFD: NSS3 (Bb), Tier II
WYNDD: G5, S3S4
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: Not ranked

Status and Rank Comments
The Wyoming Natural Diversity Database has assigned Long-billed Curlew a state conservation rank ranging from S3 (Vulnerable) to S5 (Secure) because of uncertainty about the abundance and recent population trends for this species in Wyoming.

Natural History

Taxonomy:
The taxonomy of Long-billed Curlew is uncertain, with some authorities describing the species as monotypic while others argue for the existence of two subspecies based on difference in body and bill size [1, 2]. However, it is unknown if these proposed measurements can be used to definitively identify individuals to the subspecies level, and therefore there are currently no formally recognized subspecies of Long-billed Curlew [1].

Description:
Identification of Long-billed Curlew is possible in the field. It is the largest shorebird in North America; adults weigh approximately 590 g, have a body length of 50.0–65.0 cm, and a wingspan of 25.7–30.8 cm [1, 3]. The decurved bill is distinctly long (11.3–21.9 cm) and narrow [1]. The sexes have similar plumage year-round, but females are typically larger-bodied and have longer bills (average 17.0 cm) than males (average 13.9 cm) [1]. Adults have plain buffy-brown underparts; buffy cinnamon-tinged upperparts with dark brown streaking and barring; cinnamon underwings; a dark bill that lightens to pink at the base of the lower mandible; dark eyes; and long, pale gray legs [1, 3]. Five other species of sandpiper are known to breed in Wyoming [4, 5], but all have straight bills that are significantly shorter than the bill of Long-billed Curlew. Long-billed Curlew also closely resembles Whimbrel (*N. phaeopus*), which is a rare migrant in Wyoming [5]; however, Whimbrel has a shorter bill (7.3–10.3 cm) and bold, dark crown-stripes [3, 6].

Distribution & Range:
Long-billed Curlew is endemic to the Great Plains of the western United States and southwestern Canada during the breeding season [1]. The species winters primarily in Mexico and rarely on the Pacific, Gulf, and Atlantic Coasts of the United States [1, 7, 8]. Long-billed Curlew used to breed as far east as northwestern Indiana and was a common winter resident and migrant along the entire Atlantic Coast; however, the species has experienced westward contractions in both its breeding and wintering distributions over the last century-and-a-half [1, 9]. Central and western Wyoming lie within the current core breeding distribution of Long-billed Curlew [1], although breeding has also been documented in eastern Wyoming [5]. The species migrates through the state in the spring and fall and is a summer resident [4, 5]. Long-billed Curlew has been observed across Wyoming, and confirmed or suspected breeding has been document in 19 of the 28 latitude/longitude degree blocks in the state [5].

Habitat:
In Wyoming, Long-billed Curlew nests in sparsely-vegetated shortgrass or mixed-grass prairie environments, often dominated by Wire Grass (*Juncus balticus*) and Mountain Timothy (*Phleum alpinum*), with low vegetation (≤ 10–30 cm) and topography that is flat or gently sloping [1, 4, 10]. This species typically avoids habitats with high densities of tall grass, forbs, shrubs, and/or trees [1, 4, 11], but will nest in some agricultural landscapes including hay fields and grazed pasture [1, 11-13]. Long-billed Curlew is a ground nesting species [1]. Nest are constructed by scraping dirt from beneath the body with the feet to create a shallow depression, which is then lined with a variety of materials depending on availability (e.g., pebbles, bark, twigs, grass stems and leaves, seeds, and bird and mammal droppings) [1]. Long-billed Curlew spends the non-breeding season in coastal estuaries, mudflats, salt marshes, wetlands, flooded fields, agricultural fields and pastures, and a variety of manmade waterbodies [1, 11, 14, 15].

Phenology:
In Wyoming, spring arrival of migrating and breeding of Long-billed Curlews occurs during the last two weeks of April, with most birds arriving by early May [4]. In Wyoming, nest building begins in early May [1], and clutches are initiated by the last week of May [4]. Most clutches contain 4 eggs (range 2–5), and hatching typically occurs from mid-June to mid-July [1]. Newly hatched chicks are able to venture from the nest and feed themselves within a few hours, but parents will continue to brood and provide shade for several weeks [1]. Although females may cease care of young after just 2–3 weeks, males will often continue to provide protection from predators until young fledge at 38–45 days of age [1]. Long-billed Curlew is a single-brood species, but may renest following loss of the first clutch [12, 16]. Fall migration from Wyoming to wintering grounds begins as early as late June and continues through early September, with most migrants and residents leaving the state by mid-September [4].

Diet:
Long-billed Curlew is carnivorous and opportunistically consumes terrestrial insects and worms, marine crustaceans, benthic invertebrates, and small vertebrates such as songbird eggs and nestlings [1, 5]. This species uses its extremely long bill to probe terrestrial and aquatic holes and burrows, thus allowing it to extract subterranean prey such as earthworms and mud crabs [1].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD

Wyoming: RARE
Long-billed Curlew is patchily distributed within its widespread North American distribution [1]. The species has an estimated global population of roughly 140,000 individuals and an estimated United States population of about 97,000 [17, 18]; however, there are no robust estimates of abundance for Long-billed Curlew in Wyoming. The species has a statewide abundance rank of RARE, and it appears to be uncommon within suitable environments in the occupied area [5]. In 2013, Long-billed Curlew surveys conducted on 4 routes in northwestern Wyoming by the Wyoming Game and Fish Department (WGFD) recorded 70 individuals [19]. From 1968–2015, state-wide annual Breeding Bird Survey (BBS) detections of Long-billed Curlew in Wyoming ranged from 0 to 38, with 15 recorded in 2015 [20]. Between 2009–2015, surveys for the Integrated Monitoring of Bird Conservation Regions (IMBCR) program detected a total of 27 Long-billed Curlews [21]. While surveys conducted as part of the BBS and IMBCR programs may occasional detect this species, neither is specifically designed to capture sandpiper observations.

Population Trends:
Historic: LARGE DECLINE
Recent: STABLE
Long-billed Curlew populations are believed to have experienced historic large declines over the last 150 years, and this species is considered vulnerable or imperiled in many parts of its current range [1, 9, 22, 23]. Despite high annual variability, recent detections of Long-billed Curlew in western Wyoming have remained relatively stable since the mid- to late 1990s [19], although declines have been reported in some areas of the state [23]. Trends for Long-billed Curlew populations in eastern Wyoming are unknown [4]. Wyoming trend data from the North American BBS have deficiencies, and should be viewed with caution, but suggest that Long-billed Curlew numbers increased annually by 1.75% from 1968–2013 and 2.62% from 2003–2013 [24]. Neither trend estimate was statistically significant. Across North America, BBS trend data indicate that Long-billed Curlew numbers experienced a non-significant annual increase of 0.34% from 1966–2013 and a statistically significant annual increase of 2.48% from 2003–2013 [24].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Long-billed Curlew has moderate intrinsic vulnerability in Wyoming due to low abundance, dependence on open grassland habitats for breeding, and nesting behaviors that leave the species inherently vulnerable to predation and disturbance. As a ground nesting species breeding in relatively exposed environments, Long-billed Curlew eggs and young are at risk for predation from both aerial and terrestrial predators, anthropogenic disturbance, and trampling by livestock in heavily grazed areas [1, 12, 23].

Extrinsic Stressors:
MODERATELY STRESSED
Long-billed Curlew is moderately stressed by extrinsic factors in Wyoming, where prairie grassland habitats are vulnerable to development for energy, infrastructure, and agriculture; invasive plant species such as Cheatgrass (*Bromus tectorum*) and Canada Thistle (*Cirsium arvense*); anthropogenic disturbance from off-road recreational activities; altered fire and grazing regimes; and drought and climate change [25]. Loss and degradation of habitat is thought to be the current most pressing threat to Long-billed Curlew in Wyoming and across its distribution [1, 22, 23, 26]. This species will use agricultural landscapes for both nesting and foraging, which could help alleviate the loss of natural grassland habitat; however, nests in irrigated fields are vulnerable to

failure from flooding [12, 27]. Conversion of sub-irrigated meadows to sprinkler irrigated alfalfa fields appears to becoming an increasing threat in Wyoming [28]. Fertilization and leveling of cultivated fields during the breeding season has also been shown to result in decreased nest success [29]. Although grazing can increase the risk of nests and young being trampled [12, 27, 29], limited or controlled grazing can reduce the height and density of grassland vegetation and increase breeding habitat quality for Long-billed Curlew [23, 30]. Although some invasive plant species are known to decrease suitability of breeding habitat for Long-billed Curlew, the species has been known to nest successfully in Cheatgrass-dominated landscapes [1]. Long-billed Curlew has experienced documented mortality from shooting in Idaho in an area where recreational ground squirrel shooting occurs [1, 31, 32].

KEY ACTIVITIES IN WYOMING

Long-billed Curlew is classified as a Species of Greatest Conservation Need by the WGFD, and as a Level I Priority Bird Species requiring conservation action in the Wyoming Bird Conservation Plan [10]. Breeding Long-billed Curlews have been surveyed annually in western Wyoming by the WGFD since 1991 [19]. Beginning in 2014, the WGFD partnered with the Intermountain Bird Observatory to deploy satellite transmitters on breeding adult Long-billed Curlews in Wyoming to collect information on migration patterns and habitat use [33]. One breeding adult female was tagged on the National Elk Refuge in Jackson, Wyoming in 2014 [33], and 7 additional adults were tagged in western Wyoming in 2015 [27]. In 2015, the Intermountain Bird Observatory conducted a study of curlew abundance and reproductive success in Sublette County where a previous study had been completed in the 1980s and also in the Cody area [27, 34]. Additionally, WGFD initiated a targeted grassland SGCN monitoring program in 2015 for Long-billed Curlew, Mountain Plover, Upland Sandpiper, and Burrowing Owl [35]. Current statewide bird monitoring programs are designed for monitoring breeding songbird populations and are unlikely to provide useful information on Long-billed Curlew. These monitoring programs include the BBS program conducted on 108 established routes since 1968 [24], and the multi-agency IMBCR program initiated in 2009 [21].

ECOLOGICAL INFORMATION NEEDS

In Wyoming, Long-billed Curlew would benefit from research to determine the detailed distribution and annual abundance of migrating and breeding adults, especially in the eastern portion of the state where populations remain relatively unstudied. Little is known about nest success or fledgling survival of Long-billed Curlew across most of Wyoming, and it would be valuable to quantify the extent to which suspected anthropogenic and natural stressors are currently impacting breeding populations in the state. Coordinating monitoring efforts with other states in the region would be needed to understand the overall status and trend of the United States breeding population.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Susan M. Patla. The WGFD initiated annual breeding season roadside surveys in 1991 in western Wyoming but high annual variability and changes in methodology and observers over time have made it difficult to estimate trends [19]. Survey protocols are currently being revised to allow for estimating trends and abundance across the state [19]. Cochran (1983) studied reproductive success and habitat variables at two sites near Pinedale, Wyoming and found that nest success was greatest in sub-irrigated, native hay meadows that were mowed annually in the Merna area [29]. Field dragging and grazing or fertilizing during the incubation period resulted in increased nest failure. In 2015, a study of reproductive success and habitat use in the same study areas near Pinedale found that the Merna site was still very productive with the highest density of nesting curlews compared to 5 other study sites in Wyoming, Idaho, and Montana [27]. Additional studies on nesting density, reproductive success and habitat use are continuing in the Jackson area (2016) and in Pinedale (2017). Eight additional curlews will be tagged with satellite transmitters across the state in 2017. Habitat loss and fragmentation from conversion of native, flood irrigated grasslands to cultivated crops or to rural subdivisions appear to be the greatest risk for nesting curlews in the state. Nesting in Wyoming is highly patchy and more survey work is needed to understand the distribution and abundance of curlews across the state and to quantify nesting density and success in different habitat types. Results from satellite tracking showed that Wyoming curlews travel to non-breeding destinations that were farther south and east than other curlews tracked in the Intermountain West [27]. Most curlews showed fidelity to specific wintering sites in Mexico or to the Imperial Valley of California. Data from recent and ongoing demographic and tracking studies will contribute towards a regional conservation strategy for this species [27]. Continued research on nest success and migration as well as development of a statistically sound state-wide monitoring scheme for this species are the highest management priorities. Conservation of agricultural lands where traditional grazing and irrigation methods continue to be used should also be a high priority in areas of the state where high concentrations of nesting curlews occur.

CONTRIBUTORS

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Figure 1: Adult Long-billed Curlew in Thunder Basin National Grassland, Wyoming. (Photo courtesy of Michael T. Wickens)

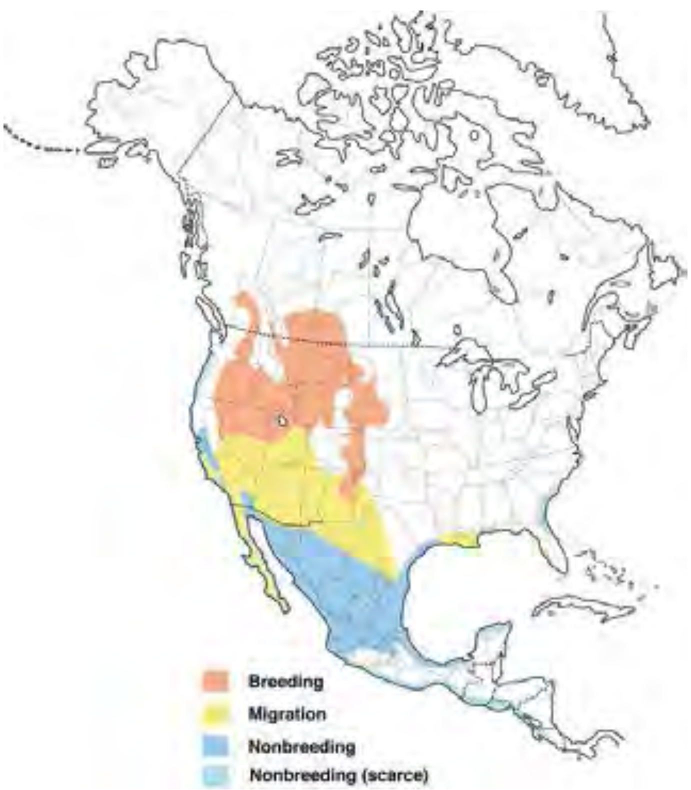
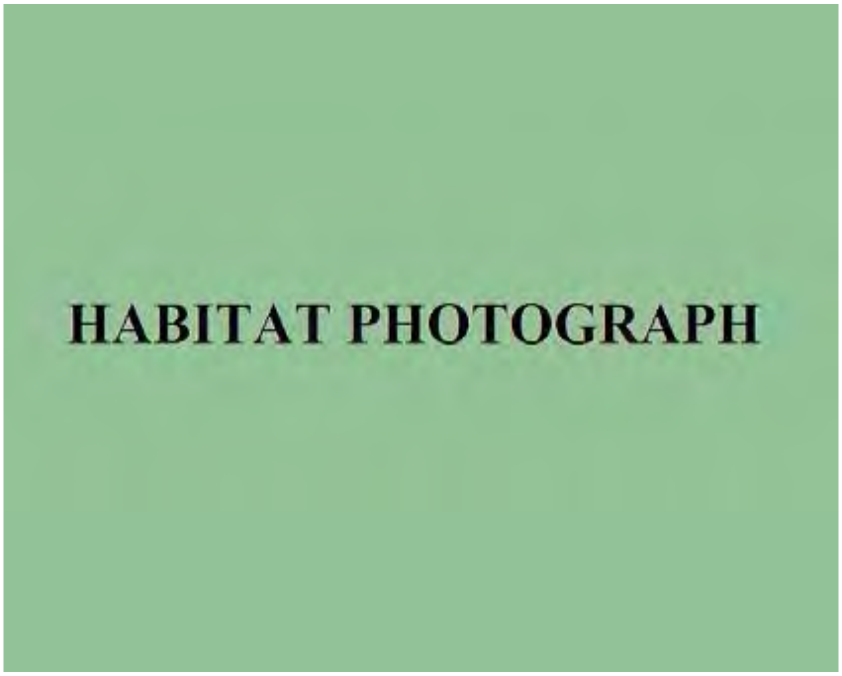


Figure 2: North American range of *Numenius americanus*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)



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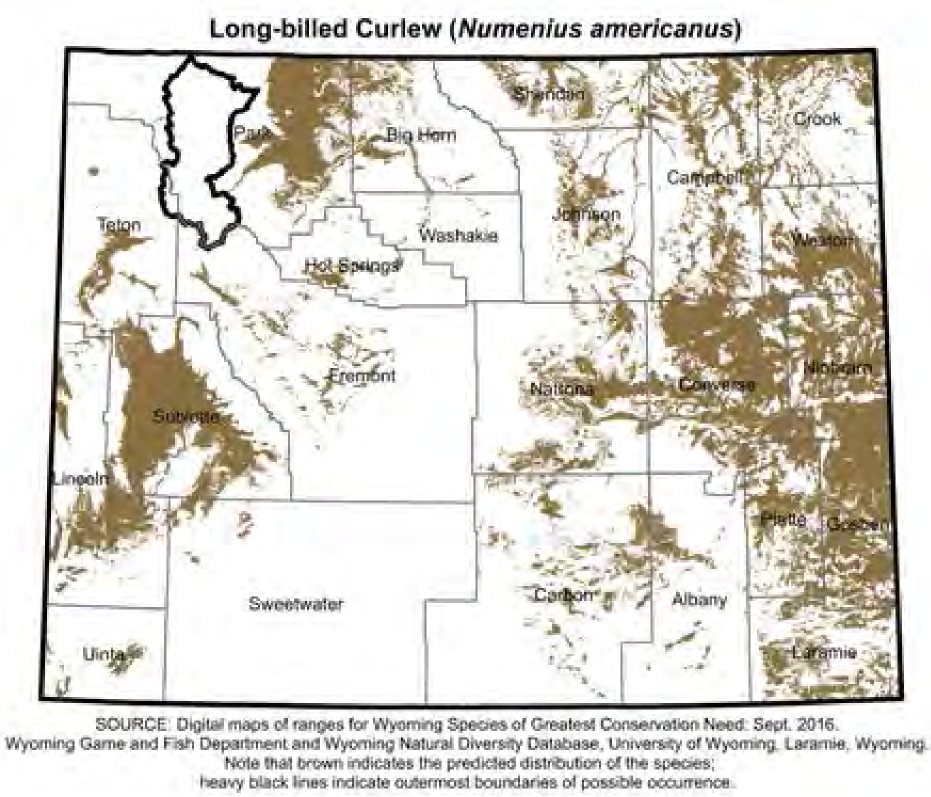

Figure 4: Range and predicted distribution of *Numenius americanus* in Wyoming.

MacGillivray's Warbler

Geothlypis tolmiei

Regulatory Status

USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

Conservation Ranks

USFWS: No special status
WGFD: NSS4 (Bc), Tier II
WYNDD: G5, S4
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 11

Status and Rank Comments

MacGillivray's Warbler (*Geothlypis tolmiei*) does not have any additional regulatory status or conservation rank considerations beyond those listed above.

Natural History

Taxonomy:

Two subspecies of MacGillivray's Warbler are recognized and known to breed in the United States: *G. t. tolmiei* and *G. t. monticola* [1]. In Wyoming, *G. t. monticola* is the known subspecies; it breeds east of the Pacific slope, in the Rocky Mountains and Great Basin, and winters in higher elevations of central and southern Mexico, occasionally in southern California [2, 3]. Two additional subspecies of *G. tolmiei* are not recognized by the American Ornithologists' Union (AOU): *G. t. intermedia* and *G. t. austinsmithi*. The distinguishing characteristic is reported to be a shorter tail length in *G. t. austinsmithi* and there are specimens of said subspecies from western Wyoming [1, 4]. Recent molecular phylogeny efforts concluded that MacGillivray's Warbler is more closely related to the genus *Geothlypis* [5]. The AOU approved the genus change in 2011 [6]. Prior to this, the species was placed in the genus *Oporornis*.

Description:

The species is a small wood-warbler in the Parulidae Family. MacGillivray's Warbler is identifiable in the field during the breeding season. Male upperparts are olive green and underparts are yellow. Head is dark gray with a black throat and black lores. Females are similarly colored, though more drab overall. Females do not have black lores. Both sexes have white crescents above and below the eye, pale pinkish legs and feet, and black eyes. Juveniles are even more drab in color than females [7]. While Common Yellowthroat (*Geothlypis trichas*) shares some basic similarities with MacGillivray's Warbler, the male has a distinct black face mask and olive head, while the female has a yellow throat. Two additional similar species include Mourning Warbler (*Geothlypis philadelphia*) and Connecticut Warbler (*Oporornis agilis*). Although both are considered rare in Wyoming, they have been documented in eastern and western parts of the state. Mourning Warbler is typically distinguished from MacGillivray's Warbler by larger body measurements, usually a lack of eye crescents, and in almost all cases, the species' ranges do not overlap [8-10]. Connecticut Warbler is larger than MacGillivray's Warbler and has a complete white eye ring. Connecticut Warbler males have a gray throat and females have a brown-gray top of the head [7].

Distribution & Range:
MacGillivray's Warbler is distributed across the western portion of North America during the breeding season. Wyoming forms a significant southeastern portion of MacGillivray's Warbler breeding range [7, 11]. MacGillivray's Warbler has been documented in 27 of Wyoming's 28 latitude/longitude degree blocks with confirmed or circumstantial breeding documented in 24 of these latitude/longitude degree blocks [12]. Limited information about distribution in Wyoming during migration suggests the species prefers low elevation areas with a shrub layer for cover; this may include developed areas [4]. MacGillivray's Warblers that summer in Wyoming are believed to primarily winter in higher elevation areas in central and south Mexico [2].

Habitat:
Rangewide, MacGillivray's Warbler is known to utilize a great variety of coniferous and deciduous forest habitats, as well as shrub-dominated areas without a canopy layer. The species is also known to use areas that have been logged, burned, and affected by windfall events. More specifically, this species tends to be highly dependent on riparian habitats with thick understories, especially so in the southern reaches of its breeding range [7, 13]. In Wyoming, MacGillivray's Warbler generally uses cottonwood-riparian, riparian shrub, and forested areas up to 3,000 m [4, 12]. In southeastern Wyoming MacGillivray's Warbler preferred areas with low tree canopy cover, dense shrub cover consisting of willows (*Salix* spp.) and Thin-leaf Alder (*Alnus incana tenufolia*), saturated soils, and a heavy grass stratum [14, 15]. Additional research in neighboring Utah indicates vegetative composition of breeding areas becomes less dominated by a deciduous tree canopy as elevation increases, to areas composed primarily of shrubs, such as willows, alder, and dogwood (*Cornus* spp.) [16]. Winter habitat includes a variety of forest types, with a strong preference for areas with shrubby, dense, overgrown understories near live water [7].

Phenology:
MacGillivray's Warbler arrives in Wyoming for the breeding season in mid-May; with the earliest report on 4 May. The species departs for wintering grounds beginning in late August through early September. There is a Wyoming report of 15 October [4]. The species lays one egg per day and a clutch usually contains 4 eggs, but can range from 1–5 eggs. Incubation is typically 11–13 days. Fledglings leave the nest 8–9 days after hatching [17, 18]. MacGillivray's Warbler is not known to initiate a second nest during the breeding season [7].

Diet:
MacGillivray's Warbler feeds primarily on insects gleaned from bark and foliage of trees and shrubs [19-21]. Prey includes true bugs (Hemiptera), leaf hoppers (Homoptera), beetles (Coleoptera), bees, wasps and ants (Hymenoptera), alfalfa weevil (Coleoptera), and caterpillars (Lepidoptera) [17, 22, 23]. In Wyoming, the species forages at different heights on a seasonal basis, with average foraging height during early summer months is 0.52 m, and 1.71 m in late summer [21]. Another study documented the species feeding 3–5 m above ground level in Wyoming [24].

Conservation Concerns

Abundance:
Continental: WIDESPREAD
Wyoming: COMMON
Using North American Breeding Bird Survey (BBS) data, the Partners in Flight Science Committee estimated the global population of MacGillivray's Warbler to be 12 million birds [25]. Approximately 1.4% of the global population, or an estimated 170,000 birds, breed in Wyoming [26]. The statewide rank of COMMON is based on the relatively large area of the state known to be occupied in any given season, and the large coverage of suitable habitat within that area. Within suitable habitat in the occupied area, MacGillivray's Warbler also appears to be common and is usually encountered during surveys that could be expected to indicate its presence [12]. MacGillivray's Warbler density (number of birds per square km) and population size estimates for Wyoming are available from the Integrated Monitoring in Bird Conservation Regions (IMBCR) program for the years 2009–2015, although detections are limited so data must be interpreted with caution [27].

Population Trends:
Historic: UNKNOWN
Recent: STABLE
MacGillivray's Warbler population trend data from the North American BBS are available from 1968–2013 and suggest a moderate decline in Wyoming [28]. However, results have been determined to fall within a credibility category containing data with 'deficiencies' due to low relative abundance and number of routes with MacGillivray's Warbler detections, so also must be interpreted with caution [28].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
In Wyoming, MacGillivray's Warbler is moderately vulnerable to extrinsic stressors. The species' primary vulnerabilities stems from impacts to montane riparian and forested breeding grounds and the potential for decreased fecundity due to brood parasitism [17, 29]. The taxon has a relatively low reproductive rate, producing only 1 brood per year [7].

Extrinsic Stressors:
SLIGHTLY STRESSED
Common stressors to MacGillivray's Warbler include livestock overgrazing, residential development, and crop agriculture in montane riparian breeding habitats [29]. In addition to direct human stressors, large ungulate herbivory and browsing may negatively influence the abundance of this taxon [30]. Moose (*Alces americanus*) population research conducted in Grand Teton National Park suggests the absence of large predators, such as Gray Wolf (*Canis lupis*) and Grizzly Bear (*Ursos arctos*), can negatively impact shrub height and volume, as well as MacGillivray's Warbler presence [31]. Another stressor to MacGillivray's Warbler populations is Brown-headed Cowbird (*Molothrus ater*) brood parasitism. Proximity to human-occupied structures and livestock structures may increase rates of parasitism and reduce nest productivity [32]. Finally, while timber harvests, avalanche run paths, and windfall corridors may initially provide new breeding habitat for this species, long-term breeding habitat is likely not improved if these areas are replanted with single species tree stock [7].

KEY ACTIVITIES IN WYOMING

MacGillivray's Warbler is listed as a Species of Greatest Conservation Need (SGCN) in Wyoming by the Wyoming Game and Fish Department, and as a Level II Priority Species requiring monitoring action in the Wyoming Bird Conservation Plan [33]. Habitat loss, degradation, and fragmentation, and incompatible livestock grazing and land use practices could be problematic for this species, and current monitoring programs suggest stable to slightly decreasing population trends. Current statewide efforts for monitoring annual detections and population trends of MacGillivray's Warbler in Wyoming include the BBS program conducted on 108 established routes since 1968 [28], and the multi-partner IMBCR program initiated in 2009 [27]. Trend data are available on the United States Geological Survey BBS website [28], and occupancy, density, population estimates, and decision support tools are available through the Rocky Mountain Avian Data Center [27]. Across its range, MacGillivray's Warbler has not been the focal species of any specific conservation or management actions. This species is likely to benefit from management practices directed to less common species with similar habitat requirements.

ECOLOGICAL INFORMATION NEEDS

Knowledge of how MacGillivray's Warbler responds to drought and climate change is poorly understood. More exact information on population trends is needed and will continue to be refined through the IMBCR and BBS programs.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. MacGillivray's Warbler is classified as a SGCN in Wyoming due to moderate population declines and severe habitat impacts that can occur from drought and climate change. Two separate but compatible survey programs are in place to monitor MacGillivray's Warbler populations. The first is the long-term BBS started in Wyoming in 1968 with 108 established routes [28]. Species must be detected on at least 14 routes for data analyses to be significant for tracking population status and trend over time. The IMBCR program was established in 2009 in Wyoming with many state, federal, and nongovernmental organization partners that contribute funding, field personnel, technical assistance, or in-kind services. Data analyses produce density, occupancy, and population estimates at various scales and provide decision support tools for managers [27]. Best management practices or key management recommendations to benefit MacGillivray's Warbler include maintaining dense shrubs and diverse vegetation heights in wetland and riparian habitats, using rotational livestock grazing during the nesting season to rest wetland and riparian areas from cowbird concentrations and brood parasitism, and minimizing insecticide use in wetland and riparian habitats [33].

CONTRIBUTORS

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Figure 1: Adult male MacGillivray's Warbler in Laramie County, Wyoming. (Photo courtesy of Shawn Billerman)

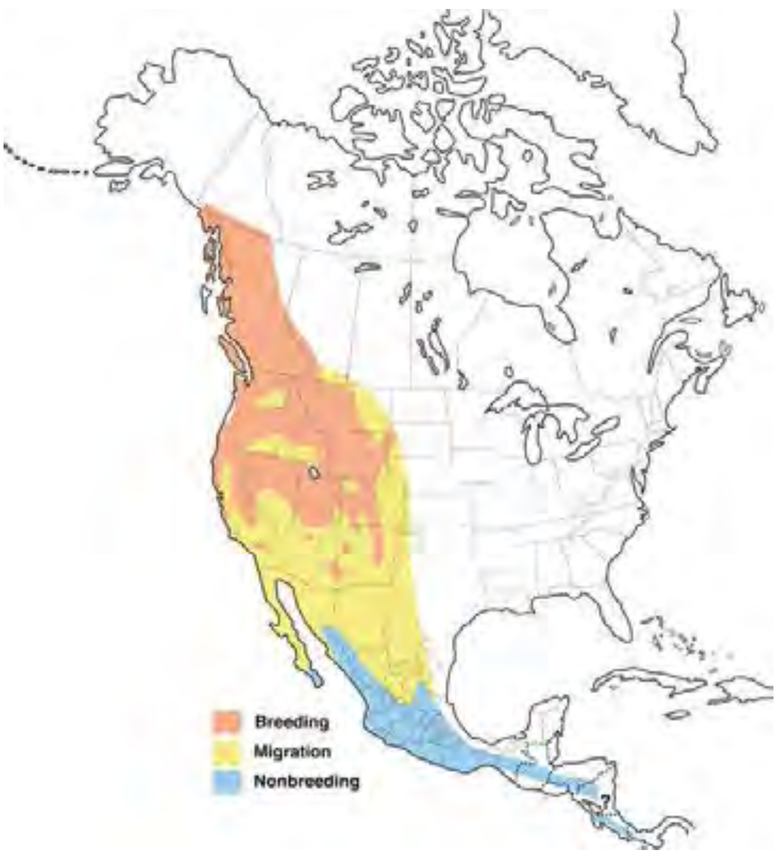

Figure 2: North American range of *Geothlypis tolmiei*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

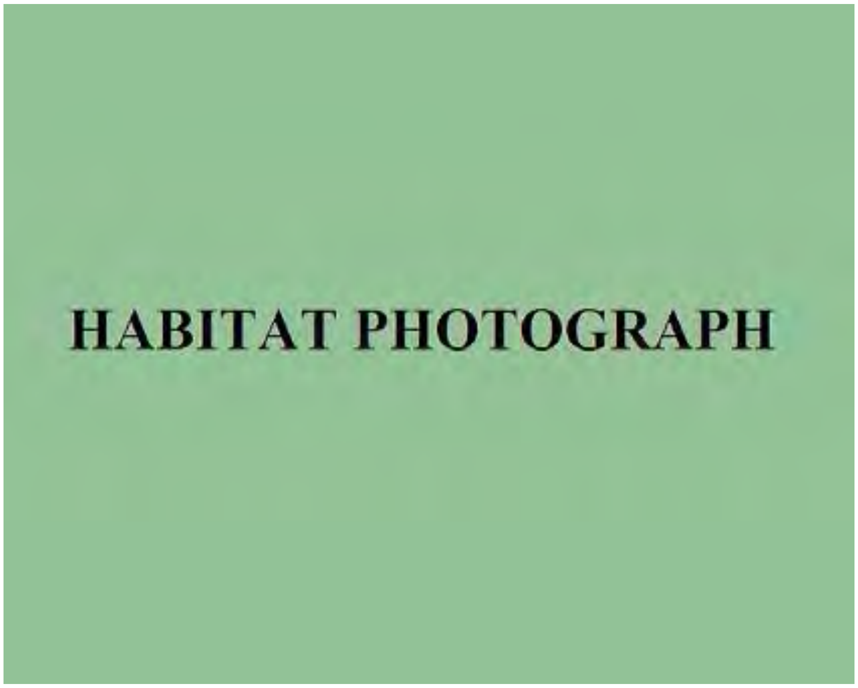

Figure 3: Photo not available.

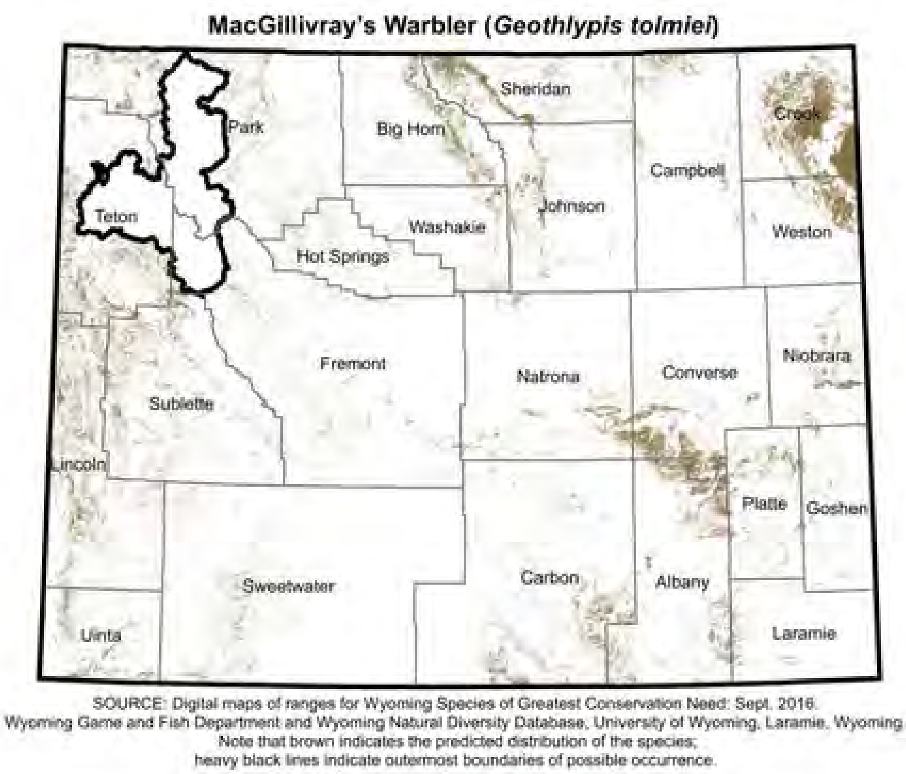

Figure 4: Range and predicted distribution of *Geothlypis tolmiei* in Wyoming.

Wyoming Species Account

McCown's Longspur

Rhynchophanes mccownii

REGULATORY STATUS

USFWS: Migratory Bird
USFS R2: Sensitive
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: Bird of Conservation Concern
WGFD: NSS4 (Bc), Tier II
WYNDD: G4, S3
    Wyoming Contribution: VERY HIGH
IUCN: Least Concern
PIF Continental Concern Score: 13

STATUS AND RANK COMMENTS

McCown's Longspur (*Rhynchophanes mccownii*) has no additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:

There are no recognized subspecies of McCown's Longspur [1, 2]. McCown's Longspur was included in the genus *Calcarius* with other longspur species until 2010. Genetic analysis showed enough differentiation to move the McCown's Longspur to its own genus, and it is monotypic within *Rhynchophanes* [1, 3, 4]. Hybridization with Chestnut-collared Longspur (*Calcarius ornatus*) is possible but apparently rare [5].

Description:

Identification of McCown's Longspur is possible in the field. Adults are similar in size to most sparrows: weight 23 g, length 15 cm, and wingspan 28 cm [1, 6]. The species is sexually dimorphic. Breeding males have a grayish appearance, with pale gray cheeks, nape, rump, and belly that may also be washed with black; black crown, malar stripe, and breast; white lores, eyebrows, and throat; brown streaked back and wings; and bold rufous wing bars. Breeding females have duller, browner plumage overall, with no black markings, less-pronounced wing bars, and a pinkish bill. Both sexes have a white tail with an inverted dark "T" that is visible in-flight [1, 6]. Similar sympatric species in Wyoming include Chestnut-collared Longspur and Lapland Longspur (*C. lapponicus*) [7]. Chestnut-collared Longspur breeding males have a rufous nape and black belly, and both sexes have a black triangle on the otherwise white tail. Lapland Longspur occurs in Wyoming only in the winter (when McCown's Longspur is absent from the state) and both sexes have a dark tail with white along the sides [6].

Distribution & Range:
Both the breeding and winter ranges of McCown's Longspur are restricted to North America. Over the past ca. 120 years McCown's Longspur has experienced drastic contractions to its continental breeding range, which historically extended south to the Oklahoma Panhandle and east to Manitoba and western Minnesota [1, 8]. As shown in Figure 5, the species currently has two disjunct breeding centers in the northwestern Great Plains of Canada and the United States [1, 8, 9]. Wyoming encompasses a majority of the southernmost breeding center, which extends into north-central Colorado [1]. McCown's Longspur migrates through the state in the spring and fall and is a summer resident [7, 10]. Confirmed and suspected breeding has been documented in 16 of the 28 latitude/longitude degree blocks in Wyoming, primarily in the eastern half of the state [10]. However, there are also several disjunct breeding records in central and western Wyoming [7]. McCown's Longspur winters in the southwestern United States and northern Mexico [1, 8]. Winter distribution can vary annually, possibly due to temporal variation in weather and habitat conditions [8].

Habitat:
Across its continental range, including Wyoming, McCown's longspur breeds primarily in large tracts of open, semi-arid, shortgrass prairie and heavily-grazed mixed-grass rangeland with low and sparse vegetation, extensive bare ground, and little ground litter [1, 7, 8]. The species may also use recently burned areas [11], prairie dog (*Cynomys* spp.) colonies [12, 13], and cultivated fields [14, 15] with similar structural characteristics. McCown's Longspur is a ground-nesting species; females construct open cup nests out of grass in existing or excavated depressions, often directly adjacent to taller vegetation or features on the landscape (i.e., bunch grass, cactus, shrub, livestock dung) [1]. Habitat use by McCown's Longspur is often compared to that of Chestnut-collared Longspur; both taxa use grassland with relatively short and sparse vegetation, but the former uses notably more barren areas than the latter [1, 5].

Phenology:
In Wyoming, spring arrival of migrating and breeding McCown's Longspurs begins as early as mid-March, with most arriving in early and mid-April [7, 16]. Males typically arrive in the state several weeks before females [16]. Egg laying typically begins in early May, with most clutches containing 3 or 4 eggs (range 2–6 eggs) [1]. Females are entirely responsible for incubation, which lasts for approximately 12 days. Young are altricial at hatching and remain in the nest until about 10 days old (range 7–11 days). Fledglings are capable of limited flight by 12 days of age, but parents continue to provide food for at least 3 weeks. McCown's Longspur can produce 2 broods in a season [1]. In Wyoming, fall migration to wintering grounds peaks in mid-September, with most migrants and summer residents leaving the state by early October [7].

Diet:
During the breeding season, McCown's Longspur consumes grass seeds, forb seeds, a variety of terrestrial and flying insects (e.g., grasshoppers, moths, beetles, ants), and other available arthropods. Nestling are fed primarily of arthropods, with grasshoppers constituting a large proportion of the diet [1]. The winter diet consists primarily of seeds as well as some grains and berries [1, 8].

CONSERVATION CONCERNS

Abundance:
Continental: REGIONAL ENDEMIC

Wyoming: COMMON
McCown's Longspur has a statewide abundance rank of COMMON, and also appears to be common in suitable environments within its Wyoming range [10]. In 2013, Partners in Flight estimated the Wyoming population of McCown's Longspur to be around 160,000 individuals, or about 27.8% of the global population [17]; however, this abundance estimate is based primarily on Breeding Bird Survey (BBS) data and should be viewed with caution due to the low detection rate of this species in the state. From 1968–2015, annual BBS detections of McCown's Longspur in Wyoming ranged from 3 to 230 (average = 57), with 49 recorded in 2015 [18]. Annual detections of McCown's Longspur ranged from 21 to 148 during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [19]. Estimated mean density across this same time period was 2.16 birds per km^2 (standard deviation 1.12, standard error 0.42) in suitable habitats in Wyoming [19].

Population Trends:
Historic: LARGE DECLINE
Recent: STABLE
Long-term, historic declines of McCown's Longspur in North American are attributed to the fragmentation of native grasslands by agriculture, urbanization and associated infrastructure, and fire suppression [1, 8]. Estimates of recent trends from survey-wide, and Wyoming-specific, BBS data have deficiencies and should be viewed with caution. Across North America, McCown's Longspur numbers experienced a statistically significant annual decline of 6.18% from 1966–2013 and a non-significant annual decline of 2.93% from 2003–2013 [9]. In Wyoming, McCown's Longspur declined annually by 0.06% from 1968–2013 and increased annually by 1.16% from 2003–2013; however, neither trend estimate was statistically significant [9].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
McCown's Longspur has moderate intrinsic vulnerability in Wyoming because it is restricted to a narrow range of habitat types and has nesting behaviors that may leave the species susceptible to nest loss. The species can tolerate some disturbances to grassland, and in fact may respond favorably to disturbances like heavy grazing and fire that maintain large patches of short and sparse vegetation. But McCown's Longspur may be negatively affected by processes that convert native shortgrass and mixed-grass prairie to other cover types, or that promote dense and heavy vegetation. As a species that nests on the ground in sparsely-vegetated environments, McCown's Longspur is vulnerable to predation and ground disturbance (both natural and anthropogenic) during the breeding season [1].

Extrinsic Stressors:
MODERATELY STRESSED
Prairie grassland habitats in eastern Wyoming are vulnerable to development for energy, infrastructure, and agriculture; invasive plant species such as Cheatgrass (*Bromus tectorum*) and Canada Thistle (*Cirsium arvense*); off-road recreational activities; altered fire and grazing regimes; and drought and climate change [10]. Habitat loss and conversion represent significant threats to McCown's Longspur across its continental distribution, and have already led to population declines and range contractions [1, 8]. The species experienced nestling mortality from direct poisoning following the aerial application of a commonly used rangeland insecticide (i.e., toxaphene) on experimental plots in Pawnee National Grassland in northern Colorado [20]. McCown's Longspur will breed in some agricultural landscapes [14, 15]. The species is known to be

very tolerant of livestock grazing and actually appears to prefer grasslands that are heavily grazed or "overgrazed" in some environments [1]. McCown's Longspur densities were similar on grazed pastures and patch-burn grazed pastures in northeastern Colorado [11]. A recent study found that McCown's Longspur reproductive success was not significantly influenced by the presence of wind energy or by turbine density at several wind farms in southeastern Wyoming [21, 22].

KEY ACTIVITIES IN WYOMING

McCown's Longspur is classified as a Species of Greatest Conservation Need by the Wyoming Game and Fish Department (WGFD), and as a Level I Priority Bird Species requiring conservation action in the Wyoming Bird Conservation Plan [23]. In 2009, the Wyoming Natural Diversity Database conducted migration and breeding season surveys of upland songbirds on the Laramie Plains National Wildlife Refuges. These surveys detected McCown's Longspur and provided baseline knowledge on habitat use and abundances for the species in that area [24]. From 2011–2012, the WGFD funded graduate research at the University of Wyoming, in conjunction with the Wyoming Cooperative Fish and Wildlife Research Unit, to examine potential indirect effects of wind energy infrastructure on the habitat use and reproductive success of McCown's Longspur and other grassland birds in southeastern Wyoming [21, 22]. Current statewide activities for monitoring annual detections and population trends for McCown's Longspur in Wyoming include the BBS program conducted on 108 established routes since 1968 [9], and the multi-agency IMBCR program initiated in 2009 [19]. There are currently no research projects designed specifically for McCown's Longspur in Wyoming.

ECOLOGICAL INFORMATION NEEDS

McCown's Longspur would benefit from research to learn more about the apparently isolated breeding populations in central and western Wyoming. Little is known about nest success and fledging survival. It is unknown how breeding McCown's Longspurs in the state respond to grassland management practices such as livestock grazing and prescribed fires. Additional research is needed to examine how the species is affected by various forms of industrial development in the state (e.g., wind energy, oil and natural gas, agriculture, urbanization), especially because Wyoming contains a significant portion of the species' global breeding distribution. Pesticide applications, especially in the context of grasshopper outbreaks in Wyoming, have the potential to drastically lower McCown's Longspur reproductive success and population performance, and should be studied further.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Zachary J. Walker. McCown's Longspur is classified as a SGCN in Wyoming due to habitat loss, fragmentation, and susceptibility to anthropogenic disturbances. Historic declines have been documented for McCown's Longspur, and it is important to monitor this species. Currently, there are two separate but compatible survey programs in place to monitor populations of many avian species that breed in Wyoming. The first is the long-term BBS started in Wyoming in 1968 with 108 established routes (Sauer et al. 2014). The second is the IMBCR program which was established in 2009 in Wyoming with many state, federal, and nongovernmental organization partners that contribute funding, field personnel, technical assistance, or in-kind services. It is recommended that these survey programs be continued into the future to help monitor McCown's Longspur. If future population declines are detected, targeted surveys could be warranted. It is recommended that nesting areas for McCown's Longspur be managed to minimize habitat alteration and fragmentation. Pesticide application should be postponed when possible to avoid impacting breeding populations. Prescribed burns could be used to help manage for McCown's Longspur but should be conducted in early fall and designed to restore early seral habitats for this species.

CONTRIBUTORS

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Figure 1: Adult male McCown's Longspur in Albany County, Wyoming. (Photo courtesy of Shawn Billerman)

Figure 2: North American range of *Rhynchophanes mccownii*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Shortgrass prairie habitat in Thunder Basin National Grassland, Wyoming, preferred habitat of McCown's Longspur. (Photo courtesy of Michael T. Wickens)

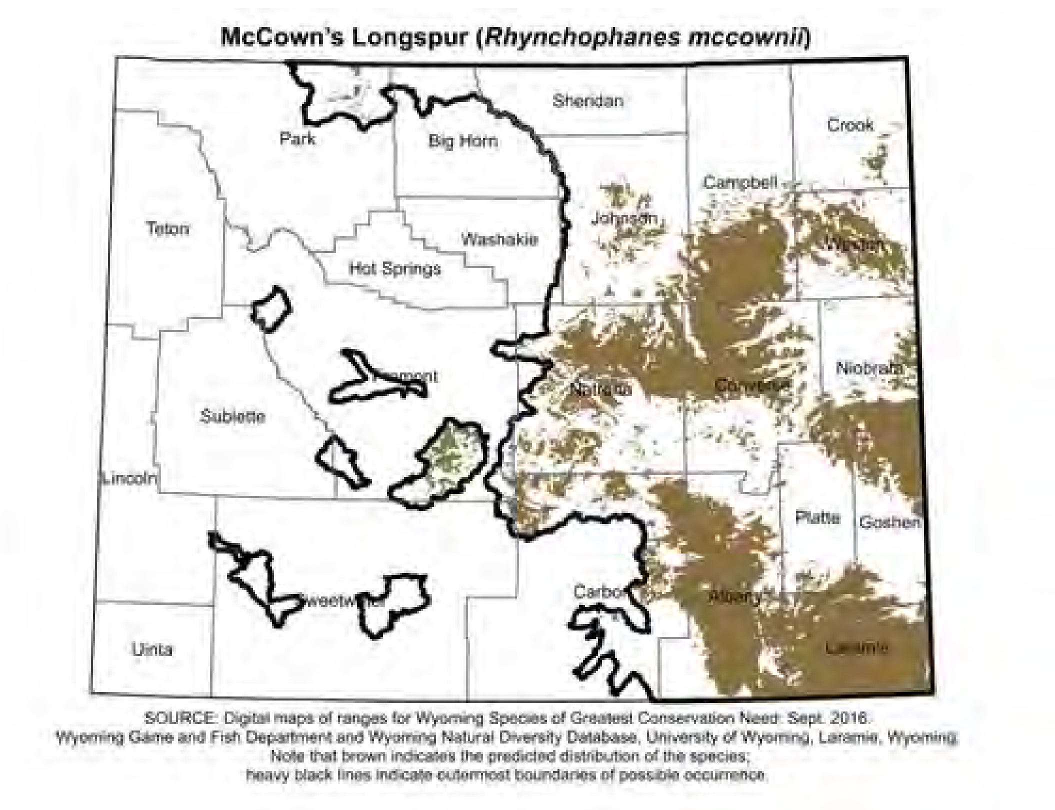

Figure 4: Range and predicted distribution of *Rhynchophanes mccownii* in Wyoming.

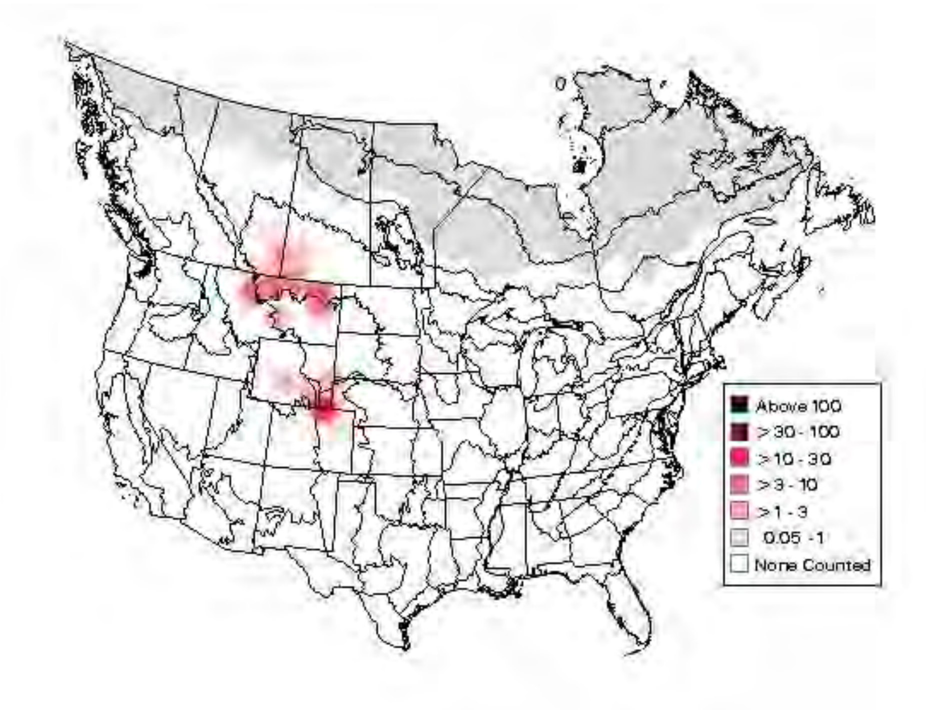

Figure 5: Relative breeding season abundance (average number of birds detected per BBS route per year) of McCown's Longspur from 2007–2013. (Map from: Sauer, J. R., et al. (2014) The North American Breeding Bird Survey, Results and Analysis 1966 - 2013. Version 01.30.2015, USGS Patuxent Wildlife Research Center, Laurel, MD.)

Merlin
Falco columbarius

Regulatory Status
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

Conservation Ranks
USFWS: No special status
WGFD: NSSU (U), Tier III
WYNDD: G5, S4
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 7

Status and Rank Comments
Merlin (*Falco columbarius*) has no additional regulatory status or conservation rank considerations beyond those listed above.

Natural History

Taxonomy:
There are nine subspecies of Merlin worldwide but only three occur in North America: Black Merlin (*F. c. suckleyi*), Boreal Merlin or Taiga Merlin (*F. c. columbarius*), and Prairie Merlin (*F. c. richardsonii*) [1, 2]. The remaining subspecies are found across Eurasia [1]. Most breeding and migrant Merlin in Wyoming are *F. c. richardsonii*.

Description:
Identification of Merlin is possible in the field. It is a small falcon, with a body length of 24 to 30 cm and a wingspan of 53 to 68 cm. Merlin is sexually dimorphic in size and plumage [1, 2]. Both sexes have strong streaking on the underside, yellow legs, and alternating broad dark and narrow light bands on the tail, ending with a light band. However, adult females are larger than males and have dusky brown plumage on the neck and back, and a dusky brown tail with cream bands. Males are noticeably smaller with a pale bluish-gray neck and back, and a dark gray to black tail with white or pale gray bands. Merlin lacks the distinct dark "mustache" facial marking common in many sympatric falcon species, and instead has indistinct streaking in the same area [1-3]. Within its Wyoming distribution, Merlin is most similar in appearance to Peregrine Falcon (*F. peregrinus*), Prairie Falcon (*F. mexicanus*), and American Kestrel (*F. sparverius*). However, both Peregrine Falcon and Prairie Falcon are much larger than Merlin and have dark mustaches. American Kestrel is slightly smaller than Merlin, with a dark mustache and rufous back and tail [3].

Distribution & Range:
During the breeding season, Merlin is widespread across northern North America [1]. Wyoming is on the southernmost extent of the breeding range, though birds may be found anywhere in the state during any time of year [4]. During the non-breeding season, some individuals remain year-round, others migrate out of the state, and some migrate into the state from northern regions. The southern boundary of the breeding distribution of Merlin in North America has been expanding southward across the northern United States from Idaho to New England over the past several decades [1, 5]. Winter season range expansions into the northern Great Plains have occurred, likely due to increases in abundance of important avian prey species [1].

Habitat:
Merlin forages in open to semi-open areas during the breeding season and will use a variety of habitats, including conifer, deciduous, and mixed-wood forests and woodlands with forest openings, riparian woodlands, shrub-steppe, prairie, and urban/suburban areas with trees [1, 6]. Potential habitat exists for this species throughout Wyoming [4]. Merlin nests in abandoned magpie, crow (*Corvus* spp.), hawk, or squirrel nests, as well as natural tree cavities, tree cavities excavated by woodpeckers, and cliff ledges. In some parts of their range where trees are absent, particularly in northern Eurasia and the arctic tundra, Merlin will nest on the ground [1, 6]. During migration and the non-breeding season the species will use grasslands, semi-open forests, and coastal areas [1].

Phenology:
Spring migration into Wyoming probably occurs from February through April, though some birds remain in the state year round [7]. Breeding phenology has not been studied in Wyoming. However, egg laying occurs from late April to late May in Saskatchewan and is usually completed by 20 May in Montana [1, 6]. Incubation lasts 28 to 32 days, and nestlings fledge at about 29 days of age. Fledglings are dependent upon the parents for food for up to five weeks. In Montana, dispersal from the nest area occurs by mid-August [1, 6]. Timing of fall migration is difficult to determine in Wyoming because some individuals remain in the state year-round while others migrate [8]. The median date for passage of fall migrants in southwestern Wyoming is October 4 and migration through Wyoming has ceased by the end of November [1, 9].

Diet:
Merlin primarily preys on small to medium-sized birds. Other prey include insects, mammals (including bats), and reptiles [1, 10].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
Abundance is poorly understood for Merlin but is known to vary markedly across the species' range, with relatively high densities in some urban areas in Canada and Britain [1]. Using Breeding Bird Survey (BBS) and Northwest Territories and Nunavut checklist data, Partners in Flight estimated the global population of Merlin to be approximately 3 million individuals in 2013, with about 140,000 in the United States and roughly 2,000 present in Wyoming during the breeding season [11]. However, the population estimate for Wyoming is based on very few detections in the state and should be viewed with caution. During winter in Wyoming, abundance of Merlin is lower as many individuals migrate out of the state [1].

Population Trends:
Historic: MODERATE DECLINE
Recent: UNKNOWN
Across North America, historic declines of Merlin occurred in the 1960s due to pesticides, including DDT and organochlorines [1]. Populations in Wyoming appear to have experienced historic declines but recent trends are poorly understood due to insufficient data [12]. Data from the BBS suggest the recent (2003–2013) population trend may be stable in Wyoming [12]; however Christmas Bird Count data suggest that the population wintering in Wyoming has fluctuated markedly over the past 10 years [13]. These data contrast with BBS data elsewhere across the continent, which show stable or increasing population trends in nearly every state, province, and bioregion. However, due to the low number of Merlin detected on BBS routes throughout the species' range, these data should be viewed with caution [12]. Data from sites monitored by Hawk Watch International in western North America also indicate increasing population trends since the early 1980s [14]. The Wyoming Game and Fish Department (WGFD) documented the extirpation of a small population that nested along the Green River in southwest Wyoming [15].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Merlin has low fecundity, which makes it moderately vulnerable. Merlin has limited opportunity to breed and increase or maintain its population. Mortality of birds in their first year is near 70%, and mean annual survivorship is 62%. Life expectancy averages 3 years for females and 2.5 years for males, and male Merlins typically do not breed until at least 2 years of age. Only one clutch can be raised each year [1].

Extrinsic Stressors:
SLIGHTLY STRESSED
Merlin is adversely affected by various human impacts on the environment, which makes the species slightly stressed in Wyoming. Pesticides such as DDT negatively affect breeding success of Merlin through eggshell thinning. Recent evidence from Canada and New York indicate that Merlin is still affected by pesticides including DDT and organochlorines that persist in the environment [1, 16]. Merlin is expanding into urban areas, where human-induced mortality such as window and automobile collisions are a leading cause of mortality [17]. The recovery of Peregrine Falcon may threaten Merlin in some areas, either directly through predation or indirectly through competition for food [18].

KEY ACTIVITIES IN WYOMING
There are currently no research projects in Wyoming specifically focused on Merlin. Annual permits are issued by the WGFD for capture of Merlin for falconry purposes, and the department monitors the number taken annually [19]. Although the species is observed on a few BBS routes in Wyoming, total detections are limited, resulting in low confidence in abundance and population trend estimates for Merlin in the state [12]. Similarly, the species is rarely detected in Wyoming by the Integrated Monitoring in Bird Conservation Regions program, prohibiting density and population estimates under this program [20].

ECOLOGICAL INFORMATION NEEDS
Current breeding locations and preferred habitat of Merlin in Wyoming are not well known, however, a survey of historic nest sites in the northeastern section of the state found a high rate of occupancy of historic sites [8]. The phenology of the species in Wyoming is poorly understood,

especially arrival and departure dates of breeding individuals. Merlin would benefit from research and long-term monitoring to examine abundance and population trends in the state, as well as the mechanisms driving those trends. Very little is known about the wintering ecology of Merlin from North America, including migration routes, the relative importance of different known wintering areas, diet, and potential threats facing the species on wintering grounds [1].

Management in Wyoming

This section authored solely by WGFD; Susan M. Patla. Currently there are no studies or monitoring of Merlin nesting populations in Wyoming or the Intermountain Region. The WGFD Nongame Program initiated monitoring of Merlin nest sites in 1980 and 1982 with limited follow up work in 1986-1989 which included banding and radio-tracking a few pairs [15, 21]. A more focused statewide survey effort in 1990 of 35 locations resulted in documenting only 3 occupied territories in the northeast corner of the state in Ponderosa pine habitat [15]. Another statewide survey completed in 1991 of 36 sites included a focus on nest site behavior [22]. Six nesting pairs were found in 1991, none in western Wyoming although 12 previously occupied sites along the Green River were surveyed. In the 1996 Nongame Bird and Mammal Plan, Merlin was designated a Species of Special Concern Category III. A study was initiated 1998 to assess Merlin population status and habitat use that included surveys of 58 historic sites and 52 random sites throughout Wyoming [8]. Confirmed breeding attempts were documented at 10 of 58 historic sites (17.2%) and Merlin was observed at a total of 18/58 sites (31.0%). Nest success (90%) and productivity of active nests (3.6 fledglings/successful attempt) was found to be high. Most nests were found in northeast Wyoming in mixed grass prairie and ponderosa pine habitat with 60% in domed magpie nest structures. To assess the current state-wide population status, a reevaluation of historic sites should be completed as well as surveys at new potential sites that have been documented since 1999 from the Wildlife Observation System, Wyoming Natural Diversity Database records, and cooperative falconers in the state. Tracking studies of nesting adults, as satellite transmitters of suitable size become available, would be valuable to provide data on migration routes, wintering areas and survivorship.

Contributors

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Figure 1: Adult female Merlin (*richardsonii* subspecies) in Boulder County, Colorado. (Photo courtesy of Bill Schmoker)

Figure 2: North American range of *Falco columbarius*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Potential Merlin habitat in Thunder Basin National Grassland. Open areas provide food and foraging areas, and trees along stream provide nest locations. (Photo courtesy of Michael T. Wickens)

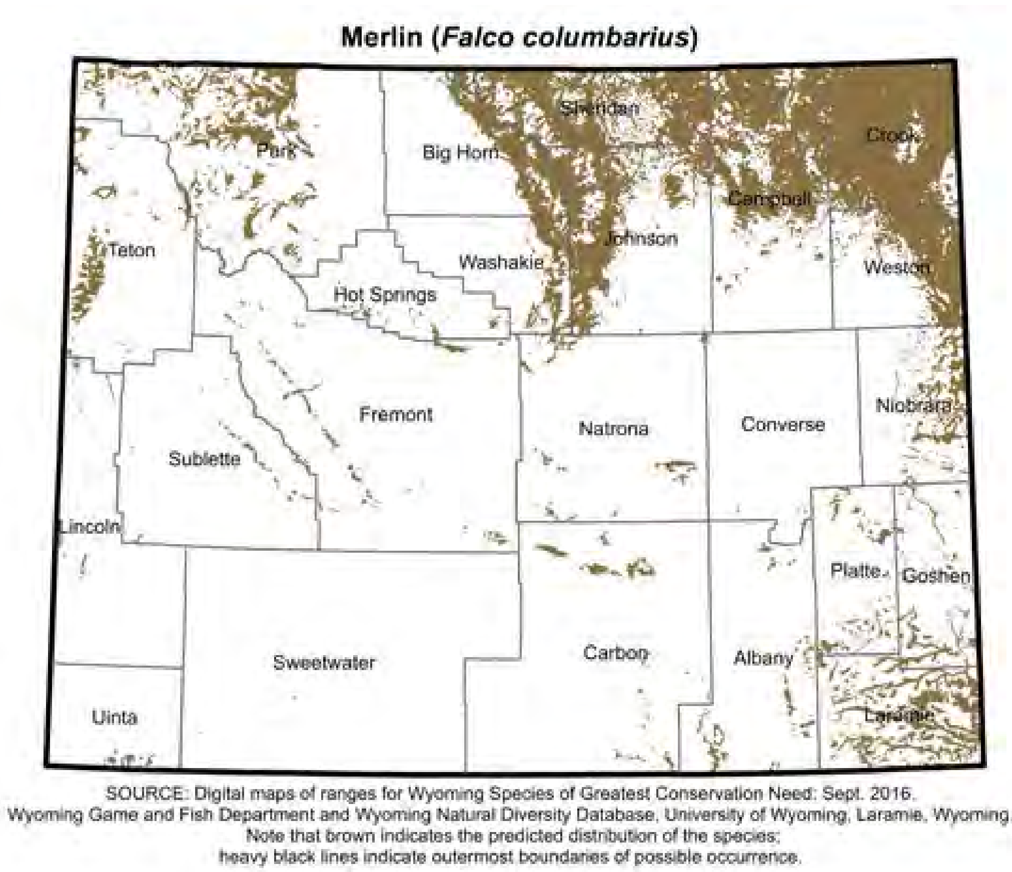

Figure 4: Range and predicted distribution of *Falco columbarius* in Wyoming.

Mountain Plover

Charadrius montanus

REGULATORY STATUS

USFWS: Listing Not Warranted; Migratory Bird
USFS R2: Sensitive
UWFS R4: No special status
Wyoming BLM: Sensitive
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: Species of Conservation Concern
WGFD: NSSU (U), Tier I
WYNDD: G3, S3
Wyoming Contribution: HIGH
IUCN: Near Threatened
PIF Continental Concern Score: Not ranked

STATUS AND RANK COMMENTS

Mountain Plover (*Charadrius montanus*) was petitioned for listing as Threatened under the Federal Endangered Species Act in 1999 [1]. Listing was denied in 2011, based upon the United States Fish and Wildlife Service finding that the species was not in danger of extinction in all or substantial portions of its range [2].

NATURAL HISTORY

Taxonomy:

There are currently no recognized subspecies of Mountain Plover [3, 4].

Description:

Mountain Plover is identifiable in the field. The sexes are similar in size and appearance. The species is similar in size and shape to other *Charadrius* plovers such as the Killdeer (*C. vociferus*), but has a more upright posture, longer legs, and comparatively short tail. During breeding, it has a distinctive black loral stripe extending from the black bill to the eye, with a forecrown mottled to solid black. Upperparts are a fairly uniform sandy brown, extending along the side of the neck, ear coverts, and chest. The forehead, throat, and breast are white, which extends into a longish supercilium. Juveniles are precocial upon hatching, and have cream or cinnamon buff upperparts with conspicuous black spots. Crown, wings, and rump have some russet while the forehead, throat, and underparts are white. Juvenal plumage is similar to non-breeding adult plumage and is attained shortly after they are first able to fly [3]. This plumage is retained into the first winter, with feathers sometimes retained into the first spring breeding season, giving a slight scalloped appearance dorsally [3, 5]. Similar species found in Wyoming are other plovers in the genus *Charadrius*: the Semipalmated Plover (*C. semipalmatus*), the Snowy Plover (*C. nivosus*), and the Killdeer. It is distinguished from all by the lack of any dark breast bands [6].

Distribution & Range:
Wyoming forms a significant portion of the breeding range of Mountain Plover, which also includes east-central and central Colorado, and eastern Montana, with localized breeding in neighboring states and Mexico. Mountain Plover overwinters outside of Wyoming. Distribution during migration is unknown. The distribution in Wyoming appears stable, though sites throughout its range show fluctuation in numbers [7].

Habitat:
Research has recently shown that Mountain Plover is best considered a sparsely-vegetated desert species rather than a short grass prairie species, though it does use sparsely-vegetated prairie as well [7, 8]. In Wyoming and elsewhere in its range, it utilizes areas grazed by herbivores, including prairie dogs (*Cynomys* spp.), Bison (*Bison bison*), Pronghorn (*Antilocapra americana*), and domestic livestock. It also uses active agricultural fields and recently burned grasslands. Agricultural fields can be sink habitat since nests are often lost due to disturbance from farm equipment [9]. In the western periphery of its range, it uses xeric shrubland communities dominated by bare ground with saltbush (*Atriplex* spp.) and sagebrush (*Artemisia* spp.). In particular, the species uses habitat with vegetation shorter than the surrounding area, generally less than 5 cm tall with a bare ground component typically over 30%. The bare ground component can be higher than 70% in some habitats [5, 7, 8, 10]. The species also prefers habitat with flat topography, generally with less than 5% slope. The minimum area required for a nesting pair can vary widely depending on habitat, from a few ha to over a hundred ha. The average home range size is 56.6 ha [7, 11]. In Wyoming, the species showed less affinity for prairie dog colonies than elsewhere [5, 8]. Concentrated areas of breeding in Wyoming include the Powder River, Shirley, Laramie, Big Horn, Great Divide, and Washakie basins [5, 8, 12]. The species overwinters in the interior lowlands of southern and central California, and to areas of Texas and Mexico. In winter, Mountain Plover utilizes agricultural fields, but the species will not occupy areas with vegetation exceeding 20 cm in height [5].

Phenology:
Mountain Plover arrives in Wyoming for the breeding season by late March or early April, and leaves for the winter grounds by mid-October [7]. Nesting begins in Wyoming by mid-May, and continues through mid-July. Timing of breeding is affected by latitude and elevation [5].

Diet:
Mountain Plover is insectivorous, feeding on ground-dwelling arthropods including beetles (order Coleoptera), grasshoppers and crickets (Orthoptera), and ants (Hymenoptera). The same food is consumed on the wintering grounds [7].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: UNCOMMON
In 2009, the national abundance of Mountain Plover, based on cumulative data, was estimated to be between 15,000–20,000 birds [13]. Mountain Plover has a statewide abundance rank of UNCOMMON and also appears to be uncommon within suitable environments in the occupied area [14]. The species is patchily distributed throughout Wyoming where appropriate habitat exists [5], and in 2003 the state population was estimated to be 3,393 [12]. From 1968–2015, annual Wyoming Breeding Bird Survey (BBS) detections of Mountain Plover ranged from 0 to 20

(average = 5), with 2 recorded in 2015 [15]. Annual detections of Mountain Plover ranged from 4 to 29 during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [16].

Population Trends:
Historic: LARGE DECLINE
Recent: UNKNOWN
Survey-wide trend data from the North American BBS indicate that Mountain Plover numbers experienced a statistically significant annual decrease of 3.11% from 1966–2013 and a non-significant annual decrease of 0.97% from 2003–2013 [17]. Wyoming BBS trend data indicate that Mountain Plover declined by 0.58% annually from 1968–2013 and 0.09% from 2003–2013; however, neither state estimate was statistically significant [17].

Intrinsic Vulnerability:
HIGH VULNERABILITY
The narrow habitat requirements and restrictive breeding biology of Mountain Plover make the species highly vulnerable. The species is restricted to habitats of sparsely vegetated desert or short grass prairie, characterized by sparse and short vegetation cover [7, 8]. The species has low population density, low dispersal, and large home area requirements [5]. Chick survival rate is low in a variety of habitats [18].

Extrinsic Stressors:
MODERATELY STRESSED
Threats to the Mountain Plover are generally from human impacts on the landscape, making the species moderately vulnerable in Wyoming. Across the species range, mechanical treatment of the native landscape threatens the species. Conversion of natural prairie habitat to agriculture, general degradation of habitat including habitat fragmentation and prairie dog eradication, can negatively affect the species. In Wyoming, the species is not as strongly tied to prairie dog habitats, and habitat conversion is less than in other plains state, so these have less an impact in Wyoming than elsewhere [5, 7, 8]. Invasive grass species, by altering habitat structure, have been shown in Colorado to negatively affect habitat suitability. Habitat in close proximity to suburban and urban development may experience increased predation rates by native and non-native predators [5]. Livestock grazing regimens that result in a uniform vegetation structure can produce non-viable habitat, while pervasive open range grazing may produce beneficial habitat [7, 8]. Development of oil, gas, and coal resources may negatively impact the Mountain Plover through vehicle collisions, especially flightless chicks, and habitat loss through surface disturbance [7]. Conversion of traditional winter habitat to agriculture in California may have a neutral effect on the species, while pesticide use on these winter grounds as well as on breeding areas may have a negative effect [3, 7, 19]. Extreme weather events can cause nest destruction [5].

KEY ACTIVITIES IN WYOMING
Mountain Plover is classified as a Species of Greatest Conservation Need (SGCN) by the Wyoming Game and Fish Department, and as a Level I Priority Bird Species requiring conservation action in the Wyoming Bird Conservation Plan [20]. The first systematic survey of the species in Wyoming was conducted in 2003 and was repeated in 2004 [8]. As a result of the ESA listing proposal in 1999, a permanent monitoring program was started in 2010 in the Laramie, Shirley, Big Horn, Great Divide, and Washakie Basins [21]. This program consists of permanently established transects to be surveyed each year. Additionally, WGFD initiated a targeted

grassland SGCN monitoring program in 2015 for Mountain Plover, Upland Sandpiper, Long-billed Curlew, and Burrowing Owl [22].

ECOLOGICAL INFORMATION NEEDS

Migration may be a significant source of mortality, suggesting that better information on migration could be important to management [18]. In Wyoming, improving knowledge of abundance and habitat use at breeding sites, as well as assessing demographic variables at those sites, would benefit status assessments. Similarly, the distribution and abundance of the species on large tracts of private land, particularly in southeastern Wyoming, is relatively unknown. The demography of Wyoming populations is poorly known. Information on the impacts of natural resource extraction on breeding individuals is needed to inform mitigation decisions [5].

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Zachary J. Walker. Mountain Plover is classified as a SGCN in Wyoming due to habitat degradation and fragmentation associated with fire suppression and other anthropogenic factors. Current monitoring programs for this species should be continued to gain a better understanding of population trends. Additional research for Mountain Plover should focus on examining population demographics, identifying critical breeding areas, and examining possible impacts of natural resource extraction development. Best management activities for this species include the conservation of suitable grassland habitats. In areas where Mountain Plover is known to occur, prescribed burns should be conducted in the fall and be designed to retain nesting cover for the following breeding season while reducing shrub density. Grazing may be used to maintain habitat, and grazing pressure should be varied and interspersed leaving a variety of suitable habitats. Prairie dog colonies should be retained when possible, and native prairie ecosystems should be conserved to the greatest extent possible for Mountain Plover.

CONTRIBUTORS

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Figure 1: Mountain Plover in Albany County, Wyoming. (Photo courtesy of Shawn Billerman)

Figure 2: North American range of *Charadrius montanus*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Typical Mountain Plover habitat, Pawnee National Grassland, Colorado. (Photo courtesy of Stephen J. Dinsmore)

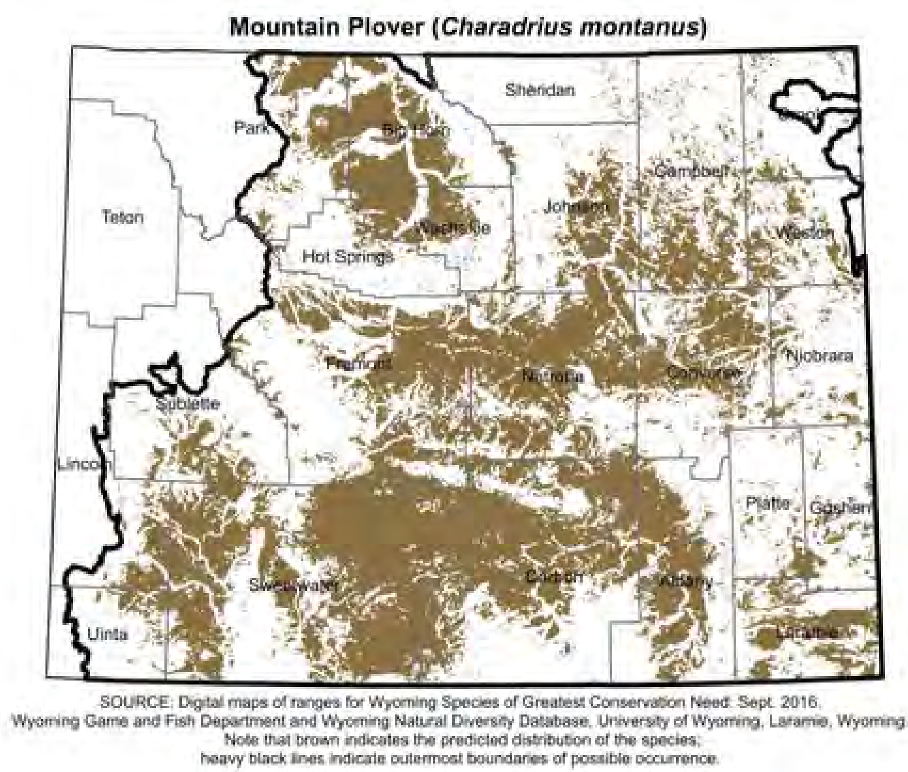

Figure 4: Range and predicted distribution of *Charadrius montanus* in Wyoming.

Figure 5: Wyoming desert–subshrub Mountain Plover habitat in south-central Wyoming. (Photo courtesy of Ian M. Abernethy)

Northern Goshawk
Accipiter gentilis

Regulatory Status
USFWS: Listing Not Warranted; Migratory Bird
USFS R2: Sensitive
UWFS R4: Sensitive
Wyoming BLM: Sensitive
State of Wyoming: Protected Bird

Conservation Ranks
USFWS: No special status
WGFD: NSSU (U), Tier I
WYNDD: G5, S2S3B/S3N
    Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 11

Status and Rank Comments
Northern Goshawk (*Accipiter gentilis*) in the contiguous United States west of the 100th meridian was petitioned for protection under the Endangered Species Act in 1997. The United States Fish and Wildlife Service found that protections were not warranted in 1998. The finding indicated that the petition did not present substantial scientific evidence that the species was in danger of extinction in that portion of its range [1]. The Wyoming Natural Diversity Database has assigned Northern Goshawk a range of state conservation breeding ranks due to uncertainty regarding the intrinsic vulnerability of the species in Wyoming.

Natural History

Taxonomy:
Northern Goshawk occurs throughout the northern hemisphere and many subspecies are recognized across its range, most in the Old World. Two subspecies in North America are recognized by the American Ornithologists Union, with a third acknowledged by some authors [2-6]. The subspecies *A. g. atricapillus*, is found in Wyoming and is the most widely distributed subspecies in North America.

Description:
Identification of Northern Goshawk is possible in the field. It is the largest raptor in the genus *Accipiter* and is similar in size to Red-tailed Hawk (*Buteo jamaicensis*) [7]. Females are larger than males but both sexes are identical in appearance. Adults have a blackish crown and cheeks and a white streak over the eye. This white streak varies from broad to barely visible. Underparts are pale gray with fine black vertical streaks [4, 7]. Dorsally, adults are slate gray to bluish-black. The tail is rounded and dark gray above, with 3–5 dark bands on the underside, and tipped with a thin white terminal band which may be absent due to wear. The feet, cere, legs, toes, and mouth lining are yellow. The eyes are red [4]. Juveniles are dark brown to brown-black dorsally through

their first winter. Underparts are buffy brown with darker brown streaking [5]. Juvenile plumage is mostly lost in the first spring, though birds will retain some juvenile characteristics for up to four years [4, 5, 8]. Northern Goshawk is similar in appearance to sympatric *Accipiters* but can be distinguished from both Cooper's Hawk (*A. cooperii*) and Sharp-shinned Hawk (*A. striatus*), which are both smaller than Northern Goshawk, and have white underparts with russet barring[7].

Distribution & Range:

Northern Goshawk has a Holarctic distribution. The North American range encompasses most of the boreal and montane forests across the continent, extending south into western Mexico along the Sierra Madre Occidental mountain range [2, 4-6]. In Wyoming, Northern Goshawk has been found throughout the state [9, 10]. Confirmed or suspected breeding has been documented in 23 of Wyoming's 28 latitude/longitude degree blocks [10]. The species is both a year-round resident and a short-distance winter migrant. Also, periodic or cyclic winter irruptions occur, as well as limited altitudinal migrations [4-6, 11].

Habitat:

Across the species' range, Northern Goshawk uses most forest types and are considered forest habitat generalists at large spatial scales [4]. In Wyoming, the species is generally associated with mature montane coniferous forests and adjacent aspen forests during the breeding season [6, 12]. Northern Goshawk has fairly specific nesting habitat requirements. Nests are generally located in mature or old-growth forest habitat, and nest sites are characterized by forest stands with high basal area; large, tall trees; high canopy cover; and an open understory [2, 4, 6, 12]. Additionally, nest trees are often located away from forest edges on the lower to middle portions of moderate slopes [6, 12, 13]. In Wyoming, most nests have been found in Douglas Fir (*Pseudotsuga menziesii*), Lodgepole Pine (*Pinus contorta*), or Quaking Aspen (*Populus* tremuloides) trees [6, 12-14]. After fledging, young stay with the adults in the vicinity of the nest until they are entirely independent [2, 4]. While poorly understood, research indicates that Northern Goshawk forages in a wide variety of forest habitats of varying age, structure, and successional stages [2, 4]. The average area used for foraging surrounding nest sites has been estimated at over 2400 ha. [4]. In some systems, Northern Goshawk prefers forests with a relatively open canopy and understory for efficient prey pursuit and capture [2, 5, 6]. Little is known about habitat associations in winter. However, Northern Goshawk appears to use a wider variety of habitats in winter, including non-forested, open habitats such as shrublands [2, 6].

Phenology:

Adults generally return to breeding areas between late March and early April [4, 6, 15]. Incubation begins in early May and ranges from 30-44 days and hatching occurs in early June [2]. Young are dependent upon adults and remain in the nest or on the nest tree for 37–45 days [2, 4]. Young begin to feed themselves after fledging, but adults continue to provision them until they become fully independent at approximately 70 days [2, 4, 6]. Fall migration occurs between September and December [2, 4, 11].

Diet:

Northern Goshawk is an opportunistic predator [2]. Prey generally consists of medium-sized mammals and birds including tree and ground squirrels, lagomorphs, gallinaceous birds, corvids, and woodpeckers [2, 12]. Infrequently, carrion, small passerines, raptors, shrews, and other small mammals are consumed [2, 4, 6, 16]. Relatively little is known about the diet of Northern Goshawk in winter, but evidence suggests that it is often different than summer diet. Available data indicate that birds dominate Northern Goshawk diet during the breeding season, while tree squirrels and rabbits comprise the majority of the winter diet [2].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: UNCOMMON
Robust estimates of abundance are not available for Northern Goshawk in Wyoming. Across the western United States, densities of nesting individuals are relatively low, ranging from 3.6 to 10.7 pairs per 100 km^2 [2]. It is assumed that densities of nesting individuals in suitable habitat are roughly similar in Wyoming. Partners in Flight (PIF) estimated a state population of 4,000 individuals in 2007 [17] and 12,000 individuals in 2013 [18]. However, these estimates should be viewed with caution because they are largely based data from the Breeding Bird Survey (BBS), which was not designed to monitor raptors and has relatively few detections of Northern Goshawk [17-19]. The recent estimate of 12,000 seems particularly questionable, since previous PIF estimates for Wyoming were generally much lower and in-line with 2013 estimates for Northern Goshawk populations in adjacent Rocky Mountain states (i.e., 4,000 in Colorado, 5,000 in Idaho, 2,000 in Montana, and 2,000 in Utah) [18].

Population Trends:
Historic: UNKNOWN
Recent: MODERTE DECLINE
Population trends for Northern Goshawk are largely inferred from changes in breeding territory occupancy. Though occupancy rates and population trends have been shown to be highly correlated, the exact nature of this relationship for Northern Goshawk is unclear [20]. Recent monitoring efforts in the Medicine Bow-Routt National Forest in Wyoming have shown a decline in territory occupancy [21]. In the Targhee National Forest in northeastern Idaho, occupancy rates of Northern Goshawk territories declined from 64% to 31%, and nest success declined from 56% to 19% from 1990–1994 and 1998–2002, respectively [22]. However, differences in land management practices and local habitat variation make it unclear how this pattern relates to population trends in Wyoming. Site occupancy and breeding success across the species' range have also declined [23, 24]. Trend estimates from BBS and Christmas Bird Count data are inconclusive because the species is infrequently detected during these surveys [19, 25]. Occupancy estimation based on the United States Forest Service (USFS) regional monitoring protocols was calculated for two study areas in Wyoming but low sample numbers hindered interpretation of results [26].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Northern Goshawk is moderately vulnerable to extrinsic stressors. While Northern Goshawk nests in most forest types across its range, nest sites are defined by relatively narrow habitat characteristics [2]. Additionally, the species requires a large home range during the breeding season, ranging from 570–5,300 ha depending on local habitat characteristics [2]. Northern Goshawk is highly territorial and defends the area around the nest, which can limit the density of nesting pairs in some systems [27]. However, in the Black Hills of South Dakota and Wyoming, evidence suggests that the locations and density of nests were limited by habitat conditions rather than by intraspecific territorial aggression [28]. It is important to note that forests in the Black Hills

are highly fragmented, limiting the availability of suitable nesting habit. Regardless of the mechanism, it is clear that nesting Northern Goshawks occur at low density across the landscape.

Extrinsic Stressors:
MODERATELY STRESSED
Extrinsic stressors to Northern Goshawk are primarily tied to the alteration of forests [2] and include both anthropogenic and natural disturbances such as timber harvest, forest thinning, fire suppression, wildfire, and pine beetle outbreaks [5]. Evidence suggests that large patches of mature or old growth forest surrounding Northern Goshawk nests are important for maintaining local populations [2] . In the Caribou-Targhee National Forest of Wyoming and Idaho, occupancy of known nesting territories was lower in timber harvest areas, which suggests that timber harvest may negatively affect Northern Goshawk [22]. Additionally, increased forest fragmentation may favor interspecific competitors and predators of Northern Goshawk such as Great Horned Owl (*Bubo virginianus*) and Red-tailed Hawk [2]. The species has experienced reduced breeding success and territory occupancy in the vicinity of trails and roads [23]. Perhaps the largest potential stressor for Northern Goshawk in Wyoming is the ongoing Mountain Pine Beetle (*Dendroctonus ponderosae*) outbreak occurring throughout much of the state in forests dominated by Lodgepole Pine (*Pinus contorta*). The pine beetle outbreak has led to nearly 100% tree mortality in affected areas of the Medicine Bow National Forest in southern Wyoming. It has been predicted that forests undergoing pine beetle infestations will become less suitable for Northern Goshawk over the next 6–20 years because the species may not breed in open canopy, needle-free forests [14]. However, Northern Goshawk in the Ashley National Forest in Utah continued to nest successfully in beetle-killed forests experiencing 80% tree mortality [14]. It is unclear if the species will respond similarly in Wyoming. Changes in forest structure and composition as a result of climate change may also reduce suitable nesting and foraging habitat for this species (Romney et. al. 2011)

KEY ACTIVITIES IN WYOMING

Monitoring known Northern Goshawk nesting territories occurs annually on the Medicine Bow-Routt National Forest [21]. Results suggest that territory occupancy is variable among years and may be experiencing a gradual decline through time [21]. In 2006, researchers implemented and tested the efficacy of the USFS "Northern Goshawk Bioregional Monitoring Design" to estimate the occupancy rates at sites across Wyoming, Colorado, and South Dakota. The researchers suggested that this monitoring plan, in conjunction with additional habitat modeling and spatial stratification, would allow land managers to detect region-wide changes in occupancy through time [29]. From 2009–2010, the Wyoming Game and Fish Department (WGFD) conducted a study on the east side of the Wyoming Range in response to proposed land-management actions in the area. The focus of this work was to locate nests, estimate nesting density, and further knowledge of habitat use of Northern Goshawk in the Wyoming Range [26, 30-32]. Results indicated that Northern Goshawk nests occur at low density in the study area and are located in diverse, mature stands on moderate slopes with a northerly aspect [32]. A number of these nest stands burned in the 2012 Fontenelle Fire that affected 9,237 hectares in the Wyoming Range. Surveys for nesting Northern Goshawk occurs on other National Forest districts in Wyoming but survey protocol and effort is inconsistent from year to year hindering any interpretation of trend or response to management treatments.

Ecological Information Needs

Estimates of abundance and population trends in Wyoming and across the range of Northern Goshawk are not well known. This is in part due to inconsistent survey protocols between organizations and over time, and use of survey protocols that do not allow for accurate inferences of abundance [2]. The effects of Mountain Pine Beetle and forest treatments including forest health and fire reduction treatments on Northern Goshawk nesting and wintering habitat in Wyoming are largely unknown. Information to identify high quality foraging habitat in different habitat types across the state is also lacking.

Management in Wyoming

This section authored solely by WGFD; Andrea C. Orabona and Susan M. Patla. Northern Goshawk is classified as a Species of Greatest Conservation Need in Wyoming. State Wildlife Grants funding has supported work to obtain data on nesting density and habitat use on the eastern side of the Wyoming Range to assist in planning future habitat projects in that area [33]. The WGFD is encouraging USFS and Bureau of Land Management personnel to use standardized techniques to monitor historic Northern Goshawk nest sites and inventory new project areas a minimum of two years prior to habitat management activities [33]. Best management practices to benefit Northern Goshawk in Wyoming focus on using a cooperative, statewide, multi-agency/organization approach [33, 34]. These include annual Northern Goshawk surveys using a standardized protocol to determine territory occupancy, nest success, and productivity; development of a database to track Northern Goshawk nest sites; use of GIS vegetation mapping to identify and quantify existing high quality Northern Goshawk nesting habitat; managing habitat to minimize human disturbance in nesting areas during the breeding season, protecting traditional or previously used nesting areas, and maintaining an adequate distribution of mature coniferous forest stands across the landscape. Recent improvements in satellite tracking technology will improve the ability to track foraging males in both summer and winter which should provide valuable new fine-scale information on goshawk habitat use beyond the nest site and also on adult survival rates.

Contributors

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Figure 1: Adult Northern Goshawk in winter, Boulder County, Colorado. (Photo courtesy of David Waltman)

Figure 2: North American range of *Accipiter gentilis*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Ponderosa Pine (*Pinus ponderosa*) forest, 1–2 years post burn, on the Kaibab Plateau, Arizona. (Photo courtesy of Terri Pope)

Figure 4: Range and predicted distribution of *Accipiter gentilis* in Wyoming.


Figure 5: Adult Northern Goshawk on nest in Rocky Mountain National Park, Colorado. (Photo courtesy of Phil Swanson)

Northern Pygmy-Owl
Glaucidium gnoma

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: No special status
WGFD: NSSU (U), Tier II
WYNDD: G4G5, S1S2
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 11

STATUS AND RANK COMMENTS
The Wyoming Natural Diversity Database has assigned Northern Pygmy-Owl (*Glaucidium gnoma*) a state conservation rank ranging from S1 (Critically Imperiled) to S2 (Imperiled) because of uncertainty about whether the Laramie, Medicine Bow, and Sierra Madre mountain ranges can be considered part of the species' range.

NATURAL HISTORY

Taxonomy:
Seven subspecies of Northern Pygmy-Owl are currently recognized. The only subspecies found in Wyoming is *G. g. pinicola*, which is part of a group of structurally and vocally similar subspecies found in northwestern North America. Other subspecies are found in Baja California, southern Arizona into Mexico, and Central America. Uncertainty exists regarding the taxonomy of Northern Pygmy-Owl, which could consist of three unique species [1].

Description:
Identification of Northern Pygmy-Owl is possible in the field. This small owl stands 16–18 cm tall [1]. Head, dorsum, and wings are gray-brown with whitish spots. The tail is dark brown with 5–6 white bars and is longer than that of owls of similar size. The back of the head has false eye spots consisting of two black ovals with white borders. The facial disk is brown and white and is not well-defined. Breast and flanks are white with brown vertical streaks and legs and toes are feathered. Northern Pygmy-Owl has yellow eyes and a pale yellow bill [1]. Plumage generally does not vary with sex or age; however, juveniles can have a darker bill and fewer dorsal spots [1]. In Wyoming, similar small owl species are Western Screech-Owl (*Megascops kennicottii*), Eastern Screech-Owl (*M. asio*), Flammulated Owl (*Psiloscops flammeolus*), Northern Saw-whet Owl (*Aegolius acadicus*), and Boreal Owl (*A. funereus*). Northern Pygmy-Owl lacks ear tufts, distinguishing it from screech-owls. Unlike Northern Pygmy-Owl, Flammulated Owl has dark

eyes. Northern Saw-whet Owl and Boreal Owl have well-defined facial disks and lack false eye spots [2].

Distribution & Range:
Northern Pygmy-Owl is found in western North America from Alaska south to Central America, generally following the distribution of mountain ranges [1]. In Wyoming, it has been documented in the northwestern part of the state in Yellowstone and Grand Teton National Parks and surrounding areas, the Wind River Range, and the Wyoming Range [3-8]. Thus far, the species has been documented only three times in southern Wyoming (all on Pole Mountain east of Laramie), despite regularly occurring in neighboring Routt and Roosevelt National Forests in northern Colorado and the Uinta-Wasatch-Cache National Forest in northeastern Utah [9].

Habitat:
Northern Pygmy-Owl uses various forest types across its range, from deciduous bottomlands to high-elevation coniferous forests [1]. The few observations of this species in Wyoming for which habitat data were recorded document the species in mature spruce/fir forests dominated by tall large-diameter trees [3]. In Montana, Northern Pygmy-Owl prefers to breed in spruce-fir forests dominated by Engelmann Spruce (*Picea engelmannii*), Douglas Fir (*Pseudotsuga menziesii*), and Subalpine Fir (*Abies lasiocarpa*), but will also use Quaking Aspen (*Populus tremuloides*) and mixed-pine (*Pinus* spp.) forests and riparian bottomlands dominated by Black Cottonwood (*Populus trichocarpa*) [1]. Elsewhere in its range the species breeds in mature, structurally diverse hardwood, conifer, and mixed forests [1, 10-12]. Some studies suggests that this species prefers forests with high (> 50%) forest cover [11, 13, 14]. Northern Pygmy-Owl is a secondary cavity nester, using either natural tree cavities or those made by woodpeckers [1].

Phenology:
Northern Pygmy-Owl is non-migratory but may move to lower elevations between November and March [1]. This crepuscular/diurnal owl typically calls at dawn and dusk all year long with call frequency increasing during the breeding season [1]. Breeding phenology has not been studied in Wyoming, but in neighboring states copulation and cavity advertising have been observed from February to April, egg-laying in April and May, hatching from late May to June, and fledging from mid-June to early August [1, 15-18]. Incubation is estimated to be 28–30 days and fledging occurs when the young are about 23–27 days of age [1, 17]. At least one adult typically remains to attend the brood for approximately 1 month post-fledging [18].

Diet:
Northern Pygmy-Owl eats small mammals, especially voles in the genus *Microtus*, small birds, insects, and small numbers of reptiles and amphibians [1, 17].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
Using Breeding Bird Survey (BBS) data, the Partners in Flight Science Committee estimated the global population of Northern Pygmy-Owl to be 80,000 birds [19]. However, this estimate is based on limited data and should be viewed with caution. Abundance is poorly understood across the range of Northern Pygmy-Owl, but likely varies among ecoregions and forest types [12, 20]. Abundance of Northern Pygmy-Owl in Wyoming is unknown. The statewide abundance rank of

VERY RARE is based on the rather small area of the state known to be occupied in any given season and limited suitable habitat within that area. However, within suitable habitat in the occupied area, Northern Pygmy-Owl appears to be rare, as it occupies only a small percentage of preferred habitat within its range and may not be readily detected during surveys expected to indicate its presence [8]. Northern Pygmy-Owl is one of the least-detected species during owl surveys in Wyoming [3-5, 7, 21, 22]; however, the nocturnal call-back surveys used for owls in Wyoming might not be as effective at detecting this crepuscular/diurnal species as early morning surveys [12, 20, 23]. The species also is rarely detected during formal surveys for both breeding and wintering birds [24-26].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Population trends for Northern Pygmy-Owl in Wyoming and across its range are largely unknown. Trend data from BBS routes across the species' range suggest that the overall population might be stable, however, data are insufficient to provide conclusive results [24].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Habitat restrictions and apparently low population density make Northern Pygmy-Owl vulnerable in Wyoming. The species prefers to breed in older, structurally diverse forest habitat [1, 10, 20], which is limiting in Wyoming. Availability and competition for nest cavities also could limit abundance [1].

Extrinsic Stressors:
MODERATELY STRESSED
Northern Pygmy-Owl has not been well studied; however, forest management practices that reduce breeding habitat, especially mature forests and snags, will likely effect Northern Pygmy-Owl [1]. Insect infestations such as the recent Mountain Pine Beetle (*Dendroctonus ponderosae*) epidemic, disease, and wildfires also could threaten the species by reducing the amount of mature forest. Natural or anthropogenic habitat changes that affect prey species or primary nest excavators (i.e., woodpeckers) could threaten Northern Pygmy-Owl.

KEY ACTIVITIES IN WYOMING

The Wyoming Game and Fish Department and collaborators have conducted surveys for forest raptor species, including Northern Pygmy-Owl, most years since 2009. Surveys have been conducted in the Bridger-Teton and Shoshone National Forests in western Wyoming [4, 5, 7, 22], and in a small portion of the Sierra Madre Mountains in southern Wyoming [21]. An earlier study also surveyed for owls in the Greys River watershed in western Wyoming [3]. In all studies, Northern Pygmy-Owl was either one of the least-detected species or was not detected. However, surveys in Wyoming have not included early morning surveys designed specifically to target this crepuscular/diurnal owl.

ECOLOGICAL INFORMATION NEEDS

The taxonomy of Northern Pygmy-Owl is still unclear. Several subspecies, including *G. g. pinicola,* could represent unique species [1]. Targeted early-morning surveys for Northern Pygmy-Owl are needed to gain a better understanding of the distribution of the species in Wyoming. The species has been detected in northern Colorado and northeastern Utah near the Wyoming border, but has been reported only twice in southern Wyoming despite the presence of similar habitat [9]. Seasonal movements and habitat preferences are poorly understood in Wyoming, as is breeding phenology. Studies of Northern Pygmy-Owl abundance and demographic rates in Wyoming are needed.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Northern Pygmy-Owl is classified as a Species of Greatest Conservation Need in Wyoming due to unknown population status and trends; the need for targeted, species-specific surveys; and the ongoing reduction or elimination of coniferous forest habitat due to beetle kill, logging, and climate change [27]. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [24] and Integrated Monitoring in Bird Conservation Regions [25]. Although these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, forest owls are one of the species groups that warrant a targeted, species-specific survey method approach to obtain these data. Best management practices and key management recommendations to benefit Northern Pygmy-Owl includes the following: implement a monitoring program in suitable Northern Pygmy-Owl habitat; manage nesting areas to minimize habitat degradation and conflicts with other forest users and land use managers; determine a crucial range delineation for Northern Pygmy-Owl; work cooperatively with other agencies to conduct surveys and manage habitat for Northern Pygmy-Owl; and work cooperatively with other forest users to avoid resource conflicts [27].

CONTRIBUTORS

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Figure 1: Northern Pygmy-Owl in Grand Teton National Park, Teton County, Wyoming. (Photo courtesy of Shawn Billerman)

Figure 2: North American range of *Glaucidium gnoma*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Spruce-fir habitat in Yellowstone National Park. (Photo courtesy of Michael T. Wickens)

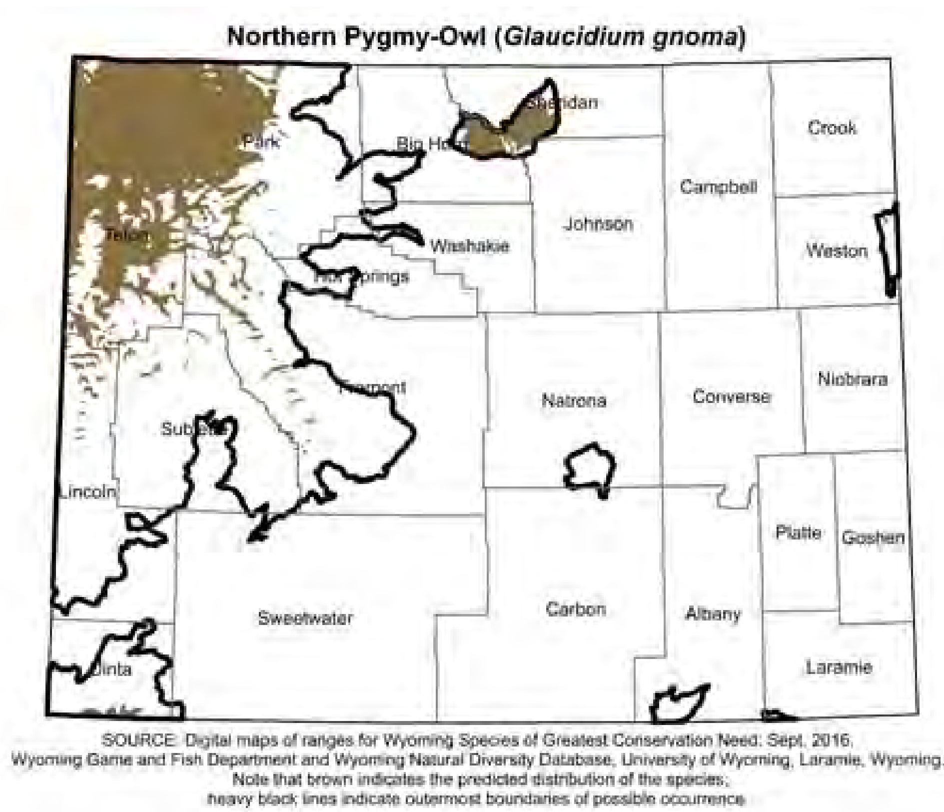

Figure 4: Range and predicted distribution of *Glaucidium gnoma* in Wyoming.

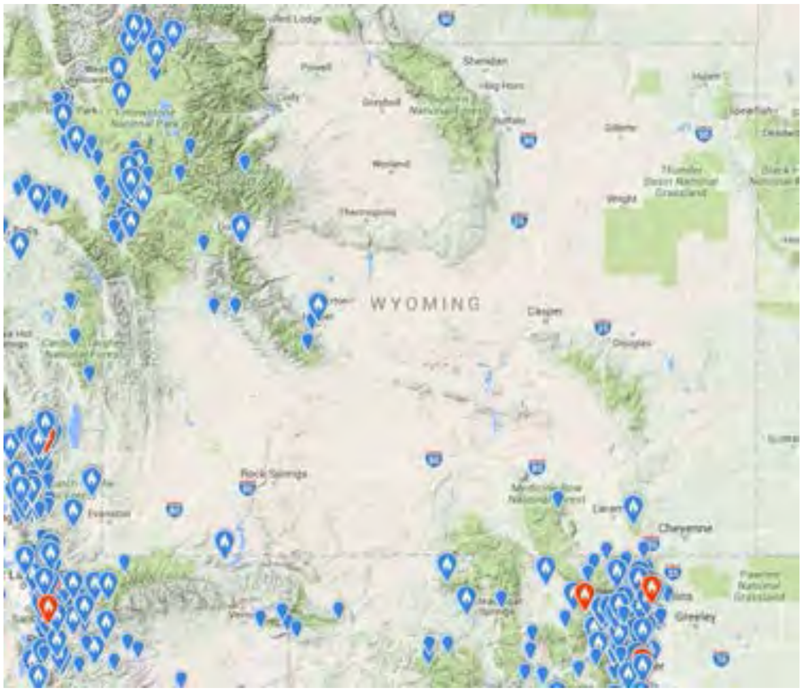

Figure 5: The blue and orange pins represent all eBird recorded sightings of Northern Pygmy-Owl in Wyoming, northeastern Utah and northern Colorado. Note that there are only three detections of the species in southern Wyoming, all just east of Laramie. (Image provided by eBird (www.ebird.org) and created April 17, 2016)

Peregrine Falcon
Falco peregrinus

Regulatory Status
USFWS: Delisted, Migratory Bird
USFS R2: Sensitive
USFS R4: Sensitive
Wyoming BLM: Sensitive
State of Wyoming: Protected Bird

Conservation Ranks
USFWS: Bird of Conservation Concern
WGFD: NSS3 (Bb), Tier II
WYNDD: G4, S2B/S2S3N
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 9

Status and Rank Comments
Arctic Peregrine Falcon (*Falco peregrinus tundrius*) was removed from the Federal Endangered Species list in 1994. American Peregrine Falcon (*F. p. anatum*) was removed from the Federal Endangered Species list in 1999. Both of these subspecies were first listed as Endangered in 1970 [1,2]. Note that the "Sensitive" status assigned by both Region 2 and Region 4 of the U.S. Forest Service formally applies to *F. p. anatum*, the form most likely encountered in Wyoming (see Taxonomy, below). Peregrine Falcon has been assigned a range of non-breeding state conservation ranks by the Wyoming Natural Diversity Database due to uncertainties in the winter population of the species. Specifically, it is uncertain how much of the state may be considered viable winter habitat, and the population trend of the winter population is unknown.

Natural History

Taxonomy:
Nineteen subspecies of Peregrine Falcon are recognized world-wide. Three subspecies are found in North America. *Falco peregrinus anatum*, commonly called American Peregrine Falcon, is the most widespread subspecies in North America and is found across most of the continent, including Wyoming. The other two subspecies in North America are *F. p. pealei*, found in the Pacific Northwest, and *F. p. tundrius*, found in the arctic [3]. *F. p. tundrius* is sometimes found in Wyoming during migration [4].

Description:
Identification of Peregrine Falcon is possible in the field. Females are larger than males, 45–58 cm tall, and 36–49 cm tall, respectively [3]. All North American adults have a yellow eye ring and cere; a large black mustache; and dark head, back, and wings. The underside is white with barring. In flight, the species shows large pointed wings and a narrow tail. Juvenile birds are brown overall, contrasting with the blue-black plumage of adults. In Wyoming, similar species

include Merlin (*F. columbarius*) and Prairie Falcon (*F. mexicanus*). Compared to the Peregrine Falcon, the Merlin is much smaller at 28–31 cm tall, lacks the mustache stripe, and is finely streaked below. The Prairie Falcon is brown overall, does not have as strong of a mustache, and has a white eyebrow stripe. In flight, the Prairie Falcon shows dark armpits. Peregrine Falcon lacks this field mark [5].

Distribution & Range:
Peregrine Falcon is found globally, absent only from Antarctica. The species was formerly found extensively across North America, but declines during the early part of the 20th century have resulted in reduced abundance and local extirpations. Currently, the species is found across western and eastern North America, with scattered breeding in the middle of the continent. Wyoming, especially the northwestern portion of the state, is part of the broad western distribution of the species, which extends from Mexico north into Canada [3, 6]. Peregrine Falcon has been documented in 27 of Wyoming's 28 latitude/longitude degree blocks, with confirmed breeding occurring in 13 of those 27 degree blocks [6]. Most Peregrine Falcons migrate out of North America for the winter to Central and South America, though some overwinter in portions of North America, including Wyoming [3, 4].

Habitat:
Peregrine Falcon is a habitat generalist across its range, using a wide variety of natural habitats and urban areas for nesting and foraging. In Wyoming, the species typically requires cliffs for nest sites, and open areas for foraging. Elsewhere in the species range, nests are constructed on buildings and other man-made structures, and sometimes on the ground in habitats like arctic tundra [3]. Most breeding Peregrine Falcons in Wyoming are found in Grand Teton and Yellowstone National Parks [4, 6, 7]. In the non-breeding season, the species uses any open habitat [3].

Phenology:
While some individual Peregrine Falcons may stay in Wyoming during the winter, most of the breeding population arrives in late March and early April [4]. In Wyoming, courtship occurs from early April to early May, and fledging is completed by late July [8]. In Colorado, egg laying begins in late April, and fledging occurs from June into July [9]. The dates of egg laying, hatching, and fledging of young vary widely across the species' range. Incubation lasts 33–35 days and young fledge from the nest at 42–44 days of age [3, 9]. After fledging, young are provisioned by parents for 4–8 weeks. The shorter period of provisioning occurs with birds that migrate, the longer periods for those that do not migrate [3]. Fall migration in Wyoming occurs from early September to early October [4].

Diet:
Peregrine Falcon primarily feeds upon birds. Other food items include bats, squirrels, small mammals, amphibians, fish, and insects [3].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
Using North American Breeding Bird Survey (BBS) data, the Partners in Flight Science Committee estimated the global population of Peregrine Falcon to be 140,000 birds [10]. Although a population estimate was not provided, about 0.6% of the global population is estimated to

breed in Wyoming [11]. However, this abundance estimate should be viewed with caution, given the very low detection rate of this species in the state during BBS efforts. The statewide rank of RARE is based on the rather small area of the state known to be occupied in any given season, and the small coverage of suitable habitat within that area. However, within suitable habitat in the occupied area, Peregrine Falcon appears to be uncommon, occurring in relatively low densities and requiring intensive survey efforts to detect the species [6]. A subset of nesting territories are monitored each year. In 2013, there were at least 118 nesting territories in Wyoming [12]. Most breeding Peregrine Falcons in Wyoming are in the northern and northwestern part of the state in the Bighorn, Teton, and Wind River Mountain Ranges [6]. Since 2005, a mean of 28 territories are checked annually, the mean number of occupied territories is 25, the mean number of successful territories is 17 (68%), the mean number of young fledged is 39, and the mean number of young per occupied territory is 1.5 [13].

Population Trends:
Historic: LARGE DECLINE
Recent: INCREASE
In Wyoming and across the globe, Peregrine Falcon numbers plummeted precipitously from the 1940s to the 1970s due to DDT and other pesticides, with extirpations occurring in many portions of the species range [3]. Laws banning the use of DDT and other pesticides, combined with reintroduction efforts across North America, have led to an increase in numbers. The species now occupies nearly all of its historical range in Wyoming, and monitoring results indicate that the population of nesting Peregrine Falcons is stable in Wyoming [13]. Long-term averages from survey results since 2005 suggest that Peregrine Falcon production is well above recovery goals and indicate that the species nesting population is stable in Wyoming [13].

Intrinsic Vulnerability:
HIGH VULNERABILITY
In Wyoming, Peregrine Falcon requires cliffs for nesting [3, 4]. Peregrine Falcons have a relatively low reproductive rate. A nesting pair of Peregrine Falcons will only produce one brood per year, and normally will not attempt to renest if the original clutch fails [3].

Extrinsic Stressors:
SLIGHTLY STRESSED
Peregrine Falcons in remote areas may abandon nest sites in the presence of human activity [3]. Pesticide and other chemical poisoning continue to negatively affect the species in many portions its range. This has not been studied in Wyoming [14-16]. Drought and other climactic conditions, such as El Niño events, in western North America may be contributing to recent observations of reduced productivity [17-19]. Normal occupancy rates but low fledging can result from inclement weather that is extreme and persistent during and shortly after Peregrine Falcon hatch in May [13].

KEY ACTIVITIES IN WYOMING
Peregrine Falcon is listed as a Species of Greatest Conservation Need in Wyoming by the Wyoming Game and Fish Department (WGFD). Wyoming participates in the National Monitoring Plan for American Peregrine Falcon. Under this program, state and federal agencies monitor populations every three years. These surveys will continue until 2015. The WGFD conducts annual surveys in the state at 30 randomly chosen territories. For both of these programs, occupancy and productivity (fledglings/territory) are determined. During the 2012 triennial survey, 15 out of 93 known territories in the state were checked. Of these 15 territories,

14 were occupied, 50% were successful, and productivity was 1.1 young/occupied territory [20]. A total of 15 territories were checked during the 2015 triennial survey; 14 were occupied, 43% were successful, and productivity was 0.9 young/occupied territory [13]. Additional monitoring efforts between years and in 2012 indicated higher productivity, which suggests that a sample size of only 15 territories under-represents actual productivity [20]. The 2015 survey by WGFD revealed 35 occupied territories out of 38 surveyed, 16 (47%) of the successful territories produced 35 young, and productivity was 1.0 young fledged per occupied territory [13]. Although productivity was slightly lower than previous years, it is still within range of the mean of 1.5 young fledged per occupied territory [13]. Fall migration of raptors has been monitored annually since 2002 at Commissary Ridge in southwestern Wyoming by Hawk Watch International. In 2011, only 6 individuals were seen. This was 50% lower than the 10 year average and was one of the lowest totals in the history of the watch [21]. Observations of Peregrine Falcon are reported to the WGFD and vetted through the Wyoming Bird Records Committee (WBRC). This is a species for which the WBRC requests documentation on first latitude/longitude degree block sightings and all nesting observations.

ECOLOGICAL INFORMATION NEEDS

Due to the historical protection of Peregrine Falcon under the Endangered Species Act, the biology of the species is very well understood. However, there are uncertainties pertaining to the population in Wyoming in winter. Specifically, it is unknown how many Peregrine Falcons overwinter in the state, how much of the state is winter range, and how the wintering population has changed through time. Continued exposure to and effects of pesticides and other chemical compounds in Wyoming's Peregrine Falcons is unknown.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Peregrine Falcon is classified as a Species of Greatest Conservation Need in Wyoming [22]. From 1980–1995, WGFD coordinated a Peregrine Falcon reintroduction program with the U.S. Fish and Wildlife Service (USFWS), National Park Service, the U.S. Forest Service, Bureau of Land Management, and state wildlife agencies in Idaho and Montana. Our goal was to establish and maintain a self-sustaining Peregrine Falcon breeding nucleus in the wild comprised of a minimum of 30 breeding pairs. During that timeframe, we released 384 Peregrine Falcons, with ≥ 325 (85%) surviving to dispersal (1 month post-release) [13]. Objectives were met in 1994–1995, and the reintroduction effort was completed. In addition to the triennial monitoring effort conducted in coordination with the USFWS, the WGFD also conducts annual monitoring of 30 randomly selected Peregrine Falcon nesting sites throughout Wyoming, which allows us to assess occupancy and productivity. Annual results are similar to long-term averages, suggesting that Peregrine Falcon populations remain well above recovery goals and are stable in Wyoming [13].

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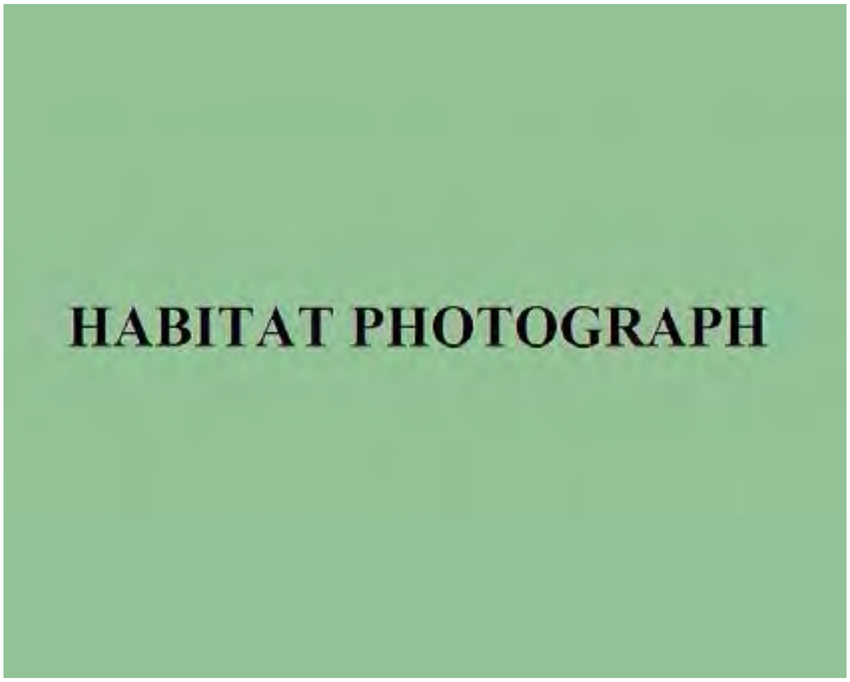
Figure 1: Adult Peregrine Falcon in southern California. (Photo courtesy of Glen Tepke, www.pbase.com/gtepke/profile)

Figure 2: North American breeding range of *Falco peregrinus*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)



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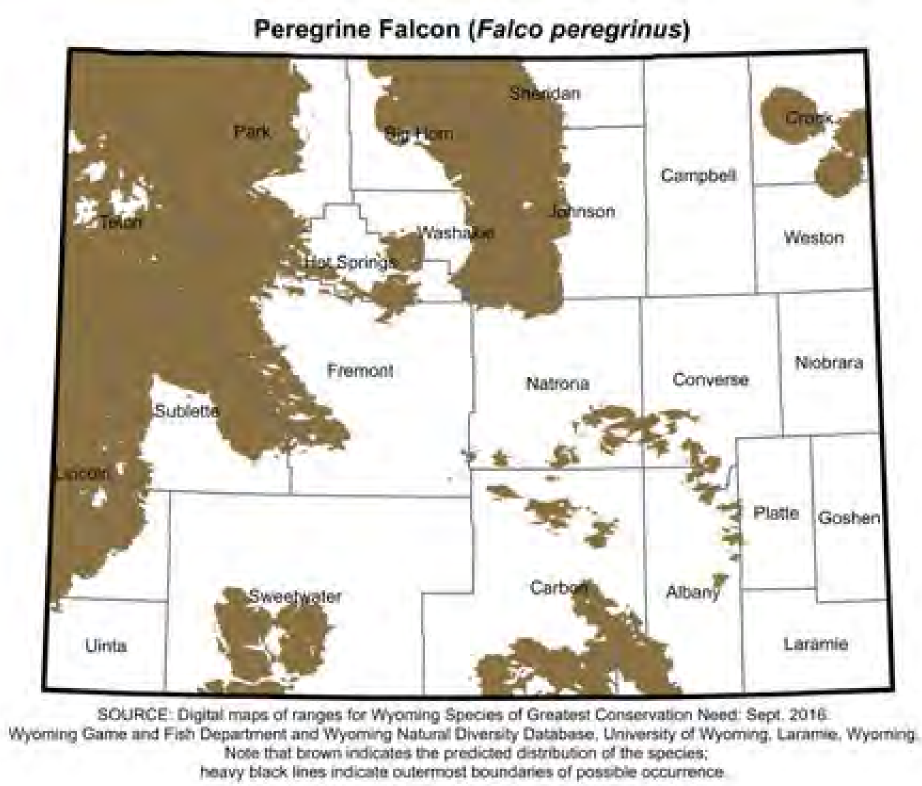

Figure 4: Range and predicted distribution of *Falco peregrinus* in Wyoming.

Purple Martin
Progne subis

Regulatory Status
USFWS: Migratory Bird
USFS R2: Sensitive
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

Conservation Ranks
USFWS: No special status
WGFD: NSSU (U), Tier III
WYNDD: G5, S1
Wyoming contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 8

Status and Rank Comments
Current long-term monitoring data are inconclusive for Purple Martin (*Progne subis*) in Wyoming, resulting in a Native Species Status (NSS) designation of unknown.

Natural History

Taxonomy:
Purple Martin belongs to the subfamily Hirundininae, including swallows and martins. There are nine species in the genus *Progne* which closely resemble one another [1]. There are three subspecies of the Purple Martin differing in body size and plumage of the adult female, with *P. s. arboricola* occurring within Wyoming.

Description:
Purple Martin is the largest swallow. Purple Martin located in the Rocky Mountains and Pacific Northwest are larger those in the eastern and southwestern United States [1]. Adult male Purple Martin is the only swallow in North America that exhibits a dark belly. Adult males are entirely glossy blue-black. The adult female resembles other swallows, but can be distinguished by their large size and brownish-gray collar around the nape. During their first year, male plumage resembles that of females, but males exhibit varying amounts of blue-black plumage on the head and belly. First year females resemble adult females but have less blue plumage on their back and lack dusky centers on the undertail-coverts [2]. Purple Martin is typically has a wing span of 134–151 mm in wing length, and mass of 54 g [1].

Distribution & Range:
Purple Martin breeds throughout eastern North America, along the Pacific northwest coast, and in isolated locations in the southern Rocky Mountains and southwestern deserts [3]. Purple Martin winters in the central South American lowlands from Bolivia to southern Brazil. The Amazon River basin is thought to be a staging area for spring and fall migrations. Wyoming populations

fall with Rocky Mountain segment of the National Range. Within Wyoming, the only known breeding colony of Purple Martin exists on the western flank of the Sierra Madre Mountains in the south-central part of the state [4]. Purple Martin has been observed in areas surrounding the known breeding colony, suggesting additional breeding pairs may exist in the state. Purple Martin has been documented in nine of Wyoming's 28 latitude/longitude degree blocks, which are dispersed throughout the state [5]. A historic breeding observation was documented within latitude/longitude degree block 21 along the North Platte River [4, 5]. The 2004 breeding observation was recorded in latitude/longitude degree block 25 [5].

Habitat:
Purple Martin was historically known to occupy forest edges and riparian habitats with abundant snags [1, 3]. Purple Martin also prefers wooded ponds, including those created by American Beaver (*Castor canadensis*). In Wyoming, Purple Martin has been documented breeding in aspen stands adjacent to water below 2,100 m [4]. Purple Martin is an obligate cavity nester. Natural preferred breeding habitat is patchily distributed and localized across the landscape. Throughout the eastern United States, Purple Martin has altered its nesting habits and primarily utilizes birdhouses specifically constructed for the species. Because of birdhouse availability, Purple Martin is now observed almost exclusively in association with human settlements in eastern portions of its range [1]. The species frequently inhabits urban environments, and has been documented breeding in large cities. During winter months, Purple Martin occupies savannas and other agricultural areas in central South America. In winter, the species frequently roosts in trees associated with human developments [1].

Phenology:
Purple Martin is primarily diurnal. Within Wyoming, the earliest observation of spring arrival occurred on 10 May 1980 [3, 4]. Females arrive later than adult males, and males may remain unpaired for up to three weeks. Breeding pair formation occurs several days after females arrive on breeding grounds following investigation of potential nest sites and subsequent cavity ownership by both sexes [1]. Purple Martin typically lays a single clutch of approximately 5 eggs, but may attempt to renest if the first nest fails. Young Purple Martins typically fledge in 27–36 days [1]. Fall departure is thought to occur in early August. The latest accepted fall observation in Wyoming was documented on 7 August 1978. There remains a later unaccepted observation on 8 September 1969, near Sheridan [4].

Diet:
Purple Martin aerially forages for flying insects often at altitudes of greater than 50 m [1, 6]. However, Purple Martin has been documented foraging from a few meters in altitude to more than 150 m [6]. This species rarely gleans insects from the ground or water surface. Purple Martin is insectivorous, and feed on most insect orders as well as spiders. Purple Martin is documented to additionally feed on small bits of gravel and eggshells to aid in digestion of their prey [1].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
Purple Martin is considered a rare summer resident in Wyoming [5]. Using Breeding Bird Survey (BBS) data, Partners in Flight have estimated the global population of Purple Martin to be 7 million birds [7]. In 2014, statewide results from the Integrated Monitoring in Bird Conservation

Regions (IMBCR) program estimated a Purple Martin population size of 787 (% CV = 103, n = 1 detection) individuals in Wyoming [8]. These results are not robust, and should be interpreted with care. However, this is currently the only population size estimate of Purple Martin in Wyoming. The statewide rank of VERY RARE is based on the rather small area of the state known to be occupied in any given season, and the small coverage of suitable habitat within that area. Purple Martin is only known to breed in one location along the west flank of the Sierra Madre Mountain Range [4]. This species is considered possibly extirpated from Wyoming by some sources [9].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Purple Martin population trends within Wyoming are unknown. There are currently no BBS trend estimates for this species within the state. Purple Martin populations have been fairly stable in recent years (2003–2013), although Purple Martin has been estimated to decline in all BBS regions (eastern, central, and western) in the last 5 decades [10]. The greatest levels of decline have occurred in the western region, but trend estimates are not robust for this region [10]. Western populations may be decreasing due to competition by European Starling (*Sturnus vulgaris*) and House Sparrow (*Passer domesticus*) for nesting cavities [9, 10]. It is suspected that this species has historically occurred in the state at low levels.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Purple Martin is an obligate cavity nester. Humans have long provided specialized nesting structures, and Purple Martin has opportunistically adapted to human-dominated environments. The species is a secondary cavity nester and is dependent on existing cavities which likely have a localized and patchy distribution across the landscape. Within more native environments, Purple Martin prefers a narrow window of habitat conditions, comprised of snags, forest edges, wooded ponds, and wet meadows [1, 3, 4].

Extrinsic Stressors:
UNKNOWN
It has been shown that human activities can reduce naturally occurring nesting habitat in montane habitats [3]. Factors that could influence Purple Martin abundance include: harvest of mature aspen, lack of aspen regeneration, and changes in water management. In addition to loss of natural nesting cavities; pesticides, road mortalities, and human roost removal have also been documented as extrinsic stressors [1]. Human activity and habitat alteration have resulted in modification of Purple Martin nesting behavior. Anthropogenic sources now provide a majority of nesting sites through specialized nest boxes [1].

KEY ACTIVITIES IN WYOMING
Purple Martin is classified as a Species of Greatest Conservation Need (SGCN) in Wyoming due to limited information on breeding status and population trend in the state. No systematic survey of Purple Martin has been conducted in Wyoming, and existing data are not robust enough to support estimates of occupancy, density, or population trend. One breeding colony has been confirmed along the west flank of the Sierra Madre Mountains [4]. Observations of this species are reported to the Wyoming Game and Fish Department and vetted through the Wyoming Bird

Records Committee (WBRC). Purple Martin is a species for which the WBRC requests documentation on all sightings.

ECOLOGICAL INFORMATION NEEDS

The distribution of Purple Martin in Wyoming remains unclear. Purple Martin breeding may remain undocumented in the southwestern flank of the Bighorn Mountains, and along the Wyoming Range [4]. A majority of information for the Purple Martin comes from eastern populations of this species. Basic natural history information is needed for Purple Martin in western states including data on general life history, delineating migratory corridors, demography, food habitats, and response to habitat management practices [3, 4].

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Zachary J. Walker and Andrea C. Orabona. Purple Martin is classified as a SGCN in Wyoming due to a lack of information on breeding status and population trends. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [10] and IMBCR [8]. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, Purple Martin may need a targeted, species-specific survey method to obtain these data. Management priorities for Purple Martin in the short-term will focus on addressing data deficiencies. Information should be gathered on species presence, distribution, population status, and the impact of potential threats. Any information gathered will ultimately be used to develop management and conservation recommendations for this species, and to designate a known NSS ranking. In order to adequately manage for this species in the state, more information on breeding status and general life history is required.

CONTRIBUTORS

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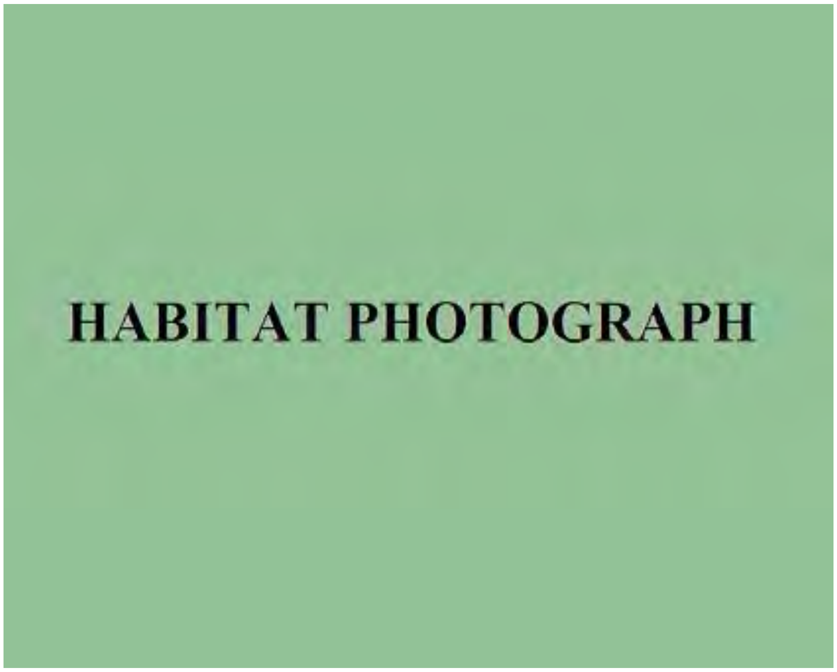
Figure 1: Adult male (left) and female (right) Purple Martins at nest cavity in Garfield County, Colorado. (Photos courtesy of Bill Schmoker).

Figure 2: North American range of *Progne subis*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)



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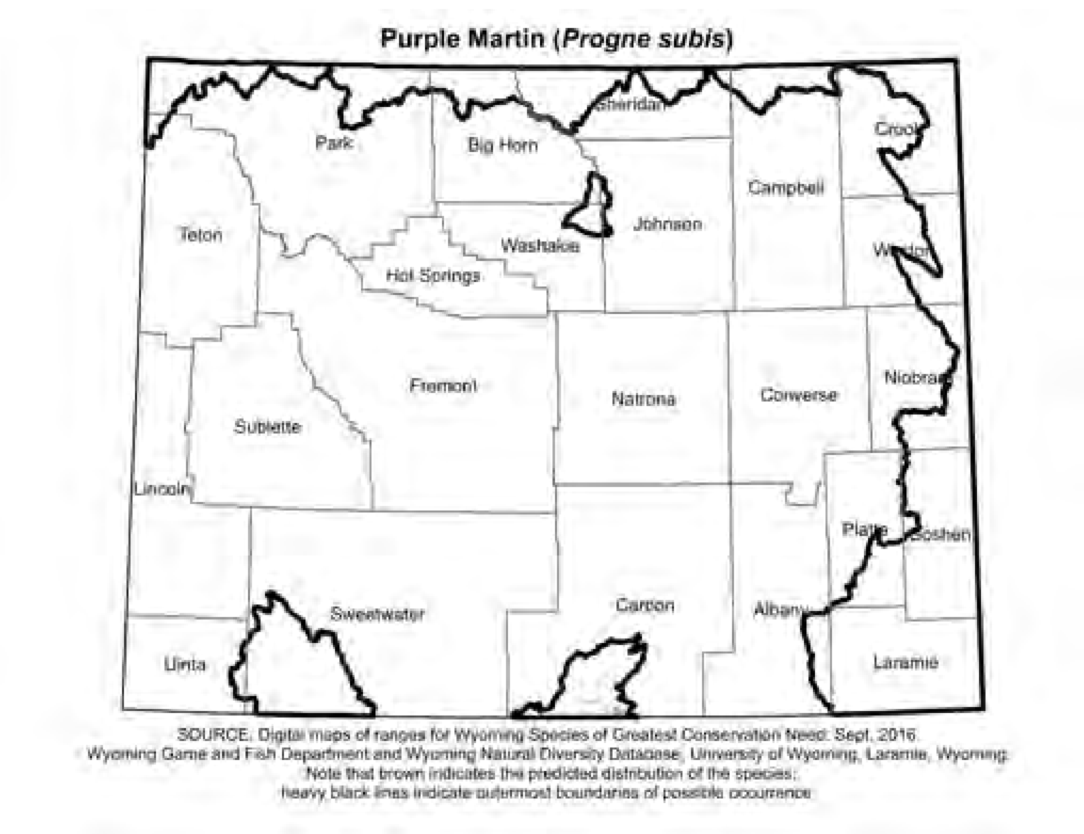

Figure 4: Range and predicted distribution of *Progne subis* in Wyoming.

Pygmy Nuthatch

Sitta pygmaea

REGULATORY STATUS

USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G5, S2S3
Wyoming Contribution: HIGH
IUCN: Least Concern
PIF Continental Concern Score: 10

STATUS AND RANK COMMENTS

The Wyoming Natural Diversity Database has assigned Pygmy Nuthatch (*Sitta pygmaea*) a state conservation rank ranging from S2 (Imperiled) to S3 (Vulnerable) because of uncertainty about the species' abundance and population trends in Wyoming.

NATURAL HISTORY

Taxonomy:

Six or seven subspecies of Pygmy Nuthatch are recognized, depending upon the reference used. Only one subspecies occurs in Wyoming, *S. p. melanotis* [1]. The remaining subspecies are found from coastal California south to Mexico [1].

Description:

Identification is possible in the field. Pygmy Nuthatch is a small songbird (9–11 cm) with a short tail. The species has a gray-brown cap coming down to a dusky or nearly black eye-line [1]. The face, breast, and underparts are white to buff and sides are bluish-gray. The back, rump, and tail are bluish-gray, and the wings are brown to dark slate. The species has a pale or whitish spot on the nape and primaries are edged with white. Males, females, and juveniles are similar in appearance [1, 2]. In Wyoming, similar species include Red-breasted Nuthatch (*S. canadensis*) and White-breasted Nuthatch (*S. carolinensis*). Pygmy Nuthatch differs from both species by it its gray-brown cap, lack of any white above the eye, and small size [2].

Distribution & Range:

Pygmy Nuthatch is patchily distributed throughout its range in western North America [1], and the species is a year-round resident in Wyoming [3, 4]. Pygmy Nuthatch has been documented in most mountain ranges in the state, but is most common in the Black Hills region and in the southeastern mountain ranges [5, 6]. Confirmed or suspected breeding has been documented in 9 of the 28 latitude/longitude degree blocks in Wyoming, primarily in the southern half of the state [4].

Habitat:
In Wyoming, Pygmy Nuthatch is strongly associated with forests dominated by old-growth or mature Ponderosa Pine (*Pinus ponderosa*), preferably with a number of large snags [1, 7]. Ponderosa Pine provides nesting locations in the form of cavities, foraging areas, and winter food in the form of pine seeds [7]. Pygmy Nuthatch is a cavity nester and will excavate new cavities as well as use existing cavities. Nest cavities are typically located in dead snags or dead sections of trees [1, 7]. The species will occasionally nest in cavities in other tree species within Ponderosa Pine stands [7].

Phenology:
Nesting phenology of Pygmy Nuthatch has not been studied in Wyoming. In other areas, the breeding season of Pygmy Nuthatch begins early April to early May and pairs can have up to 2 clutches per breeding season. Cavity excavation occurs 3–6 weeks prior to breeding [1, 7]. In Colorado, nest building has been observed in early May to early June. Incubation lasts approximately 12–17 days and young fledge at 14–22 days of age. Fledglings are partly dependent on adults for food until at least 30 days post-fledging. Family groups typically stay together through the winter [1, 7]. Although individuals and family groups may wander after the breeding season, the species does not migrate [7].

Diet:
During the breeding season, Pygmy Nuthatch primarily eats insects from the orders Coleoptera (beetles), Hymenoptera (ants and wasps), and Hemiptera (true bugs), as well as the larva of Lepidoptera (caterpillars). In winter, the diet consists primarily of pine seeds [1].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD BUT PATCHY
Wyoming: RARE to UNCOMMON
Based on results from Breeding Bird Survey (BBS) data, Partners in Flight estimated the global population of Pygmy Nuthatch to be 3 million and the Wyoming population to be 1,200; however, this state abundance estimate should be viewed with caution due to the low number of detections of the species in Wyoming [8]. Pygmy Nuthatch has a statewide abundance rank of RARE to UNCOMMON and appears to be uncommon within suitable environments in the occupied area [4]. Most records of this species in Wyoming come from the southern Laramie Range in southeastern Wyoming and the Black Hills region in northeastern Wyoming [6, 7].

Population Trends:
Historic: STABLE
Recent: UNKNOWN
There are no population trend data for Pygmy Nuthatch in Wyoming. Across the species' range, BBS data suggest the population is stable [9]. Christmas Bird Count (CBC) results suggest a possible increase in the range-wide population, though limited CBC results from Wyoming suggest the population is small and fluctuates across years [10]. Long-term research in Colorado and Arizona show that local populations can fluctuate dramatically year to year, likely due to variation in cone crops and/or climactic conditions [7].

Intrinsic Vulnerability:
HIGH VULNERABILITY

In Wyoming, Pygmy Nuthatch has high intrinsic vulnerability due to the species' dependence on mature and old-growth Ponderosa Pine forests, which are limited across the species' range, including Wyoming [1, 7]. More specifically, Pygmy Nuthatch prefers Ponderosa Pine forests with high snag density (including live trees with some dead limbs), high foliage volume, and a heterogeneous forest structure consisting of old and intermediate aged Ponderosa Pines [7]. These characteristics are necessary to provide cavities for nesting and roosting, foraging substrate during the summer, and sufficient cone crops for winter food. Research suggests that the availability of cavities for nesting and roosting may limit Pygmy Nuthatch abundance [11, 12].

Extrinsic Stressors:
MODERATELY STRESSED
Pygmy Nuthatch is threatened by disturbances that reduce the number of large mature trees and snags. Most forms of timber harvesting negatively impact Pygmy Nuthatch by reducing foliage volume and removing nesting and roosting trees, and numerous studies report lower abundances of Pygmy Nuthatch in heavily managed forests [7]. However, thinning practices and selective cutting that removes only some mature trees can benefit the species by reducing crowding and allowing the remaining trees to grow larger [7]. Fuelwood harvesting that removes standing dead trees also negatively impacts Pygmy Nuthatch, but collecting fuelwood from fallen trees and downed woody debris can positively impact the species by reducing fuel loads and decreasing the likelihood of high-intensity, stand-replacing fires [7]. Fire has mixed effects on Pygmy Nuthatch depending on severity. Low-intensity fires reduce the density of young trees and maintain open park-like forests dominated by large mature trees preferred by Pygmy Nuthatch. Low-intensity prescribed burns have little or no negative impact on Pygmy Nuthatch abundance but may benefit the species by reducing the risk of stand-replacing fires [7, 13-15]. High-intensity, stand-replacing fires reduce or eliminate Pygmy Nuthatch habitat [7]. The current Mountain Pine Beetle (*Dendroctonus ponderosae*) epidemic occurring across the Rocky Mountain region has been predicted to drastically reduce the seed supply of Ponderosa Pine forests, which is an important food for overwinter survival of Pygmy Nuthatch [16].

KEY ACTIVITIES IN WYOMING

Currently, there are two monitoring efforts in Wyoming that detect Pygmy Nuthatch. These are the BBS and the Integrated Monitoring in Bird Conservation Regions (IMBCR) programs [9, 17]. Both have low numbers of detection for the species, limiting inferences about population size and trends; however, results have refined our knowledge of the species' range in Wyoming.

ECOLOGICAL INFORMATION NEEDS

Pygmy Nuthatch would benefit from information regarding the distribution, population size, and population trends of the species in Wyoming. A better understanding of immigration and dispersal of the species between and among habitat patches is needed in order to better understand population dynamics [7]. Information on the projected response of Pygmy Nuthatch to the Mountain Pine Beetle epidemic and to climate change are needed for Wyoming.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Zachary J. Walker. Pygmy Nuthatch is classified as a Species of Greatest Conservation Need in Wyoming due to limited information on breeding, distribution, population trends, and habitat requirements. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the

North American BBS [9] and the multi-partner IMBCR [17]. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, a targeted, species-specific survey method may be warranted to obtain these data for Pygmy Nuthatch. Best management practices or key management recommendations to benefit Pygmy Nuthatch include maintenance of suitable mature forest habitat [18, 19]. Snags and trees with suitable nesting cavities should be retained on the landscape. Where snags are unavailable, nest boxes may be used to supplement breeding cavities. Low intensity fire may be used as a management tool to maintain open woodland conditions and to reduce fuel loads.

CONTRIBUTORS

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Figure 1: Adult Pygmy Nuthatch in British Columbia, Canada. (Photo courtesy of Lanaye Baxter)

Figure 2: North American range of *Sitta pygmaea*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Ponderosa Pine habitat in Medicine Bow National Forest, Laramie Peak region, Wyoming. (Photo courtesy of Michael T. Wickens)

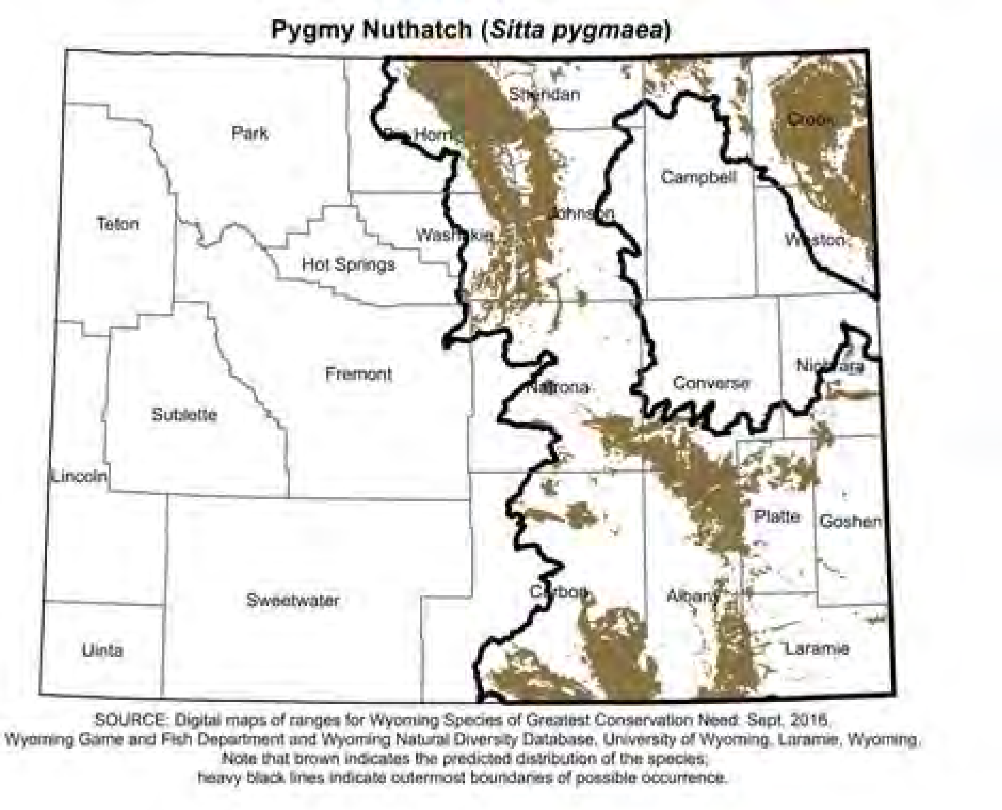

Figure 4: Range and predicted distribution of *Sitta pygmaea* in Wyoming.

Figure 5: Pygmy Nuthatch pair attending a nest cavity in Mt. San Jacinto State Park, California. (Photo courtesy of Glen Tepke, http://www.pbase.com/gtepke/profile)

Red Crossbill
Loxia curvirostra

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS4 (Bc), Tier II
WYNDD: G5, S5
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 10

STATUS AND RANK COMMENTS
Red Crossbill (*Loxia curvirostra*) has no additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY
Taxonomy:
There are eight subspecies of Red Crossbill that have been identified [1]. These subspecies are primarily based on flight call and morphology (body size, bill size, and bill shape), and exhibit little genetic differentiation [2]. Subspecies of Red Crossbill have also been proposed as pseudo-species based upon lack of subspecies isolation [1]. Additional work needs to be completed on taxonomy. For this account, flight call variation (call type) will be used to describe intraspecific variation. It is believed that flight calls are imprinted within flocks and trend towards localized adaptations for feeding upon variations in conifer cones [3]. Learned flight call type (within flock) could promote reproductive isolation and localized adaptation, although there is widespread sympatry between call types [1, 3-5]. Five flight call types have been observed in Wyoming [6]. An additional call type has been observed close to the northwestern border, and may occur in the state [6].

Description:
All crossbills can be identified in the field by their distinctive curved bill, which is crossed at the tip. Red Crossbill is known for its extreme phenotypic variability [4, 5]. Individuals of each call type have variations in bill shape and size from other call types [1, 3, 5]. Adult male Red Crossbills are typically red to reddish-yellow; have dark brown flight feathers; and a dark, deeply notched tail [1]. Females are gray to olive in coloration, with a green to yellow breast and rump. Immature Red Crossbills resemble adult females, and may exhibit coloration similar to adults based upon sex and age. Juveniles are typically distinguished from adults by buffy edgings on the wing

coverts [1]. Adult Red Crossbills are typically 14–20 cm in total length and weigh 24–45 g [1]. White-winged Crossbill (*L. leucoptera*) is similar in appearance, but can easily be distinguished from Red Crossbill by its two bold, white wing-bars [7].

Distribution & Range:
Red Crossbill is widespread throughout Eurasia and North America. Within North America, Red Crossbill is a permanent resident in Alaska, Canada, states adjacent to the Canadian border, western states, and throughout the Appalachian Mountains [8]. Crossbills are considered a nomadic species [5]. Wandering Red Crossbills have been observed throughout North America [1]. Within Wyoming, Red Crossbill occurs in all mountain ranges and lower elevation pine (*Pinus* spp.) forests [6, 9]. The distributions of call types within the state follow key confer species in which the specific call types specialize in. Call types 2 and 5 are the most widely distributed in Wyoming [6]. Call types 4, 3, and 1 are found within the state in respective decreasing abundance. Red Crossbill has been observed in all of Wyoming's 28 latitude/longitude degree blocks, with confirmed or circumstantial evidence of breeding occurring in 23 of the 28 degree blocks [9].

Habitat:
In general, Red Crossbill prefers mature conifer forests. The exact conifer species and microhabitat are determined by call type and morphological bill specialization. Within Wyoming, call types 2 and 5 specialize on Ponderosa Pine (*P. ponderosa*) and Lodgepole Pine (*P. contorta*) [6]. Call type 3 specializes on Western Hemlock (*Tsuga heterophylla*), and call type 4 specializes on Douglas-fir (*Pseudotsuga menziesii*). However, both call type 3 and 4 have additionally been observed in association with Engelmann Spruce (*Picea engelmannii*) in the state. Call type 1 does not appear to specialize on a single species of conifer, and has been documented feeding from a variety of conifer species [1, 10]. Females build nests from conifer twigs, grasses, lichen, and other plant materials [1]. The nest is often lined with feathers.

Phenology:
Red Crossbill is primarily diurnal. This species is considered nomadic and does not seasonally migrate [1, 5, 6]. Red Crossbill is found in Wyoming year-round but shifts its range based primarily upon food availability and seed production of key forage species [1]. The species is thought to breed opportunistically throughout the year as food resources allow [1, 11]. Red Crossbill breeding is tied to photo cycles, as with most other temperate birds, and more information is needed to determine factors which allow this species to breed at any time of the year [11]. Typically, 3 eggs are laid per clutch [1]. Incubation lasts for approximately 14 days, with nestlings fledging within 35 days of hatching [1].

Diet:
Red Crossbill feeds primarily on conifer seeds, with different call types foraging from different conifer species based on bill morphology (see Habitat).

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: ABUNDANT
Using North American Breeding Bird Survey (BBS) data, the Partners in Flight Science Committee estimated the global population of Red Crossbill to be 20 million birds [12]. Approximately 1.1% of the global population, or around 300,000 birds, is estimated to breed in

Wyoming [13]. The statewide rank of ABUNDANT is based on the large area of the state known to be occupied in any given season, and the large coverage of suitable habitat within that area. Within suitable habitat in the occupied area, Red Crossbill appears to be common and is usually encountered during surveys that could be expected to indicate its presence [9]. Red Crossbill density (number of birds per square km) and population size estimates for Wyoming are available from the Integrated Monitoring in Bird Conservation Regions (IMBCR) program for the years 2009–2015 [14].

Population Trends:
Historic: UNKNOWN
Recent: MODERATE DECLINE
Red Crossbill population trend data from the BBS in Wyoming are available from 1968–2013, and suggest a statistically insignificant decline of 1.16% annually (N = 36 routes, 95% CI: -4.61–2.14), although results fall within a regional credibility category containing data with deficiencies, so must be interpreted with caution [15]. Western region BBS data indicate a statistically insignificant annual population decline of 1.11% (N = 541 routes; 95% CI: -3.58–0.57) [15].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Within call types, Red Crossbill is dependent on a narrow suite of conifer species [1]. In addition, Red Crossbill prefers older tree stands for foraging [16], because older conifer stands produce larger cones that are thought to decrease foraging effort. Conifer specialization, in addition to their nomadic life history, makes Red Crossbill susceptible to changes in forest stand management and age across a large landscape. If the conifer assemblage for which a given call type is impacted, this will have impacts on the call type population. Red Crossbill is also known to feed on salt deposits [17], which could make the species vulnerable to vehicle mortality on seasonally salted roads.

Extrinsic Stressors:
MODERATELY STRESSED
Extrinsic stressors to Red Crossbill include degradation of habitat and disturbance to nesting and roost sites [1]. Any alteration to Red Crossbill habitat which reduces forest age or area could have an impact on this species. Loss of mature conifer stands could reduce Red Crossbill food resources. Red Crossbill has shown reduced abundance in younger and more fragmented forests [16], and the species was found to avoid young stands even when other cone sources were limited [18]. The nomadic nature of Red Crossbill means it requires intact older conifer stands across a large geographic scale.

KEY ACTIVITIES IN WYOMING
Red Crossbill is classified as a Species of Greatest Conservation Need (SGCN) in Wyoming by the Wyoming Game and Fish Department. Current statewide activities for monitoring annual detections and population trends for Red Crossbill in Wyoming include the BBS program conducted on 108 established routes since 1968, and the multi-partner IMBCR program initiated in 2009. Trend data are available on the United States Geologic Survey BBS website [15], and occupancy, density, population estimates, and decision support tools are available through the Rocky Mountain Avian Data Center [14]. No systematic surveys of the Red Crossbill have been conducted in Wyoming.

Ecological Information Needs

More information is needed to determine the breeding status and range of specific call types within Wyoming. Information is still needed on how forest management, drought, fire suppression, conifer disease, and pine beetle outbreaks affect this species in the state.

Management in Wyoming

This section authored solely by WGFD; Andrea C. Orabona. Red Crossbill is classified as a SGCN in Wyoming due to reported population declines within the state, and possible reductions to habitat and food availability. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming. The first is the long-term BBS started in Wyoming in 1968 with 108 established routes [15]. Species must be detected on at least 14 routes for data analyses to be significant for tracking population status and trend over time. The IMBCR program was established in 2009 in Wyoming with many state, federal, and nongovernmental organization partners that contribute funding, field personnel, technical assistance, or in-kind services. Data analyses produce estimates of density, occupancy, and population size at various scales; present habitat associations; and provide decision support tools for managers [14]. Management priorities for Red Crossbill in the short-term will focus on addressing data deficiencies. More detailed information should be gathered on species presence, distribution, population status, and the impact of potential stressors in order to develop management and conservation recommendations for this species in Wyoming.

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Figure 1: Adult male (left) and female (right) Red Crossbills in Jefferson County, Colorado. (Photos courtesy of Bill Schmoker)

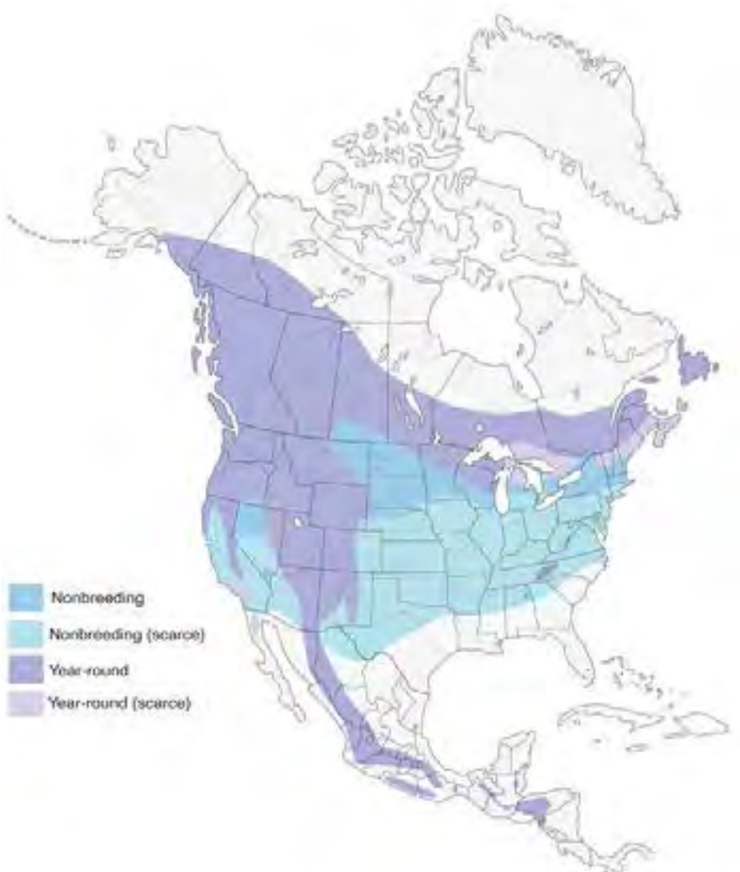

Figure 2: North American range of *Loxia curvirostra*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

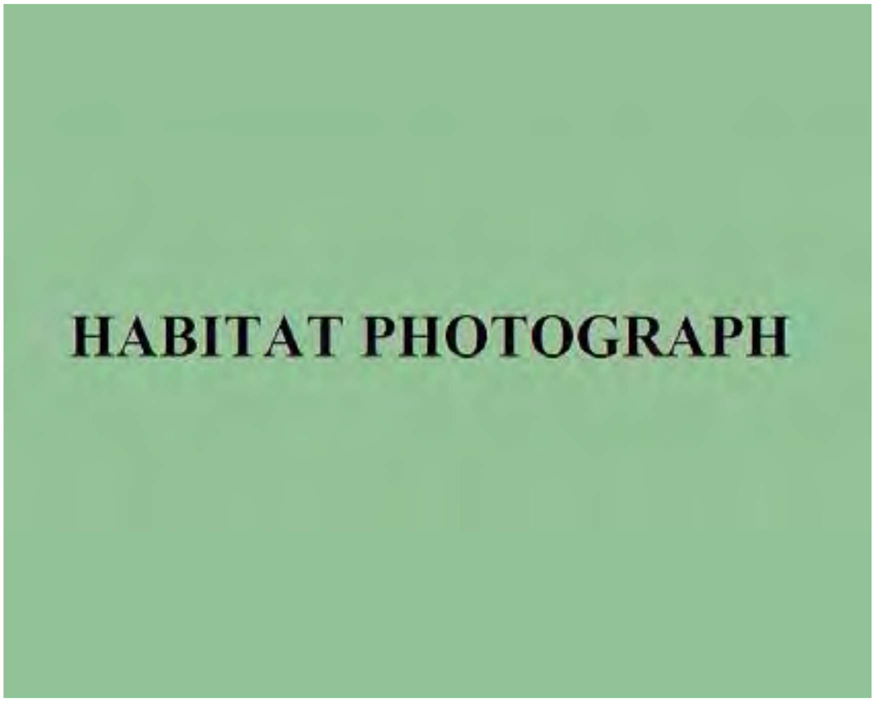

Figure 3: Photo not available.

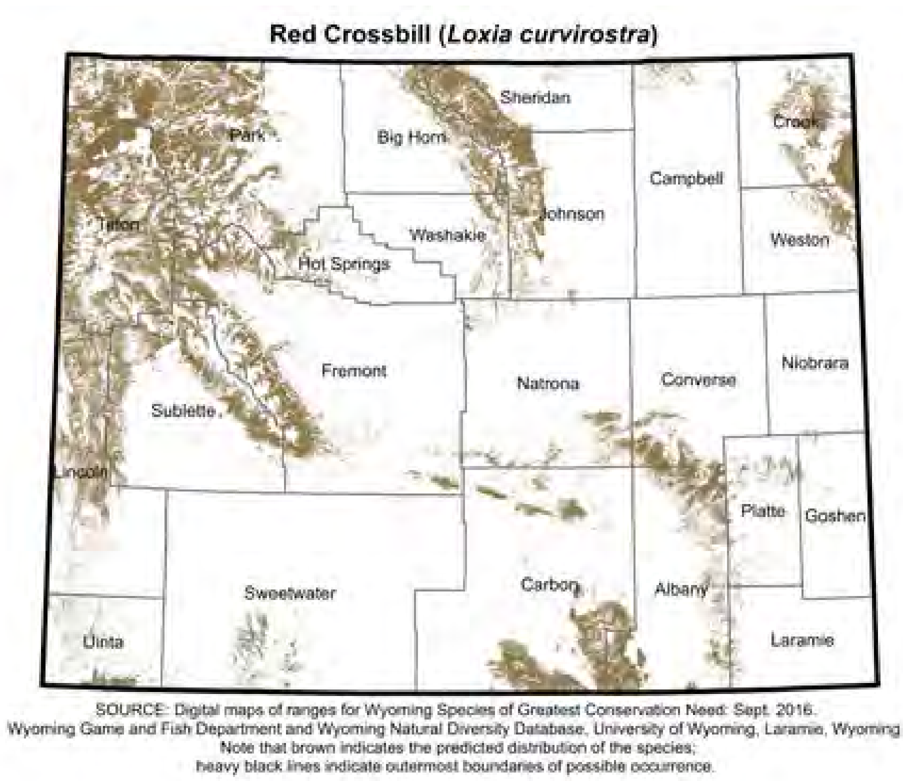

Figure 4: Range and predicted distribution of *Loxia curvirostra* in Wyoming.

Red-eyed Vireo
Vireo olivaceus

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: No special status
UWFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS4 (Bc), Tier II
WYNDD: G5, S2
Wyoming contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 5

STATUS AND RANK COMMENTS
Red-eyed Vireo (*Vireo olivaceus*) does not have any additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY
Taxonomy:
Red-eyed Vireo is composed of 10 or 11 subspecies which are divided into 2 regional groups: the *olivaceus* group (North American breeders, 1–2 subspecies) and the *chivi* group (South American breeders, 9 subspecies) [1-3]. Two subspecies are recognized in the *olivaceus* group (*V. o. caniviridis* and *V. o. olivaceus*) by Browning (1990) and Phillips (1991) [4, 5]; however, many authors do not recognize the differences between the two and consider them one (*V. o. olivaceus*) [1, 3, 6, 7]. Regardless of the disagreement, the subspecies that occurs in Wyoming is *V. o. olivaceus*.

Description:
Red-eyed Vireo is a large vireo (12–13 cm long, 12–26 g) that is identifiable in the field, although it resembles two other *Vireo* spp. in Wyoming (see below). Adults have a gray to blue-gray crown, whitish supercilium, white underparts, and grayish olive-green upperparts [3]. A distinctive characteristic is the sharp blackish line on the lateral edge of the crown bordering the supercilium. Iris color ranges from bright red to brownish red in adults. Compared to the upperparts, the sides of the neck and ear-coverts are lighter and more grayish (i.e., pale olive-gray). On average, males are larger and heavier than females, but are otherwise similar in appearance. In fall and early winter of their first year, immature Red-eyed Vireos are distinguishable from adults by their brown to grayish-brown irises. In basic plumage, juveniles have bright olive sides and pale yellow under tail-coverts, while the under tail-coverts of most adults are white [3]. Similar species in Wyoming are Philadelphia Vireo (*V. philadelphicus*) and Warbling Vireo (*V. gilvus*); however, both have dark irises and lack the distinct dark line

between the supercilium and crown [8]. Additionally, Red-eyed Vireo typically exhibits underparts that are less yellow than Philadelphia Vireo, and upperparts less gray (more olive) than Warbling Vireo. The song of Red-eyed and Philadelphia Vireo can be indistinguishable at times, but Philadelphia Vireo is typically higher-pitched and slower [3].

Distribution & Range:
During the breeding season, Red-eyed Vireo is widely distributed throughout Canada and the U.S., with the exception of the southwestern states. Far northern Wyoming is on the southwestern edge of the species' core breeding distribution, and most of the state falls within a region where breeding is thought to be scarce. Red-eyed Vireo has been observed in 23 of Wyoming's 28 latitude/longitude degree blocks [9]. Confirmed or circumstantial evidence of breeding has been documented in 6 of those degree blocks, only 1 of which occurs in the southern half of the state [9]. Detections from the Integrated Monitoring in Bird Conservation Regions (IMBCR) program have occurred in the Shoshone National Forest northwest of Cody, in the Black Hills National Forest east of Devils Tower and east of Sundance, in the Medicine Bow National Forest west of Laramie, and in the Laramie Range west of Wheatland and east of Laramie. Red-eyed Vireo winters in South America and rarely on the southern U.S. coastline [10, 11].

Habitat:
Across its range, Red-eyed Vireo breeds in deciduous and mixed deciduous-coniferous forests [12-16] with a dense understory of shrubs [13, 14, 17, 18]. In Wyoming, it prefers low elevation deciduous forests near water sources or openings in the interior forest canopy [19]. Within the Rocky Mountains, it breeds at elevations up to 2,000 m [20] and often breeds in Quaking Aspen (*Populus tremuloides*) groves and alder (*Alnus* spp.) thickets in northern portions of its range [21]. Additionally, Red-eyed Vireo can inhabit urbanized areas such city parks, residential areas, and cemeteries [16, 22]. Compared to the breeding season, Red-eyed Vireo uses a greater diversity of forested habitats during migration, although it still prefers deciduous over coniferous forests [3]. Red-eyed Vireo winters in South America in rain forests, plantations, xerophytic vegetation, and mangroves ranging from sea level to 3,000 m [23-26].

Phenology:
Red-eyed Vireo begins departing its breeding grounds in South America in March, and most individuals have left by late April [23, 25]. Migrants begin arriving in Wyoming in mid-May [19]. Females arrive 3–15 days after the first males, and pair formation occurs shortly thereafter [13]. Nest building occurs mid-April to early June, with each initial nest taking 4–5 days to complete [13, 14, 16]. After nest completion, eggs are laid within 1–4 days and require 3–4 days to complete the clutch [13, 14]. Clutch size ranges from 1–5 eggs. Incubation period is 12–14 days, with a 10–12 day nestling period [13, 14, 16, 27]. Chicks are altricial at hatching and leave the nest in 10–12 days [13, 14]. For breeding adults, the estimated probability of surviving to the following year is 0.53 [28]. The oldest known Red-eyed Vireo was at least 10 years old [29]. In the fall, migration occurs from mid- to late August, with most individuals departing by mid-September. Arrival in South America begins in September [23, 25]. Migratory movements are typically nocturnal [16, 30, 31].

Diet:
Red-eyed Vireo consumes primarily insects, particularly caterpillars [22, 32, 33]. In the late summer and fall, Red-eyed Vireo will also eat various small fruits [16, 22, 32, 34]. In winter, it becomes nearly completely frugivorous [25].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
Using North American Breeding Bird Survey (BBS) data, the Partners in Flight Science Committee estimated the global population of Red-eyed Vireo to be 180 million birds [35]. Approximately 0.04% of the global population, or around 70,000 birds, is estimated to breed in Wyoming [36]; however, this state abundance estimate is likely high and should be viewed with caution. The statewide rank of RARE is based on the limited area of the state known to be occupied in any given season, and the relatively small coverage of suitable habitat within that area. Within suitable habitat in the occupied area, Red-eyed Vireo appears to be uncommon, occurring in relatively low densities and requiring intensive survey efforts to detect the species [9]. There are no robust estimates of density for Red-eyed Vireo in Wyoming.

Population Trends:
Historic: UNKNOWN
Recent: DECLINING
Red-eyed Vireo population trend data from the BBS in Wyoming are available from 1968–2013, and suggest a decline of 5.82% annually (N = 13 routes, 95% CI: -9.54 to 2.07), although results are not statistically significant and fall within a regional credibility category containing data with deficiencies, so must be interpreted with caution [37]. Western region BBS data, however, indicate a statistically significant annual population decline of 3.09% (N = 220 routes; 95% CI: -3.69 to -2.49) [37].

Intrinsic Vulnerability:
LOW VULNERABILITY
Insect larvae (caterpillars) is a major food source for Red-eyed Vireo. Changes in abundance of this prey item such as through larvicide use, which has been shown to cause Red-eyed Vireo to pursue different prey items and expand their foraging area, could have detrimental effects on the species [38].

Extrinsic Stressors:
MODERATELY STRESSED
Stressors to Red-eyed Vireo include deforestation, nest parasitism, and collision mortality. In Ontario, there were fewer Red-eyed Vireos in areas with low forest cover, and individuals had more difficulty attracting mates [39]. It is likely that deforestation and habitat fragmentation could be a threat to this species in the long-term. Red-eyed Vireo is vulnerable to nest parasitism by Brown-headed Cowbird (*Molothrus ater*) [40], and in Colorado this parasitism is thought to be concentrated and sustained in areas occupied by domestic livestock [41]. Additionally, Red-eyed Vireo migrates nocturnally and is susceptible to mortality from collisions with buildings and towers [31]. At one television tower in Florida, Red-eyed Vireo was the bird species most often killed over a 29-year period [42].

KEY ACTIVITIES IN WYOMING

Red-eyed Vireo is listed as a Species of Greatest Conservation Need (SGCN) in Wyoming by the Wyoming Game and Fish Department. Current statewide efforts for monitoring annual detections and population trends of Red-eyed Vireo in Wyoming include the BBS program conducted on 108 established routes since 1968 [37], and the multi-partner IMBCR program initiated in 2009 [43]. Trend data are available on the U.S. Geological Survey BBS website [37], and occupancy, density, population estimates, and decision support tools are available through the Rocky Mountain Avian Data Center [43]. Although BBS data analyses are able to produce robust population trend estimates for Red-eyed Vireo in the western U.S., low sample sizes limit the usefulness of trend estimates for this species in Wyoming [37]. IMBCR density and population estimates for Red-eyed Vireo are similarly limited by low sample sizes in Wyoming [43].

ECOLOGICAL INFORMATION NEEDS

Additional information is needed on Red-eyed Vireo distribution and breeding status in Wyoming, especially in the northwestern portion of the state [19]. Limiting factors that may affect this species include habitat loss, degradation, and fragmentation, and incompatible forest management practices. It would be beneficial to ascertain the degree to which these factors affect Red-eyed Vireo in the state.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Red-eyed Vireo is classified as a SGCN in Wyoming due to insufficient information on breeding, distribution, and population status and trends; potential problems associated with habitat loss, degradation, and fragmentation; and incompatible forest management practices that could be problematic for this species. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming, the BBS [37] and the IMBCR [43]. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, survey efforts do not tend to detect Red-eyed Vireo at adequate levels, suggesting targeted, species-specific monitoring efforts may be needed.

CONTRIBUTORS

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Figure 1: Adult Red-eyed Vireo in Laramie County, Wyoming. (Photo courtesy of Pete Arnold)

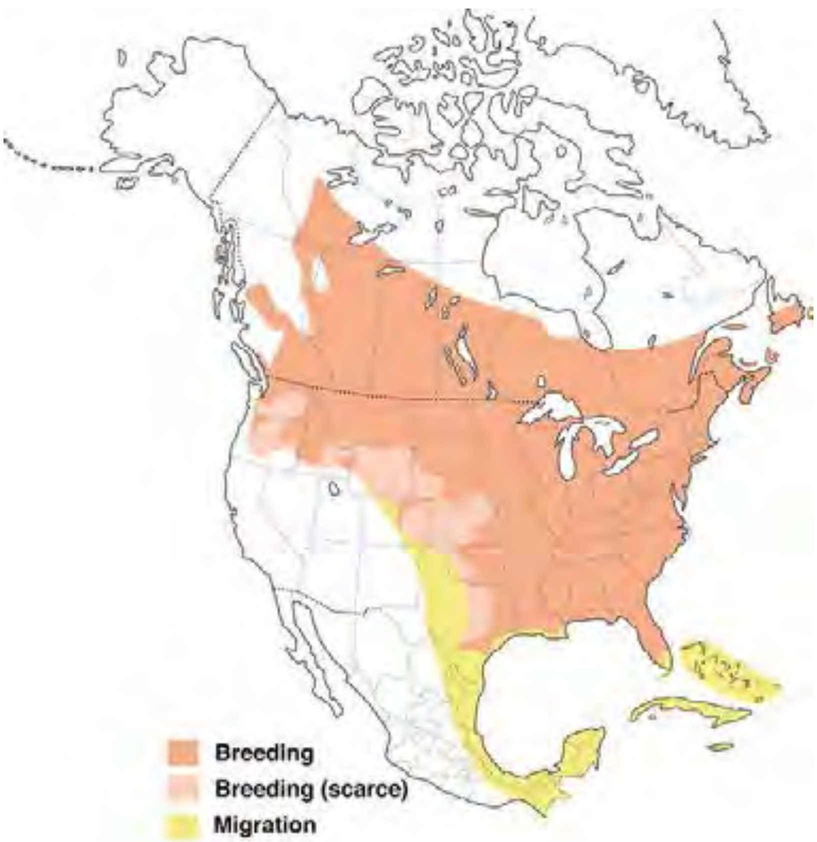
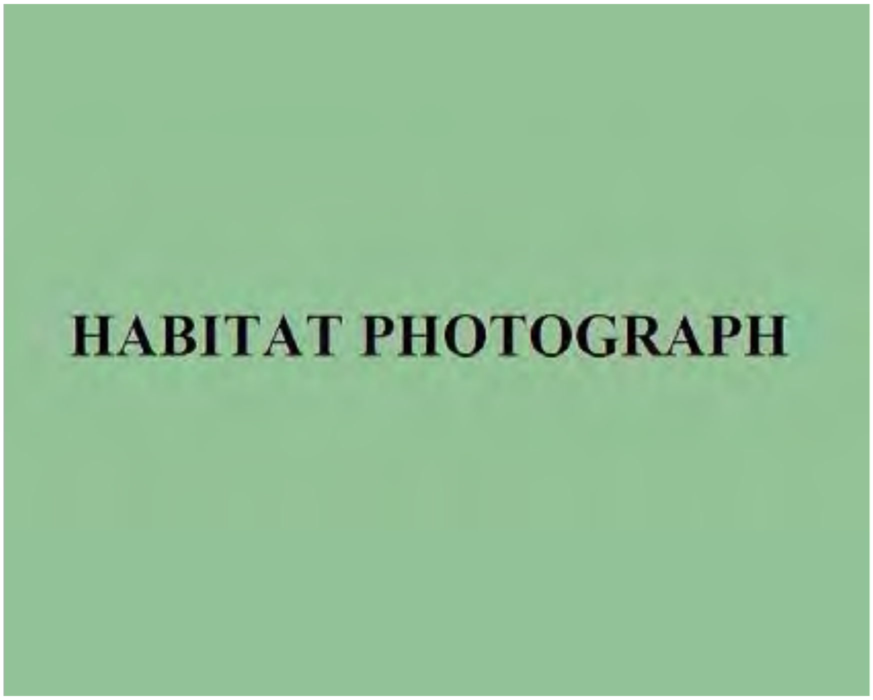


Figure 2: North American range of *Vireo olivaceus*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)



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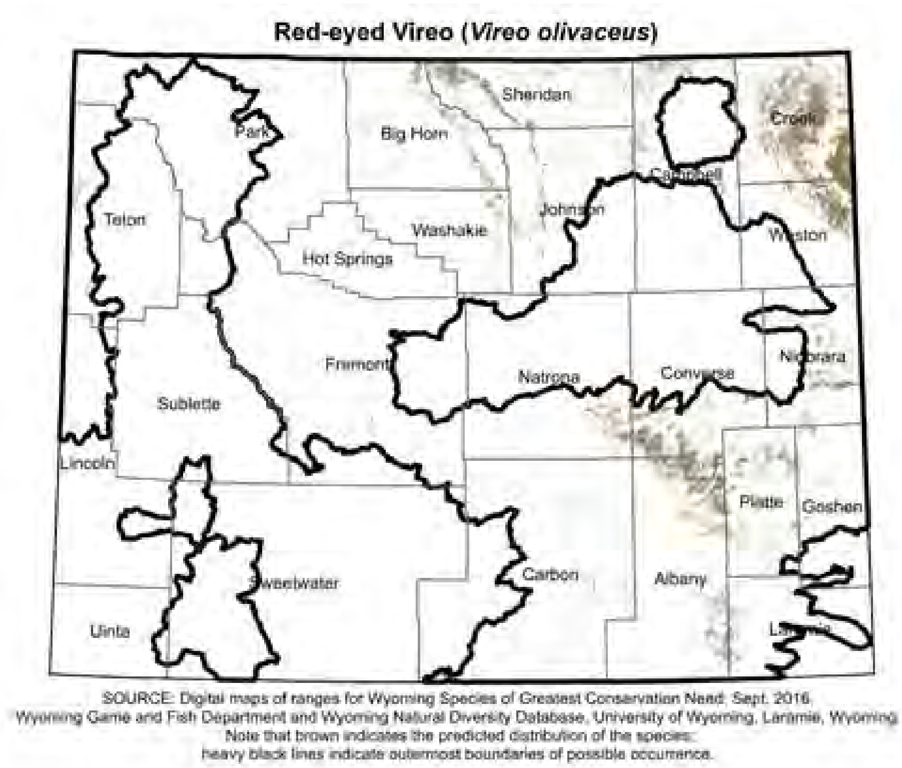

Figure 4: Range and predicted distribution of *Vireo olivaceus* in Wyoming.

Red-headed Woodpecker
Melanerpes erythrocephalus

Regulatory Status
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

Conservation Ranks
USFWS: Bird of Conservation Concern
WGFD: NSS4 (Bc), Tier II
WYNDD: G5, S2S3
Wyoming Contribution: LOW
IUCN: Near Threatened
PIF Continental Concern Score: 13

Status and Rank Comments
The Wyoming Natural Diversity Database has assigned Red-headed Woodpecker (*Melanerpes erythrocephalus*) a state conservation rank ranging from S2 (Imperiled) to S3 (Vulnerable) because of uncertainty about abundance and population trends in Wyoming.

Natural History

Taxonomy:
Red-headed Woodpecker is considered monotypic, with no subspecies currently recognized [1]. Geographic variation within the species is considered clinal.

Description:
Red-headed Woodpecker is easily identified in the field by bright crimson coloration that extends over the head, neck, throat, and upper breast. The underside of Red-headed Woodpecker is white. The dorsal coloration is black, with a large white patch on the wings extending across the secondaries and tertials [1]. The rump and upper tail coverts are also white. Adult male and female Red-headed Woodpeckers are identically colored. Juveniles are colored similar to adults; except the red head may vary from grayish brown to crimson. Juveniles additionally have a subterminal black band on the secondaries and dusky streaking on the flanks [1]. Adult overall body length averages 21 cm, with weight averaging 74 g [1]. Red-headed Woodpecker is unlikely to be confused with any other species within its Wyoming distribution.

Distribution & Range:
Red-headed Woodpecker ranges from the Atlantic Coast westward to the Rocky Mountains, and is primarily restricted to the United States. Red-headed Woodpecker can also be observed along the southern edge of the Canadian provinces Manitoba, Alberta, Ontario, and Quebec. It is considered a year-long resident in the midwestern, eastern, and southern states, and a breeding-only resident within the Great Plains and Great Lakes regions. The range of this species is

thought to be contracting as a result of population declines [1]. Red-headed Woodpecker has been documented in 25 of Wyoming's 28 latitude/longitude degree blocks, with confirmed or circumstantial evidence of breeding occurring in 11 of the 25 degree blocks [2]. Only 4 of the 25 degree blocks in which sightings have occurred include confirmed observations as accepted by the Wyoming Bird Records Committee (WBRC) [3]. The Wyoming range of this species occurs in eastern third of the state primarily below 6,500 ft [4].

Habitat:
Red-headed Woodpecker is found in wooded habitats that contain dead limbs or snags [1]. This species prefers larger trees, a moderate to open understory, high snag density, and mast producing trees. Red-headed Woodpecker may also be found in more open, disturbed habitats that retain snags, such as burns. Red-headed Woodpecker was found to utilize high intensity burned areas within the Black Hills National Forest [5], and has also been documented in pine (*Pinus* spp.) scrub, mixed pine, and hardwood forests; urban settings; savannahs; and wooded swamps [1]. Within Wyoming, Red-headed Woodpecker is found in open deciduous woodlands and Ponderosa Pine (*P. ponderosa*) forests that are associated with riparian zones [2, 4]. This species prefers larger forest blocks with numerous clearings [6], and can also be found in open farmlands and urban settings if snags are available. Red-headed Woodpecker is a cavity nester that utilizes dead trees and snags in habitats with little to no understory, and occasionally utility poles. Within Wyoming, nests were found on average 9.8 m from the ground with a nest opening of approximately 6.4 cm in diameter [6]. Both sexes excavate the nest cavity [1]. The nest cavity is typically gourd shaped and takes on average 12–17 days to create. Red-headed Woodpecker is known to reuse nesting cavities and shows fidelity to nest sites [1].

Phenology:
Red-headed Woodpecker is primarily diurnal. Migration patterns and movements of this species are variable and dependent on mast production [1]. In years when food is plentiful, Red-headed Woodpecker may remain in the northern portion of its range. If migration occurs, birds will move to the south and east out of the Great Plains and Great Lakes regions. There is evidence that extreme southwestern individuals will migrate to the north away from Texas and the Louisiana Coast [1]. In Wyoming, spring arrival of Red-headed Woodpecker is typically documented in early May [4], and breeding is thought to occur in mid-May or later [1]. The average clutch size is 5 eggs. The incubation period is 12–14 days long, with fledging occurring when young are 24–27 days old [1]. If a nest fails early in the season, Red-headed Woodpecker may renest. The species has been documented raising 2 broods in a year. In Wyoming, Red-headed Woodpecker does not have a distinct fall migration. Individuals are primarily absent by October, with a handful of reports documenting this species throughout the winter [4].

Diet:
Red-headed Woodpecker is omnivorous, feeding on hard nuts and seeds, fruit, insects, and other animal matter. Summer diet consists of 34% animal matter and 66% vegetable matter [1]. Summer animal matter intake is primarily insects. Red-headed Woodpecker has been documented hawking, gleaning, and excavating prey [1]. Winter diet consists primarily of hard mast. Red-headed Woodpecker is known to cache food in 2 phases [1]. Initially, food will be cached in a single area. This is often followed by scatter storage, where food items are placed individually throughout a territory [1].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
Using North American Breeding Bird Survey (BBS) data, the Partners in Flight (PIF) Science Committee estimated the global population of Red-headed Woodpecker to be 1.2 million birds [7]. Approximately 0.2% of the global population, or around 3,000 birds, is estimated to breed in Wyoming [8]; however, this abundance estimate should be viewed with caution given the low detection rate of this species in the state. The statewide rank of RARE is based on the limited area of the state known to be occupied in any given season, and the relatively small coverage of suitable habitat within that area. Within suitable habitat in the occupied area, Red-headed Woodpecker appears to be uncommon, occurring in relatively low densities and requiring intensive survey efforts to detect the species [2]. There are no robust estimates of density for Red-headed woodpecker in Wyoming.

Population Trends:
Historic: UNKNOWN
Recent: MODERATE DECLINE
Red-headed Woodpecker population trend data from the BBS in Wyoming are available from 1968–2013, and suggest a statistically insignificant decline of 1.77% annually (N = 26 routes, 95% CI: -4.98 to 1.48), although results fall within a regional credibility category containing data with deficiencies, so must be interpreted with caution [9]. However, 1966–2013 BBS trend analyses suggest statistically significant annual population declines of 2.48% (N = 1,851 routes, 95% CI: -2,81 to -2.16) across North America and 1.43% (N = 48 routes, 95% CI: -2.21 to -0.65) in Nebraska [9].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
The nesting requirements and habitat preferences of Red-headed Woodpecker makes it vulnerable to changes in habitat. Red-headed Woodpecker is an obligate cavity nester, and the loss of nesting habitat throughout its range has resulted in habitat shifts to suboptimal conditions, and consequent reduction of reproductive success in some areas [10]. Utilization of utility poles treated with creosote has led to reproductive failure due to environmental toxins [11]. One study observed that all young in telephone pole cavities perished by the third day after hatching due to the possible toxic effects of creosote. Feeding behavior and a propensity to fly low across roads makes this species vulnerable to road mortality [1, 12].

Extrinsic Stressors:
MODERATELY STRESSED
Red-headed Woodpecker is largely impacted by habitat loss and degradation. Historic habitat for this species has disappeared on the landscape due to changes in habitat management and fire suppression [1]. Loss of oak-savannas, small orchards, riparian corridors, and hedgerows has likely lead to population declines. Red-headed Woodpecker has shown shifts in habitat away from open situations, and has been observed to nest in closed canopy habitats [10]. However, the use of these habitats is associated with higher levels of nest failure and is considered suboptimal. In addition to nest failure, utilization of utility poles is seen as a human nuisance. Some regions of the United States are documented to lethally remove nuisance woodpeckers [1]. Red-headed Woodpecker was historically shot for its bright plumage [1].

KEY ACTIVITIES IN WYOMING

Red-headed Woodpecker is listed as a Species of Greatest Conservation Need (SGCN) in Wyoming by the Wyoming Game and Fish Department (WGFD), and as a Wyoming PIF Level III Priority Species [13]. Although BBS population trend estimates are available for Red-headed Woodpecker, data for Wyoming contain deficiencies which limits the usefulness of estimates for the state [9]. The IMBCR program has similarly low detections of Red-headed Woodpecker in Wyoming, with only 37 detections since the program's inception in 2009 (range 0–18 detections per year) [14]. No targeted, systematic surveys of Red-headed Woodpecker has been conducted in Wyoming. Nesting studies have been completed within eastern Wyoming, examining response to burns and general nesting behavior. Observations of Red-headed Woodpecker are reported to the WGFD and vetted through the WBRC. Red-headed Woodpecker is a species for which the WBRC requests documentation on first latitude/longitude degree block sightings and all nesting observations.

ECOLOGICAL INFORMATION NEEDS

Populations of the Red-headed Woodpecker may be declining in Wyoming; however, more robust data are needed to determine population trends within the state. More information is needed regarding impacts of land management activities on Red-headed Woodpecker breeding and survival, and potential impacts of herbicides, pesticides, and climate change on the species.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Red-headed Woodpecker is classified as a SGCN in Wyoming. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [9] and the multi-partner IMBCR [14]. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, survey efforts do not tend to detect Red-headed Woodpecker at adequate levels, suggesting targeted, species-specific monitoring efforts are needed. Wyoming management priorities for the species in the short-term will focus on addressing these data deficiencies. Information should be gathered on Red-headed Woodpecker presence, distribution, population status, and the impact of potential threats. Any information gathered will ultimately be used to develop management and conservation recommendations for this species in the state. Best management practices to benefit Red-headed Woodpecker includes maintaining open riparian and Ponderosa Pine woodland habitats, particularly those with mature trees; managing for a mosaic of large trees with open canopies and clusters of snags where this species occurs; retaining mature and decadent trees for future snag production; using forestry practices, such as prescribed fire and staggered planting, to maintain open stands of forests and woodlands where Red-headed Woodpecker occurs; limiting insecticide use in woodland habitats to ensure a food source for this species (and other insectivores); and controlling or removing European Starling (*Sturnus vulgaris*) where Red-headed Woodpecker occurs to eliminate competition for cavity nests [13].

CONTRIBUTORS

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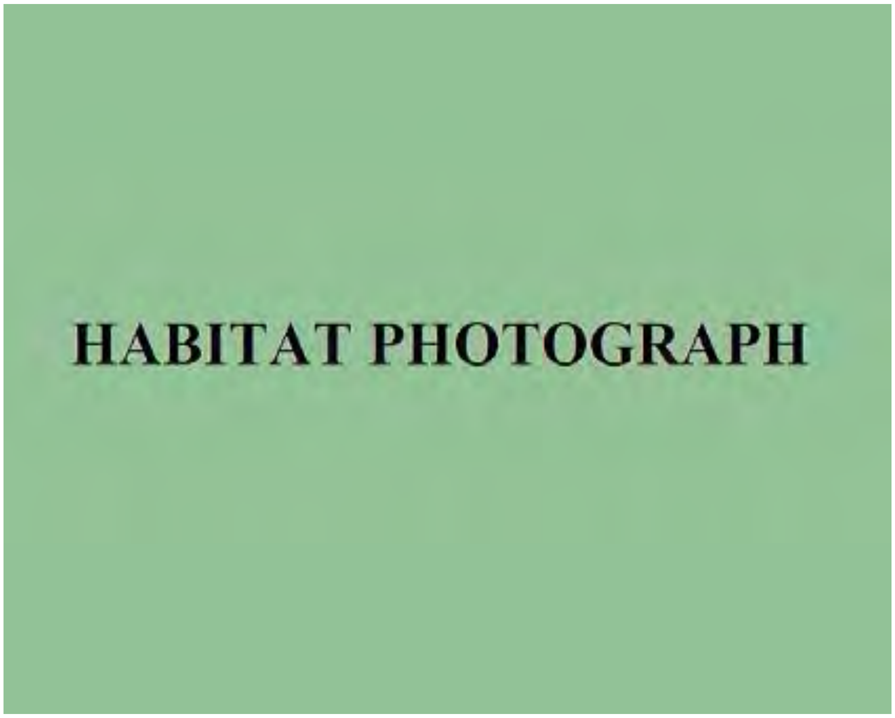
Figure 1: Adult Red-headed Woodpecker in Laramie County, Wyoming. (Photo courtesy of Pete Arnold)

Figure 2: North American range of *Melanerpes erythrocephalus*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)



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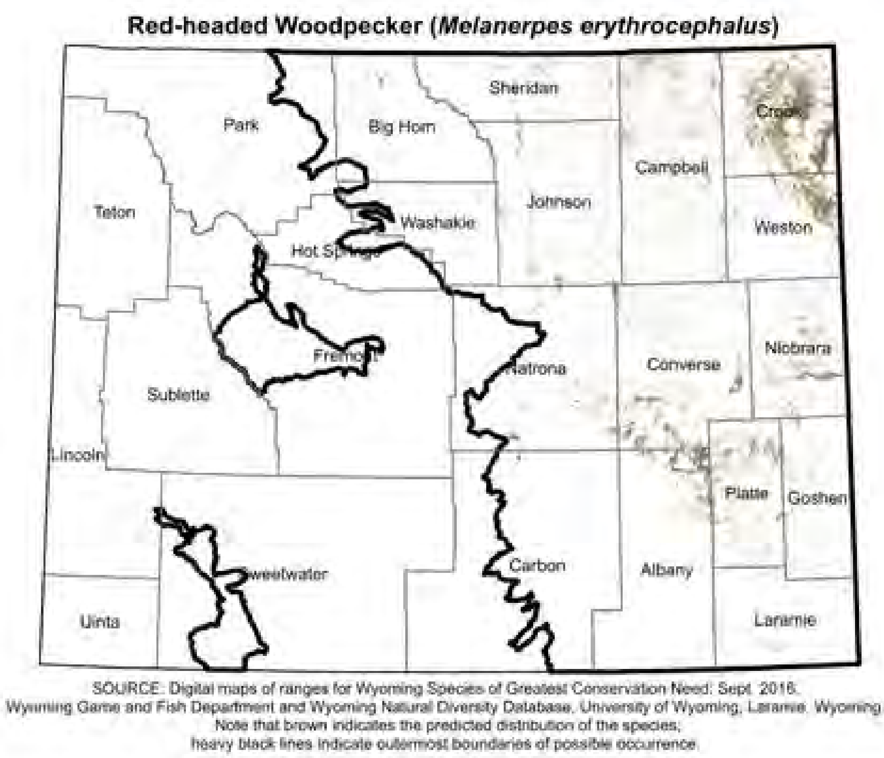

Figure 4: Range and predicted distribution of *Melanerpes erythrocephalus* in Wyoming.

Rufous Hummingbird

Selasphorus rufus

REGULATORY STATUS

USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS4 (Bc), Tier II
WYNDD: G5, S3
    Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 13

STATUS AND RANK COMMENTS

Rufous Hummingbird (*Selasphorus rufus*) does not have any additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:

Rufous Hummingbird is considered monotypic and has no geographic variation in physical appearance [1]. Rufous Hummingbird is most closely related to Allen's Hummingbird (*S. sasin*) [1], which does not occur in Wyoming. However, it is suspected that hybridization may occur in these species where their ranges overlap [1, 2].

Description:

Identification of Rufous Hummingbird is possible in the field. Adults have an average total length of approximately 10 cm and a wingspan of approximately 11 cm [1, 3]. As the name implies, males are primarily rusty orange in color with a white breast; green forehead and shoulders; black wings and tail tip; and orange to scarlet iridescent gorget [4]. Adult females have green upperparts; orange on the flanks and at the base of the tail; a white breast; and a white throat that can be streaked or spotted with bronze or green, sometimes with a small cluster of iridescent orange-red feathers. Juvenile Rufous Hummingbirds resemble females, but the uppertail coverts are mostly rufous [1]. Male Rufous Hummingbirds are unlikely to be confused with any other species in Wyoming. Females are similar in appearance to female Broad-tailed Hummingbirds (*S. platycercus*); however, female Broad-tailed Hummingbirds have a light eye-ring and less extensive orange on the tail [4].

Distribution & Range:

Rufous Hummingbird's breeding range extends from southern Alaska, southeast to central Montana, south through northwestern Wyoming, and west to the Oregon coast. Within

Wyoming, it is uncertain if Rufous Hummingbird is a regular breeder [5], but the species is known to regularly pass through Wyoming during fall migration. This species can be found in mountain and foothills habitats, but may be absent from the Black Hills [5]. Rufous Hummingbird is observed less frequently in lower elevations, including southeastern Wyoming. Rufous Hummingbird has been documented in 24 of Wyoming's 28 latitude/longitude degree blocks [6]. Confirmed breeding has been documented within latitude/longitude degree blocks 1 (Yellowstone area), 2 (Cody area), 8 (Jackson area), and 23 (Green River area). Most occurrences in the state likely represent fall migrants. Winter range occurs in Baja, California and southern mainland Mexico [3], but individuals are often noted outside of this accepted range. Wintering Rufous Hummingbirds are being observed more commonly in the southeastern U.S. along the Gulf of Mexico [1, 7, 8].

Habitat:

Rufous Hummingbird uses a broad range of habitats across its continental distribution. Within its breeding range, the species primarily utilizes secondary succession communities and openings [1]. However, Rufous Hummingbird has also been documented in mature forests, parks, and residential areas. In Wyoming, the species inhabits riparian shrublands; mountain-foothills grasslands; and wet-moist meadows within coniferous forests, aspen stands, and mountain-foothills shrublands [6]. Occupied habitats typically have, or are adjacent to areas with, abundant nectar-producing flowers [3]. Rufous Hummingbird nests are hemispherical cup-shaped, approximately 5 cm in outer diameter, and lined with downy plant materials. Nests may also be decorated with lichens, moss, or bark fragments anchored by cobwebs [1, 9]. During spring and fall migration, Rufous Hummingbird can be found primarily in montane meadows and other disturbed areas with abundant food sources.

Phenology:

Rufous Hummingbird is primarily diurnal. The migratory pathway of Rufous Hummingbird can be described as a clockwise pattern. Rufous Hummingbird's spring migration occurs along the Pacific coast [1]. These northerly spring migrations typically miss Wyoming [5]. Southerly fall migrations occur inland along the highlands of the Rocky Mountains. All migrations are timed ideally with floral phenology, occurring when flowers are open [1]. Rufous Hummingbird makes the longest migration of any hummingbird species [10]. Males tend to arrive on the breeding grounds several days before females [1]. The earliest observation of Rufous Hummingbird in Wyoming is 5 May [5]. However, this species is commonly observed in the Jackson region around mid-May. Males typically begin breeding displays as soon as females arrive on the breeding grounds, and continue to display until they leave for migration [1]. Females begin building nests within 3 days of their arrival at breeding habitats [1]. Females lay 2 eggs per clutch and may re-nest if the clutch is lost. The incubation period for Rufous Hummingbird is approximately 16 days [1]. Fall migration typically occurs in August [5]. There are a few September reports of Rufous Hummingbird in Wyoming, with the latest accepted date occurring on 14 September.

Diet:

The primary diet of Rufous Hummingbird consists of floral nectar and small insects that are aerially hawked or gleaned from vegetation [1, 11]. The species will also use residential hummingbird feeders and may consume tree sap from sapsucker (*Sphyrapicus* spp.) wells [1, 12].

Conservation Concerns

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
Using North American Breeding Bird Survey (BBS) data, the Partners in Flight Science Committee estimated the global population of Rufous Hummingbird to be 11 million birds [13]. Approximately 0.014% of the global population, or around 1,500 birds, is estimated to breed in Wyoming [14]. The statewide rank of RARE is based on the rather small area of the state known to be occupied in any given season, and the small coverage of suitable habitat within that area. However, within suitable habitat in the occupied area, Rufous Hummingbird appears to be common and is usually encountered during surveys that could be expected to indicate its presence [6]. From 2009–2015, only 13 Rufous Hummingbirds were detected on Integrated Monitoring in Bird Conservation Regions (IMBCR) survey grids in Wyoming [15].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Currently, there are no robust BBS population trend data available for Rufous Hummingbird in Wyoming due to a limited distribution in the state and low detection rates during monitoring surveys [16]. However, 1968–2013 BBS trend analyses indicate a statistically significant annual population decline of 2.10% (*N* = 348 routes; 95% CI: -2.70 to -1.50) in the Western Region [16].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
As a primarily nectivorous species, Rufous Hummingbird is dependent on floral abundance. Artificial feeders can supplement food during periods of flower unavailability [1]. Rufous Hummingbird winters in Central America, and availability of food sources and fat reserves during migration may directly impact migrating individuals.

Extrinsic Stressors:
MODERATELY STRESSED
Rufous Hummingbird is largely impacted by changes in flower abundance [1]. Forest management, weather variation, and disease can alter abundance of floral food sources. Habitat alteration and changes in land use are considered the major threats to hummingbird conservation [17]. Pesticide application, herbicide use, and climate change may impact populations of Rufous Hummingbird.

Key Activities in Wyoming

Rufous Hummingbird is listed as a Species of Greatest Conservation Need (SGCN) in Wyoming by the Wyoming Game and Fish Department, and as a Level II Priority Species requiring monitoring action in the Wyoming Bird Conservation Plan [18]. Annual statewide songbird monitoring efforts do not adequately detect Rufous Hummingbird. The BBS program is conducted on routes statewide; however, only 16 Rufous Hummingbirds have been reported since the survey was initiated in 1968 [16]. Similarly, only 13 Rufous Hummingbirds have been detected during IMBCR surveys through 2015 [15]. No additional, targeted, systematic survey of Rufous Hummingbird has been conducted in Wyoming.

ECOLOGICAL INFORMATION NEEDS

More information is needed to determine the breeding range and status of Rufous Hummingbird in Wyoming [5]. Additional natural history information is needed for this species, including home range size, impacts of land management activities on breeding and survival, direct and indirect impacts of herbicides and pesticides, and potential responses to changing floral phenology due to climate change. The use of pesticides, herbicides, or other activities that reduce nectar producing plants and insect food sources could impact populations [3]. Long-term effects of deforestation and climate change are unknown [1].

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Rufous Hummingbird is classified as a SGCN in Wyoming due to range-wide population declines, and possible population effects from climate change and forest management practices. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [16] and the multi-partner IMBCR [15]. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, survey efforts do not tend to detect Rufous Hummingbird at adequate levels, suggesting targeted, species-specific monitoring efforts are needed. Management priorities for the species in the short-term will focus on addressing data deficiencies. Information should be gathered on Rufous Hummingbird presence, distribution, population and nesting status, specific habitat requirements, and the impact of potential threats. Any information gathered will ultimately be used to develop management and conservation recommendations for this species. Best management practices to benefit Rufous Hummingbird includes maintaining a mosaic of mixed coniferous forests, meadows, and riparian shrubland habitats within this species' range in Wyoming [18].

CONTRIBUTORS

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Figure 1: Adult male (left) and female (right) Rufous Hummingbirds at a feeder in Durango, Colorado. (Photos courtesy of Bill Schmoker)

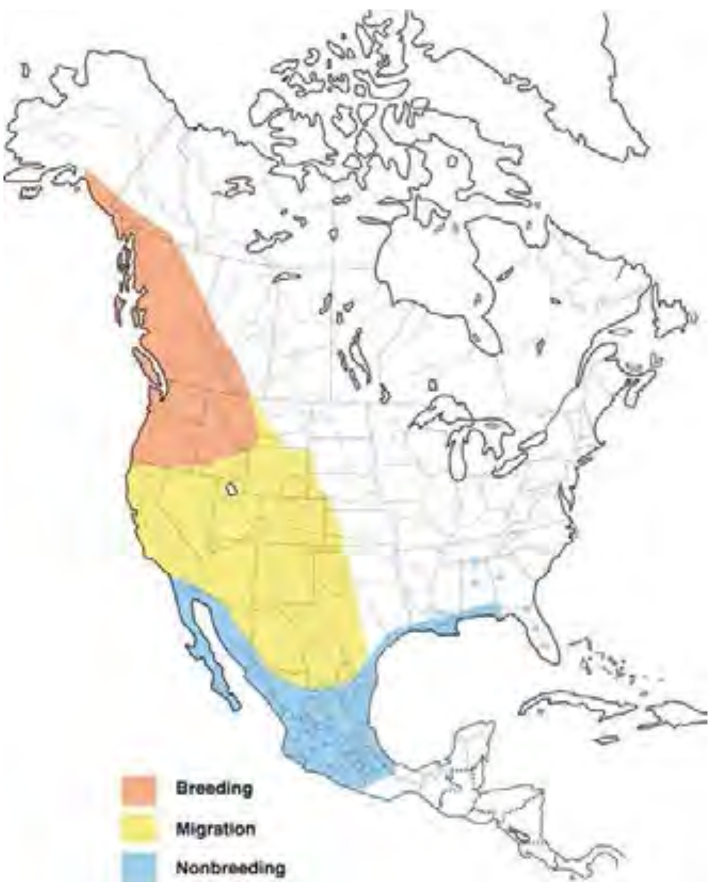

Figure 2: North American range of *Selasphorus rufus*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

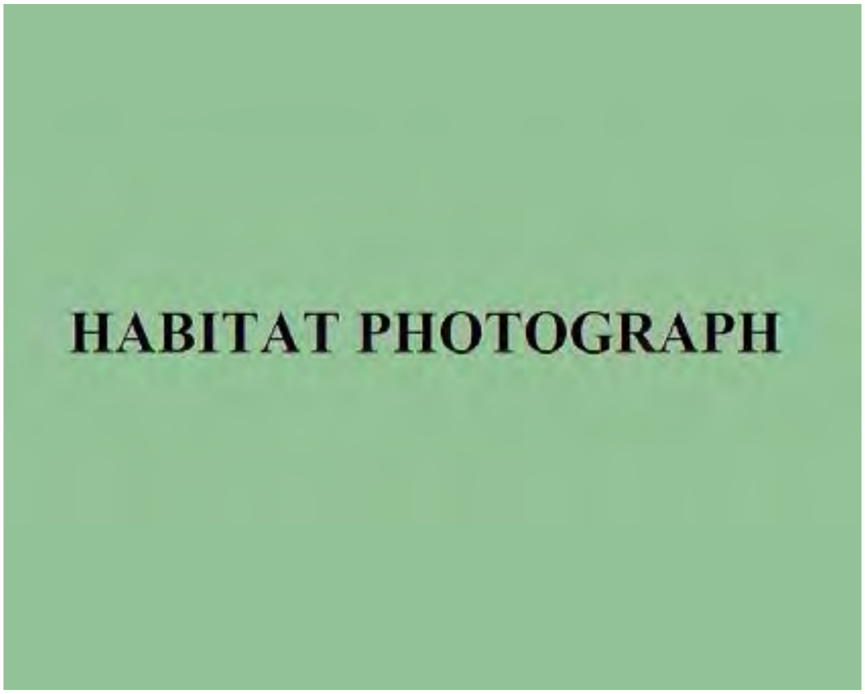

Figure 3: Photo not available.

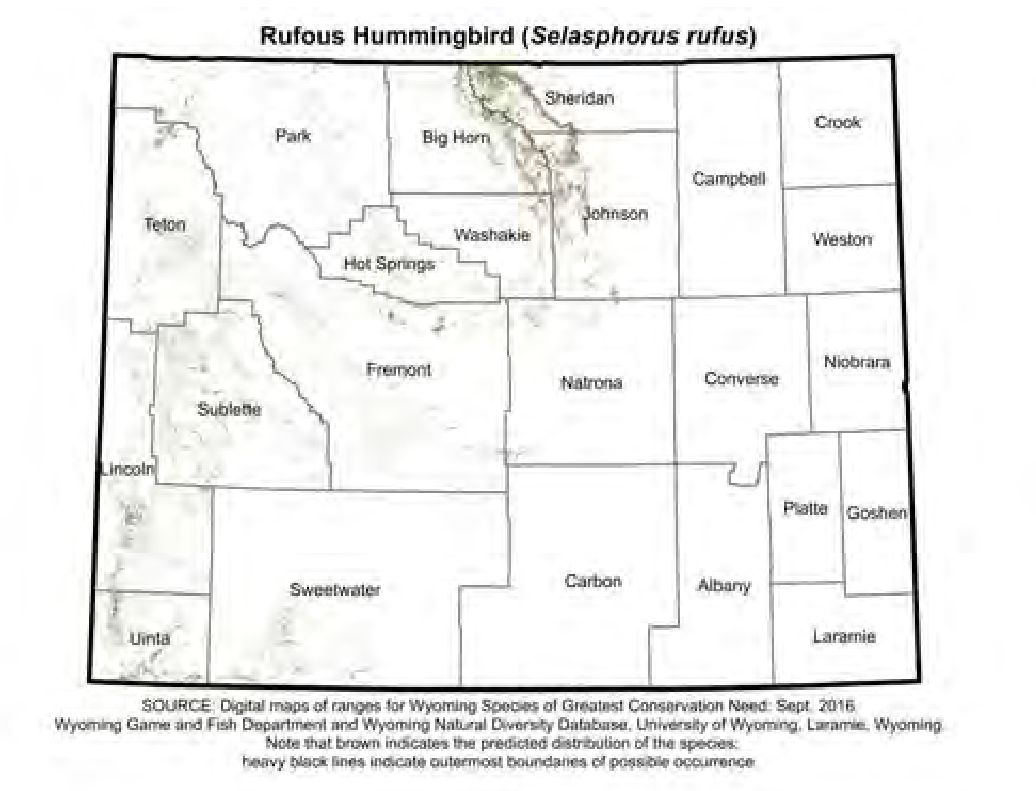

Figure 4: Range and predicted distribution of *Selasphorus rufus* in Wyoming.

Sagebrush Sparrow

Artemisiospiza nevadensis

Regulatory Status

USFWS: Migratory Bird
USFS R2: Sensitive
USFS R4: No special status
Wyoming BLM: Sensitive
State of Wyoming: Protected Bird

Conservation Ranks

USFWS: Bird of Conservation Concern
WGFD: NSS4 (Bc), Tier II
WYNDD: G5, S3S4
Wyoming Contribution: HIGH
IUCN: Least Concern
PIF Continental Concern Score: 11

Status and Rank Comments

The Wyoming Natural Diversity Database has assigned Sagebrush Sparrow (*Artemisiospiza nevadensis*) a state conservation rank ranging from S3 (Vulnerable) to S4 (Apparently Secure) because of uncertainty about the abundance and population trends of this species in Wyoming.

Natural History

Taxonomy:

In 2013, Sage Sparrow (*Artemisiospiza belli*, previously *Amphispiza belli* [1]) was split into two species based on genetic evidence and differences in ecology and morphology: Sagebrush Sparrow (*Artemisiospiza nevadensis*) and Bell's Sparrow (*Artemisiospiza belli*) [2, 3]. Only Sagebrush Sparrow is found in Wyoming. Due to the extremely recent nature of this taxonomic revision, most of the references cited in this account refer to Sage Sparrow as it was recognized before the split. There are currently no recognized subspecies of Sagebrush Sparrow [4].

Description:

Identification of Sagebrush Sparrow is possible in the field. Adults weigh between 15.3–21.9 g, range in length from 12.1–15.0 cm, and have a wingspan of approximately 21.0 cm [3, 5]. The sexes are similar in appearance, but males are larger than females [3]. Adults have a pale grey head; black eyes with a complete white eye ring; white spots above the lores; white malars; gray bill; white throat and whitish underparts with an isolated dark spot on the breast; pale grayish brown upperparts with dark streaking on the mantle; dark brown tail; and brown legs [3, 5]. Sagebrush Sparrow is similar in size and appearance to several other sparrow species in its range. Unlike Sagebrush Sparrow, Brewer's Sparrow (*Spizella breweri*) has indistinct facial markings and an unmarked breast, Vesper Sparrow (*Pooecetes gramineus*) has vertical dark streaking on the breast, and Lark Sparrow (*Chondestes grammacus*) has bold black, white, and rufous facial markings [5].

Distribution & Range:
The breeding and year round distribution of Sagebrush Sparrow is spread widely across the Great Basin and interior western United States, while that of Bell's Sparrow is restricted to parts of California, San Clemente Island, and the Baja Peninsula [2]. The breeding ranges of these two species overlap in eastern California; however, interbreeding is believed to be limited [2, 6, 7]. Sagebrush Sparrow migrates through Wyoming in the spring and fall and is a summer resident [8, 9]. It has been observed across most of the state [8], but is most abundant in the southwestern counties [9]. Confirmed and suspected breeding has been documented in 17 of the 28 latitude/longitude degree blocks [8]. Sagebrush Sparrow winters in the southwestern United States, and south to central Baja California and northern mainland Mexico [2].

Habitat:
Sagebrush Sparrow is a sagebrush-obligate species that breeds preferentially in arid shrublands dominated by Big Sagebrush (*Artemisia tridentata*) [3, 9]. This species will breed in both pure sagebrush stands and those mixed with other arid shrub species such as Antelope Bitterbrush (*Purshia tridentata*), rabbitbrush (*Chrysothamnus* and *Ericameria* spp.), saltbush (*Atriplex* spp.), and Greasewood (*Sarcobatus vermiculatus*) [3]. Sagebrush Sparrow is typically found in sagebrush shrublands with tall, robust shrubs interspersed with open areas and limited herbaceous groundcover [3, 9]. Most nest sites are located in shrubs, especially those that are tall and healthy, with large canopies and at least 75% live foliage; however, this species may occasionally nest beneath shrubs or in clumps of bunchgrass [3]. Females construct open cup nests out of twigs, grasses, and other plant material, and may line the inside with feathers and animal hair [3].

Phenology:
Spring arrival of migrating and breeding Sagebrush Sparrow in Wyoming occurs from mid- to late March, and peaks in April [9]. Most clutches are likely initiated from early April through mid-June. Clutch size ranges from 1–4 eggs, with most containing 3 eggs [3]. Eggs hatch after being incubated by the female for 10–16 days, and young fledge 9 or 10 days after hatching [3]. Sagebrush Sparrow typically has 2 broods per year, although some pairs may raise 3 broods in a single breeding season [3]. The timing of fall migration from Wyoming to wintering grounds is not well known [9].

Diet:
During the breeding season Sagebrush Sparrow is omnivorous, foraging on the ground around shrubs for insects and spiders, larvae, seeds, fruits, and succulent leaves [3]. This species is granivorous in the non-breeding season, but will opportunistically consume insects in addition to a main diet of seeds and plant matter [3].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: COMMON
In 2013, Partners in Flight estimated that Sage Sparrow (i.e., combined populations of the currently recognized Sagebrush Sparrow and Bell's Sparrow, prior to the taxonomic split) had a global population of approximately 4 million individuals and a Wyoming population of approximately 400,000 [10]; however, this abundance estimate is based primarily on Breed Bird Survey (BBS) data and should be viewed with caution. The species has an estimated statewide abundance rank of COMMON and also appears to be common within suitable environments in

the occupied area [8]. From 1968–2015, annual Wyoming BBS detections of Sagebrush Sparrow ranged from 1 to 664 (average = 224), with 278 recorded in 2015 [11]. Annual detections of Sagebrush Sparrow ranged from 290 to 567 during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [12]. Estimated mean density across this same time period was 4.60 birds per km^2 (standard deviation 1.40, standard error 0.53) in suitable habitats in Wyoming [12].

Population Trends:
Historic: UNKNOWN
Recent: STABLE
Like other sagebrush-obligate birds in North America, Sagebrush Sparrow appears to be declining across much of its continental distribution, with especially large, significant declines recorded in Idaho and Oregon [13, 14]. However, Wyoming trend data from the North American BBS indicate that Sagebrush Sparrow numbers experienced a statistically significant annual increase of 1.98% from 1968–2013 and a non-significant annual increase of 2.10% from 2003–2013 [13]. Survey-wide BBS trend data indicate that Sage Sparrow (*A. belli*) declined annually by 0.67% from 1966–2013 and 0.13% from 2003–2013; however, neither trend estimate was statistically significant [13].

Intrinsic Vulnerability:
HIGH VULNERABILITY
Sagebrush Sparrow has high intrinsic vulnerability in Wyoming because it is restricted to a narrow range of habitats. As a sagebrush-obligate species it is likely to be affected, either directly or indirectly, by any natural or anthropogenic stressors that negatively impact sagebrush shrublands in Wyoming.

Extrinsic Stressors:
MODERATELY STRESSED
Sagebrush Sparrow is moderately stressed by extrinsic stressors in Wyoming. Sagebrush habitat is threatened across the western United States, primarily due to anthropogenic activities [14]. Sagebrush shrublands are the predominant habitat type in Wyoming, but they are increasingly vulnerable to development for energy and infrastructure, the spread of invasive plant species, encroachment by native conifer species, disturbance from off-road recreational activities, drought and climate change, and conflicting management goals and practices [14, 15]. A majority of Wyoming's oil and natural gas development occurs in sagebrush habitats [14]. Multiple studies have identified negative direct and indirect effects of energy development on breeding Sagebrush Sparrows in the state, including decreased abundance [16-18], decreased daily nest survival [16, 19, 20], increased risk of nest predation by rodents [19, 21], and decreasing occupancy at the landscape scale with increasing road density [22]. However, Sagebrush Sparrow landscape-scale occupancy was actually positively associated with well pad density at one natural gas field in southern Wyoming [22]. Invasive plant species such as Cheatgrass (*Bromus tectorum*) can fill in the understory and open areas between shrubs, potentially reducing foraging habitat and food availability for Sagebrush Sparrow [23], and can alter natural fire regimes leading to reduced sagebrush cover on the landscape [14, 24]. As a sagebrush-obligate species that preferentially selects large, mature shrubs for nesting, Sagebrush Sparrow will likely respond negatively to disturbance events and management activities that substantially reduce sagebrush cover and the availability of mature shrubs [23-26]. This species has also shown sensitivity to habitat fragmentation [27, 28].

KEY ACTIVITIES IN WYOMING

Sagebrush Sparrow is classified as a Species of Greatest Conservation Need (SGCN) by the Wyoming Game and Fish Department (WGFD), and as a Level I Priority Bird Species requiring conservation action in the Wyoming Bird Conservation Plan [29]. Current statewide activities for monitoring annual detections and population trends for Sagebrush Sparrow in Wyoming include the BBS program conducted on 108 established routes since 1968 [13], and the multi-agency IMBCR program initiated in 2009 [12]. In 2004 and from 2008 to present, the WGFD has funded graduate research at the University of Wyoming, in conjunction with the Wyoming Cooperative Fish and Wildlife Research Unit, to examine potential effects of oil and natural gas development on Sagebrush Sparrow and other sagebrush-obligate songbirds in Wyoming [16-21]. From 2011 to present, the WGFD has funded graduate research to determine if state-wide efforts to conserve the Greater Sage-Grouse (*Centrocercus urophasianus*) may simultaneously benefit other SGCN species, including Sagebrush Sparrow [30]. In 2016, the WGFD funded an additional project to examine the effects of climate on nongame sagebrush bird demography and populations. Field work is scheduled to begin in 2017. The United States Bureau of Land Management funded research from 2010–2012 to examine the potential effects of natural gas extraction infrastructure (i.e., roadways and well pads) on the distribution of sagebrush-obligate songbirds, including Sagebrush Sparrow, at a natural gas field in southern Wyoming [22].

ECOLOGICAL INFORMATION NEEDS

Past and current research on Sagebrush Sparrow in Wyoming has focused on anthropogenic disturbance and the direct and indirect effects of various forms of energy development. Sagebrush Sparrow would benefit from research to determine its detailed distribution and actual abundance in the state, as well as how the species may be impacted by current and future management activities aimed at improving and conserving sagebrush habitat for livestock and wildlife (e.g., burning, chemical treatments, mowing, etc.).

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Zachary J. Walker. Sagebrush Sparrow is classified as a SGCN in Wyoming due to habitat loss and fragmentation. Currently, there are two separate but compatible survey programs in place to monitor populations of many avian species that breed in Wyoming. The first is the long-term BBS started in Wyoming in 1968 with 108 established routes in Wyoming [13]. Species must be detected on at least 14 routes for data analyses to be significant for tracking population status and trend over time. The IMBCR program was established in 2009 in Wyoming with many state, federal, and nongovernmental organization partners that contribute funding, field personnel, technical assistance, or in-kind services. Data analyses produce density, occupancy, and population estimates at various scales; present habitat associations; and provide decision support tools for managers [12]. It is recommended that these survey programs be continued into the future. If population declines are detected in Sagebrush Sparrow populations, targeted surveys should be conducted. Results from completed research should be used to refine management practices. Land managers should work to maintain large blocks of unfragmented sagebrush where Sagebrush Sparrow is known to breed. Habitats should include a variety of shrub cover of varying heights with a high level of live canopy foliage. Habitats should be managed to avoid conflicts with incompatible land use practices and to reduce the risk of fire.

Contributors

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Figure 1: Adult Sagebrush Sparrow in Sweetwater County, Wyoming. (Photo courtesy of Shawn Billerman)

Figure 2: North American range of *Artemisiospiza nevadensis*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Wyoming Big Sagebrush habitat in Sweetwater County, Wyoming. (Photo courtesy of Ian M. Abernethy)

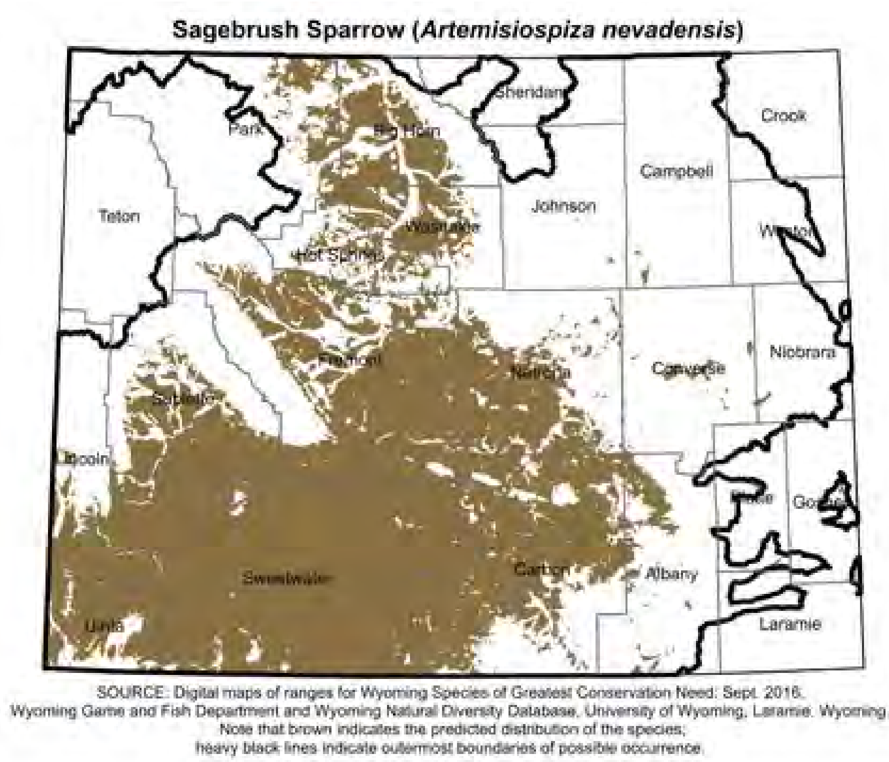

Figure 4: Range and predicted distribution of *Artemisiospiza nevadensis* in Wyoming.

Sage Thrasher

Oreoscoptes montanus

REGULATORY STATUS

USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: Sensitive
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: Bird of Conservation Concern
WGFD: NSS4 (Bc), Tier II
WYNDD: G4, S5
    Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 11

STATUS AND RANK COMMENTS

Sage Thrasher (*Oreoscoptes montanus*) has no additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:

There are currently no recognized subspecies of Sage Thrasher [1, 2]. On average, northern populations have longer tails than southern populations, indicating slight phenotypic differences between populations [1]. Beyond this, there is no evidence supporting subspecific designation.

Description:

Identification of Sage Thrasher is possible in the field. Sage Thrasher is a medium sized passerine and is the smallest thrasher species [1]. Males are slightly larger than females, but plumage is similar for both sexes [1]. Adults are generally drab brown-grey. The head is characterized by an indistinct whitish supercilium, whitish leading edge of the nape, and whitish malar with thin black submoustachial stripe. Underside is lighter and breast, sides, flanks, and belly have distinct dark streaking. Back and wings are brown-grey. Wings have two narrow, crisp wing-bars [1, 3, 4]. Juveniles are similar in appearance, paler overall with less distinct streaking on underside [1, 3, 4]. The species is distinguished from other thrashers by its smaller size and short, straight bill [1]. Sage Thrasher is similar in appearance to Bendire's Thrasher (*Toxostoma longirostre*). Bendire's Thrasher has small triangular spots on its breast while Sage Thrasher has streaks on its breast and crisp white wing-bars [4].

Distribution & Range:

Sage Thrasher breeds from northern New Mexico and Arizona north to extreme southern British Columbia. Wyoming constitutes a relatively large portion of the breeding range and marks the northeastern edge of summer range. Confirmed or suspected breeding has been documented in all of the state's 28 latitude/longitude degree blocks [5]. Sage Thrasher migrates south and winters in the southwestern United States, central Mexico, and Baja Peninsula. There are no known range contractions or expansions. But local extinctions have been observed in some areas that have undergone significant habitat alteration [1].

Habitat:
Sage Thrasher is considered a sagebrush obligate species [1, 3]. In Wyoming and other parts of its range, the species is found in shrubsteppe habitats dominated by big sagebrush (*Artemisia* spp.). The species is occasionally found nesting in desert shrublands with Black Greasewood (*Sarcobatus vermiculatus*), rabbitbrush (*Chrysothamnus* spp.), and Bitterbrush (*Purshia tridentata*) [3]. In other portions of their range, they may be found in semi-arid grasslands and juniper woodlands [3]. Sage Thrasher typically nests in large, healthy sagebrush shrubs. Shrubs greater than 70 cm in height and with greater than 75% living canopy are generally selected for nesting [3]. Additionally, Sage Thrasher is typically associated with areas of higher than average cover and height of sagebrush shrubs [3]. In Wyoming, Sage Thrasher is most common in areas with contiguous tracts of healthy sagebrush steppe. Specifically, Sage Thrasher is common in the Upper Green River Basin, Great Divide Basin, and Big Horn Basin. Habitat use during migration and non-breeding season is more general than during breeding [1, 3]. Sage Thrasher is still typically found in shrubsteppe habitats including mixed desert shrublands, arid grasslands with shrub cover, and open pinyon-juniper woodlands [1, 3].

Phenology:
Sage Thrasher arrives in Wyoming in mid to late March and departs for wintering grounds in August through early October [1]. In Wyoming, Sage Thrasher establishes territories and nest shortly after arriving in the breeding range [1]. Inter-annual timing of seasonal migration and nesting is dependent upon weather conditions and may vary by several weeks.

Diet:
Sage Thrasher feeds primarily on insects, but berries and other small fruits are consumed when available [1, 3].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: COMMON
In 2013, Partners in Flight estimated that Sage Thrasher had a global population of approximately 5.9 million individuals and a Wyoming population of approximately 1 million [6]. The species has a statewide abundance rank of common and appears to be common within suitable environments in the occupied area [5]. From 1968–2015, annual Wyoming Breeding Bird Survey (BBS) detections of Sage Thrasher ranged from 13 to 1,015 (average = 521), with 531 recorded in 2015 [7]. Annual detections of Sage Thrasher ranged from 264 to 559 during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [8]. Estimated mean density across this same time period was 2.31 birds per km^2 (standard deviation 0.63, standard error 0.24) in suitable habitats in Wyoming [8].

Population Trends:
Historic: MODERATE DECLINE
Recent: STABLE

Wyoming trend data from the North American BBS indicate that Sage Thrasher declined by 0.53% annually from 1968–2013 and 1.94% annually from 2003–2013; however, neither state estimate was statistically significant [9]. Survey-wide BBS trend data indicate that Sage Thrasher numbers experienced a statistically significant annual decline of 1.39% from 1966–2013, and a non-significant annual decline of 1.21% from 2003–2013 [9].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Sage Thrasher has a high degree of habitat specificity, preferring contiguous stands of healthy, mature sagebrush [1, 3]. For example, along a successional gradient of sagebrush steppe habitat, Sage Thrasher was strongly associated with mature sagebrush as opposed to recently burned sagebrush or juniper-sagebrush mosaic in Oregon [10]. Similarly, in Wyoming, Sage Thrasher was negatively associated with areas that had undergone controlled burning [11]. Furthermore, it appears that requirements for suitable nesting habitat are quite narrow, being restricted to large, healthy sagebrush shrubs [3].

Extrinsic Stressors:
MODERATELY STRESSED
Research indicates that the largest threat to Sage Thrasher is habitat loss, degradation, and fragmentation [1, 3, 12]. Evidence suggests that Sage Thrasher abundance was negatively correlated with grass cover in Washington State [1]. Sagebrush steppe habitats in portions of Wyoming have experienced large-scale invasions of Cheat Grass (*Bromus tectorum*). It is likely that this negatively affects Sage Thrasher populations in the state. Additionally, cheat grass increases fire frequency in sagebrush ecosystems [12]. It is well established that Sage Thrasher avoids burned areas [10, 11, 13]. In Wyoming, sagebrush habitats have also been fragmented by energy development, including traditional oil and gas, coal bed methane, and wind power. Patterns of sensitivity to habitat fragmentation are mixed and may be context dependent. For example, reproductive success of Sage Thrasher was lower in habitats fragmented by agriculture [14] and energy development [15]. However, abundance of Sage Thrasher was not influenced by the density of natural gas wells. Reproductive success of Sage Thrasher was lower in energy development areas [15]. Increasing energy development in Wyoming may lead to population declines of Sage Thrasher.

KEY ACTIVITIES IN WYOMING

Sage Thrasher is classified as a Species of Greatest Conservation Need (SGCN) by the Wyoming Game and Fish Department (WGFD), and as a Level II Priority Bird Species requiring monitoring in the Wyoming Bird Conservation Plan [16]. The WGFD, Bureau of Land Management (BLM), and United States Forest Service have implemented increased monitoring efforts for Sage Thrasher and other sagebrush songbirds [17]. In 2004 and from 2008 to present, the WGFD has funded graduate research at the University of Wyoming, in conjunction with the Wyoming Cooperative Fish and Wildlife Research Unit, to examine potential effects of oil and natural gas development on Sage Thrasher and other sagebrush-obligate songbirds in Wyoming [15, 18-22]. From 2011 to present, the WGFD has funded graduate research to determine if state-wide efforts to conserve the Greater Sage-Grouse (*Centrocercus urophasianus*) may simultaneously benefit other SGCN species, including Sage Thrasher [23]. In 2016, the WGFD funded an additional project to examine the effects of climate on nongame sagebrush bird demography and populations. Field work is scheduled to begin in 2017. The BLM funded research from 2010–2012 to examine the potential effects of natural gas extraction infrastructure (i.e., roadways and well pads) on the distribution of sagebrush-obligate songbirds, including Sage Thrasher, at a natural gas field in southern Wyoming [24].

Ecological Information Needs

Data regarding both abundance and population trends are lacking for Sage Thrasher. Also, a better understanding of how habitat loss and fragmentation affects this species is needed.

Management in Wyoming

This section authored solely by WGFD; Zachary J. Walker. Sage Thrasher is classified as a SGCN in Wyoming due to habitat degradation and fragmentation. Broad scale monitoring efforts, such as the BBS and IMBCR, should be continued. Additional research should focus on addressing ecological information needs, and should examine the impacts of habitat loss and fragmentation on Sage Thrasher populations. Best management practices for this species include maintenance of large (> 50 acres) unfragmented stands of sagebrush habitat. Fragmentation and disturbance should be limited with effort to maintain large suitable habitat tracts.

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Figure 1: Adult Sage Thrasher in Wyoming. (Photo courtesy of Gunnar Kramer)

Figure 2: North American range of *Oreoscoptes montanus*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Large, mature, sagebrush typically preferred by Sage Thrasher in Sublette County, Wyoming. (Photo courtesy of Ian M. Abernethy)

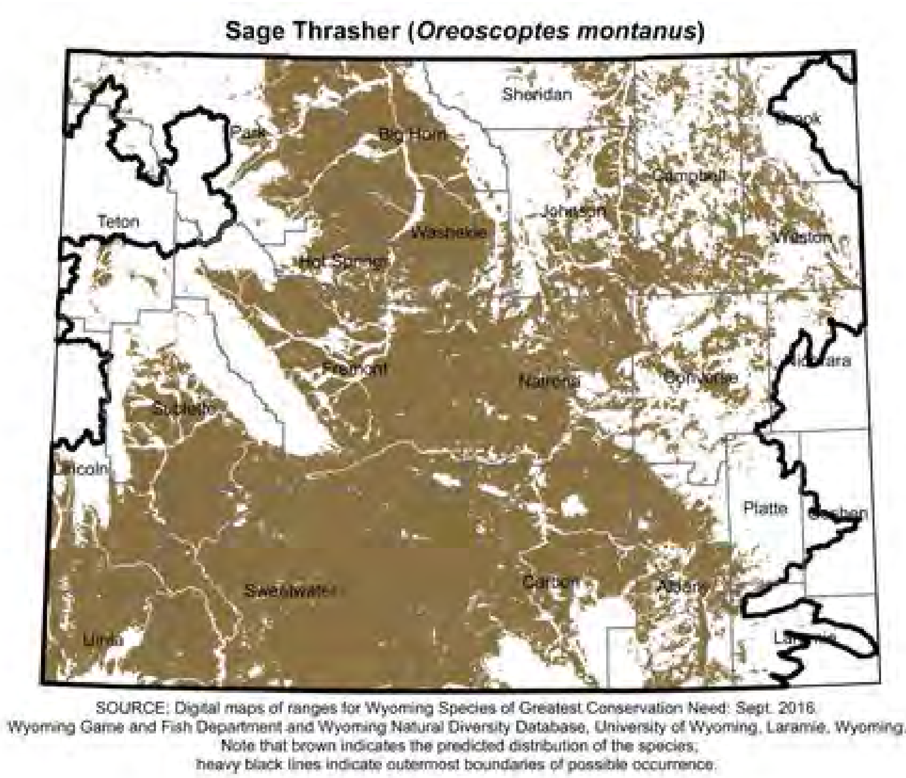

Figure 4: Range and predicted distribution of *Oreoscoptes montanus* in Wyoming.

Scott's Oriole
Icterus parisorum

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: No special status
UWFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: No special status
WGFD: NSSU (U), Tier II
WYNDD: G5, S1
Wyoming contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 11

STATUS AND RANK COMMENTS
Scott's Oriole (*Icterus parisorum*) has no additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:
Orioles are monophyletic, with all species belonging to the genus *Icterus*. No subspecies of Scott's Oriole are recognized [1].

Description:
Scott's Oriole is a medium-sized oriole. The sexes are dimorphic in both size and color, with females slightly smaller than males. Although the species does not display geographic variation in plumage, male plumage changes with age. Adult males have a black hood, chest, back, wings, and tail feathers. The wings have white wing bars with a yellow epaulet. The rest of the body is bright yellow. Adult females are generally paler than males, with a yellow-green body and brownish black wings with white wing bars. The head coloration is highly variable and can range from only a few black feathers to a nearly solid brownish-black color on the head, back, and throat. Juvenile males display similar plumage to adult females, but with a dark head and throat and olive-colored tail feathers [1]. Scott's Oriole can be distinguished from Orchard Oriole (*I. spurius*) by a yellow body as compared to a rusty orange in Orchard Oriole and a non-overlapping range in Wyoming. Bullock's Oriole (*I. bullockii*) has wider white wing bars, and the cheeks, throat, and chest are yellow as compared to the black coloration of Scott's Oriole [2].

Distribution & Range:
Scott's Oriole, sometimes called the Mountain or Desert Oriole, is found throughout the southern Rocky Mountains and the southwestern United States from extreme southwestern Wyoming through southern Mexico, although detailed information from Mexico is lacking. Breeding range

extends north from roughly Michoacán, Puebla, and Oaxaca, Mexico. Winter range extends south from central Baja California, Sonora, and Chihuahua, Mexico [1]. In Wyoming, Scott's Oriole is only found in areas of Utah Juniper (*Juniperus osteosperma*) interspersed with Wyoming Big Sagebrush (*Artemisia tridentata*), shrubs, and grasses in Sweetwater County, reaching as far north as Little Firehole Canyon at Flaming Gorge Reservoir [3, 4]. An isolated observation of a male near Lander is the only confirmed sighting outside of this range [2]. Scott's Oriole has been observed in 4 of the state's 28 latitude/longitude degree blocks, with confirmed or circumstantial evidence of breeding documented in 3 of those 4 degree blocks [4].

Habitat:
Scott's Oriole is typically associated with higher-elevation arid habitats, including those dominated by juniper and yucca. In Wyoming, the species is restricted to Utah Juniper woodlands with moderate to sparse canopy closure located in extreme southern Sweetwater County [4, 5]. Wintering habitat is not well-studied, but likely includes arid habitats dominated by pine-oak (*Pinus* spp.-*Quercus* spp.) woodlands [1]. Nests are often constructed in yuccas [1], although in Wyoming nests are built near the ends of branches in mature Utah Junipers [3, 5, 6]. Smaller junipers and deciduous shrubs are also used for foraging [5].

Phenology:
Scott's Oriole migrates north from Mexico in March and April, typically reaching northernmost breeding grounds in early May [1], where it has been observed as early as 16 May in Wyoming [2]. Adult males are the first to reach breeding grounds, followed by second-year males and females; nest building begins soon after both adults have arrived. Egg laying begins 2–4 days after the nest is completed; clutches average 3 eggs (range 1–6). Hatching begins 12–14 days after the last egg is laid, and young typically fledge 12 days later. Juveniles are dependent on adults for an additional 2–3 weeks after fledging. Scott's Oriole may raise 1 or 2 broods per season; pairs occasionally raise 3 broods. Typically, however, only a single brood is successful per season. Individuals begin leaving breeding grounds in late July or early August, reaching wintering sites by late September [1].

Diet:
Scott's Oriole primarily consumes insects captured from the ground or gleaned or probed from leaves of yucca and shrubs. Both adults and larvae of Lepidoptera, Orthoptera, Hymenoptera, and Coleoptera as well as spiders are consumed. Other food items include fruit, especially from cacti; nectar; and lizards. Monarch Butterfly (*Danaus plexippus*) may be an important food item in winter. Scott's Oriole does not appear to need to drink frequently, as the diet may provide most of the needed water, especially at cooler temperatures [1].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
Using North American Breeding Bird Survey (BBS) data, the Partner's in Flight (PIF) Science Committee estimated the global population of Scott's Oriole to be 4 million birds [7]. Currently, no population estimates exist for the state. The statewide rank of VERY RARE is based on the rather small area of the state known to be occupied in any given season and the small coverage of suitable habitat within that area. However, within suitable habitat in the occupied area, Scott's Oriole appears to be rare, as it occupies only a small percentage of preferred habitat within its

range and may not be readily detected during surveys expected to indicate its presence [4]. There are only two confirmed breeding records and one suspected breeding record for the species in the state [3, 4, 6]. Scott's Oriole density and population size estimates for Wyoming are not available from the Integrated Monitoring in Bird Conservation Regions (IMBCR) program [8].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Population trends are not available for Scott's Oriole in Wyoming due to a limited number of survey routes or grids in place in the state where this species occurs and low detection rates during monitoring surveys. Currently, there are no North American BBS trend data for Scott's Oriole in Wyoming [9]. According to the BBS, Scott's Oriole has experienced a slight but insignificant decrease range-wide, with decreases becoming more pronounced in recent years. Decreases are more prominent in southern California, with increases throughout New Mexico as well as near Wyoming in Colorado and Utah [9]. In contrast, PIF categorizes Scott's Oriole as displaying a stable to significant but small increase [7]. In general, the species is thought to be expanding northward in both breeding and wintering range, potentially in response to climate change [1].

Intrinsic Vulnerability:
HIGH VULNERABILITY
Scott's Oriole has somewhat specialized habitat requirements, especially in Wyoming where it is restricted to a narrow area of Utah Juniper in extreme southern Sweetwater County [3]. Scott's Oriole is fairly faithful to breeding sites, but does not seem to be restricted by population density. Approximately 50–60% of females successfully raise a brood to fledging each season [1]. Other life history characteristics do not predispose the species to declines from changes in environmental conditions.

Extrinsic Stressors:
SLIGHTLY STRESSED
Predation is a major cause of nest failure, followed by nest parasitism, particularly by Brown-headed Cowbird (*Molothrus ater*) [1]. PIF assigns Scott's Oriole a threat level of 3, indicating that the species is expected to display a slight to moderate decline in the future suitability of breeding conditions. The factors that may contribute to this decline are variable but, for Scott's Oriole, likely include sensitivity to parasitism and loss of habitat due to a relative specialization on sensitive habitats [7]. In fact, the loss of habitat is likely the most significant issue facing the species range-wide, especially loss of wintering habitat in Mexico, where much less is known about the status and ecology of the species [1]. In contrast, juniper habitat may be expanding range-wide as a result of fire suppression, climate change, and grazing practices, although this expansion may not be as prominent in Wyoming as in other portions of the western United States [10-12]. However, the availability of Utah Juniper habitat remains limited in Wyoming and may be negatively impacted through fragmentation, disruption of historic fire regimes, climate change, energy development, and removal and thinning programs [12-15]. Consequently, the future availability and suitability of this habitat in Wyoming is unclear.

KEY ACTIVITIES IN WYOMING
Scott's Oriole is classified as a Species of Greatest Conservation Need (SGCN) in Wyoming by the Wyoming Game and Fish Department (WGFD) and a Wyoming PIF Level II Priority Species

[10]. The species is not adequately monitored by current national or regional avian monitoring efforts in Wyoming, including the IMBCR program initiated in 2009 (0 detections since initiation) [8] or the BBS program conducted on 108 established routes since 1968 [9]. Scott's Oriole is a species for which the Wyoming Bird Records Committee requests documentation on all sightings. Observations of this species are reported to the WGFD and vetted through the Wyoming Bird Records Committee. In 2016, the WGFD began a project focused on addressing data deficiencies for piñon-juniper obligate species in southwestern Wyoming, including Scott's Oriole. This project will be completed in 2017 and will address a number of objectives, including evaluating species distribution and richness, estimating relative abundance and occupancy rates, and quantifying and evaluating habitat characteristics.

ECOLOGICAL INFORMATION NEEDS

In Wyoming, assessment of the status of Scott's Oriole is hampered by a lack of ecological and population data. Additional information is needed on distribution and habitat use, and estimates of abundance and occupancy rates are needed to assess status, monitor populations, and evaluate trends. Traditional state-wide survey efforts do not tend to detect Scott's Oriole, suggesting targeted, species-specific monitoring efforts are needed. Because only two breeding records are available for the species in Wyoming, additional work is needed to determine the frequency of these events in the state. Additionally, the distribution of juniper forests in Wyoming is far vaster than the distribution of Scott's Oriole, and a better understanding of habitat use and requirements at this northernmost range boundary is needed. Finally, because the species is potentially expanding northward with changes in climate conditions, a better understanding of the current range boundary for both the species as well as the juniper habitat on which it depends is needed to evaluate potential expansions.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Scott's Oriole is classified as a SGCN in Wyoming due to a need for robust information on breeding status and population trends in Wyoming; limited distribution of required breeding habitat; loss, degradation, and fragmentation of Utah Juniper habitat due to industrial developments; and incompatible management practices [12]. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [9] and IMBCR [8]. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, Scott's Oriole needs a targeted, species-specific survey method approach to obtain these data. Initial work and written species accounts on avian Utah Juniper-obligate species, including Scott's Oriole, occurred in 1988 [5]. However, higher priorities and limited personnel and funding precluded conducting additional work on these species until recently. Best management practices to benefit Scott's Oriole include implementing a sufficient monitoring technique; maintaining mature stands of Utah Juniper habitat where Scott's Oriole nests, including herbaceous vegetation and shrubs for foraging; implementing prescribed and natural fire management to maintain savannah-like stands of juniper woodlands in areas occupied by Scott's Oriole; and coordinating Utah Juniper management to provide a mosaic of juniper woodland conditions [16].

CONTRIBUTORS

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Figure 1: Adult male Scott's Oriole in Boulder, Colorado. (Photo courtesy of Bill Schmoker)

Figure 2: North American range of *Icterus parisorum*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Scott's Oriole habitat in southwestern Wyoming, dominated by Utah Juniper. (Photo courtesy of Leah H. Yandow, WGFD)

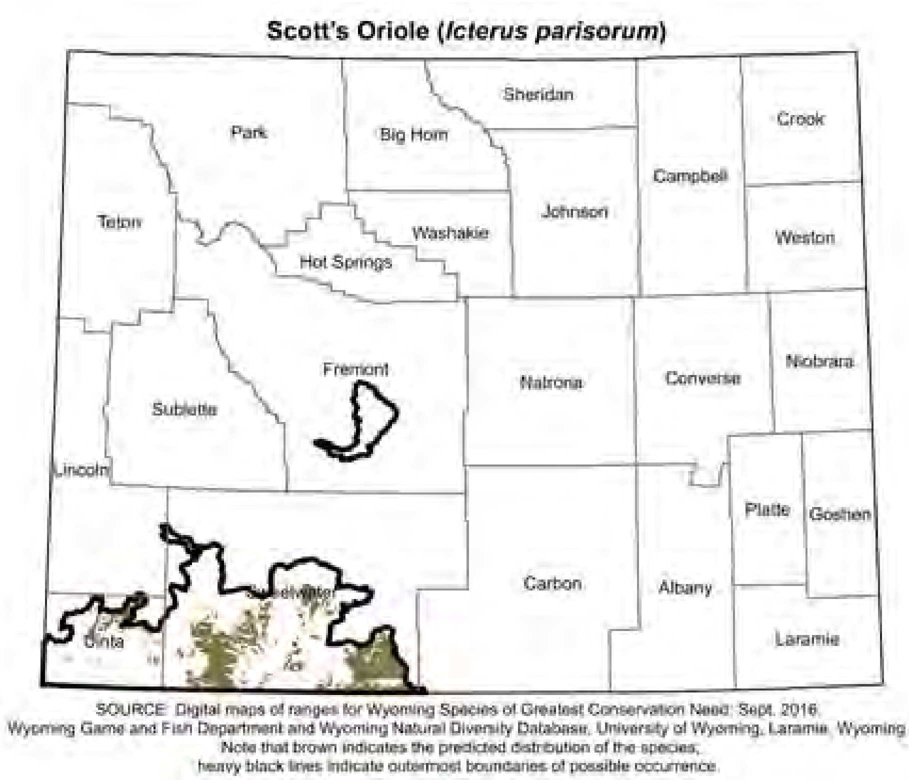

Figure 4: Range and predicted distribution of *Icterus parisorum* in Wyoming.

Short-eared Owl
Asio flammeus

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: Sensitive
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: Bird of Conservation Concern
WGFD: NSS4 (Bc), Tier II
WYNDD: G5, S1S2
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 12

STATUS AND RANK COMMENTS
The Wyoming Natural Diversity Database has assigned Short-eared Owl (*Asio flammeus*) a state conservation rank ranging from S1 (Critically Imperiled) to S2 (Imperiled) because of uncertainty about the species' population trends and intrinsic vulnerability to habitat modification in Wyoming.

NATURAL HISTORY

Taxonomy:
There are ten recognized subspecies of Short-eared Owl, though some subspecies may constitute unique species [1]. The only subspecies in Wyoming, *A. f. flammeus*, also occurs across North America, Europe, northern Asia, and northern Africa. Other subspecies are found in South America and in isolated populations on Pacific, Caribbean, and south Atlantic islands [1].

Description:
Identification of Short-eared Owl is possible in the field. Short-eared Owl is a medium-sized owl, measuring 38 cm from bill to tail [2]. Females are slightly larger than males, but plumage is similar between sexes [1]. Dorsal plumage is mottled brown and buff. Ventral plumage is whitish to rust colored with dense vertical streaking on the breast and thinner streaking on the sides and flanks. Short-eared Owl has small, often inconspicuous, ear tufts near the center of the forehead. The facial disk is large, grayish-white, with a ruff around the rim. Short-eared Owl has yellow eyes and a black bill. Juveniles plumage is similar to that of adults, but the facial pattern is not as pronounced and the upperparts and head are more dusky [1]. Short-eared Owl is most similar in appearance to Long-eared Owl (*A. otus*), Great-horned Owl (*Bubo virginianus*), and Northern Harrier (*Circus cyaneus*). Long-eared and Great-horned Owls have large ear tufts. Northern Harrier has a conspicuous white rump patch, which Short-eared Owl lacks [2].

Distribution & Range:
Short-eared Owl is widely distributed across open habitat in northern temperate and arctic regions as well as in northwestern and southern South America and various island groups. Changes in the species' distribution in North America have recently been documented. Specifically, a westward shift has been observed along with large contractions of the breeding range in northeastern North America [1, 3]. Some range expansions in the Antilles also have occurred [1, 3]. The species is nomadic within its range, and may be absent from some areas for many years [3]. Individuals that breed in the northern portion of the range migrate south in the winter. During the non-breeding season, most individuals are found south of Canada to northern and central Mexico [3]. In Wyoming, the species is found in low numbers across the state in appropriate habitat but distribution is patchy and irregular and numbers can vary greatly in abundance depending upon prey and spring weather conditions [3-5].

Habitat:
Short-eared Owl breeds in open habitat including: intermountain, prairie, and coastal grasslands, sagebrush steppe, marshes, arctic tundra, and shrub-steppe plateaus. The species prefers native and seeded grasslands. Agricultural fields are used to a lesser degree [3, 6, 7]. The species also has been observed using strip- and surface-mines that have been reclaimed [8, 9]. Short-eared Owl requires dense horizontal cover for nest concealment and proximity to preferred foraging areas. In Wyoming, the species occupies undisturbed open habitats below approximately 2,100 m including grasslands, meadows, and marshes and, less frequently, shrubsteppe [5]. Winter habitat is similar to breeding habitat, but the species also will use large open areas within woodlots, dumps, gravel pits, rock quarries, and shrub thickets [1].

Phenology:
In Wyoming, some Short-eared Owls are year-round residents while others are nomadic or migrate in winter. Although phenology has not been studied in Wyoming, migration probably occurs in April and October [10]. In other parts of the species' range, pair formation begins in mid-February and continues into June [1]. In the Great Plains, egg-laying has been observed from the end of March into late June, and hatching from early May to mid-July [6]. Incubation lasts 21 to 37 days [1]. Young disperse from nests at 14 to 17 days of age and are capable of flight at 27 to 35 days of age [1].

Diet:
Short-eared Owl can hunt day and night during the breeding season and eats a variety of small mammals, especially voles in the genus *Microtus*. Birds also are consumed, though typically not as frequently as small mammals [1].

CONSERVATION CONCERNS

Abundance:
Continental: CONTINENTAL
Wyoming: UNCOMMON
Short-eared Owl abundance in many areas fluctuates annually, due in part to prey abundance and the nomadic nature of the species [1, 3, 11-13]. In 2013, Partners in Flight estimated the Wyoming population of Short-eared Owl to be about 7,000 birds [14]. However, this estimate is extrapolated from Breeding Bird Survey (BBS) data and should be viewed with caution due to the low number of detections of the species both in Wyoming and across its range using this survey technique.

Population Trends:
Historic: MODERATE DECLINE
Recent: MODERATE DECLINE to STABLE
Due to annual variations in abundance and the nomadic and crepuscular nature of the species, population trends are hard to determine [1, 3]. However, multiple data sources indicate that Short-eared Owl has declined. Long-term (1966–2013) BBS data indicate that Short-eared Owl has declined across both the United States and Canada and limited data suggest a decline in Wyoming [11]. Christmas Bird Count (CBC) data for the United States and Canada also show that the number of Short-eared Owls detected per unit effort has declined 50% and 80%, respectively [13, 15]. Limited CBC data could suggest an overall decline in Wyoming; however, samples sizes are extremely small and data are inconclusive [13]. A 2008 status assessment of Short-eared Owl in Canada reported a decline of 27% in the previous 10 years, falling just short of criteria for listing the species as Threatened in Canada [16]. NatureServe lists Short-eared owl as possibly extirpated, critically imperiled, imperiled, or vulnerable in 37 states (74%) in the United States [15]. Comparisons between recent atlas projects in various states and anecdotal historical records also suggest a decline in the species' abundance [3]. Recent declines in eastern Europe prompted the European Commission to list Short-eared Owl in the 2013 European Union Annex 1 (Threatened) Birds Directive [17].

Intrinsic Vulnerability:
MODERATE to HIGH VULNERABILITY
Short-eared Owl is moderately or highly vulnerable to extrinsic stressors because the species has relatively narrow habitat requirements and a large home range. Short-eared Owl requires relatively large tracts, a minimum of 100 ha, of native grassland or other open habitats for successful breeding. Reproductive success and population dynamics are strongly influenced by prey abundance and dependence on cyclical and irruptive small mammals as primary prey requires owls to travel long distances in search of prey irruptions. The species also nests on the ground and needs tall dense vegetation cover around the nest to protect eggs and young from predation [1, 3, 15].

Extrinsic Stressors:
HIGHLY STRESSED
Short-eared Owl uses landscapes with potential high human impacts, which makes the species highly threatened in Wyoming. Livestock grazing poses a serious potential threat to Short-eared Owl if grazing practices significantly reduce the amount of tall dense herbaceous plant cover necessary for nesting. Research suggests that Short-eared Owl has significantly higher reproductive success and lower nest mortality in ungrazed grasslands compared to grazed grasslands [3, 6, 18]. The species is sensitive to areas with a large proportion of edge habitat. This may indicate that habitat fragmentation may have a strong negative effect on the owl. Extensive historical and ongoing fragmentation and conversion of both breeding and non-breeding habitat from land development, agricultural practices, and recreational use threaten the species across its range, including Wyoming [3, 15]. Mowing of hayfields also may threaten this species in Wyoming because young of this late-nesting species may not fledge until late-July or August [19].

KEY ACTIVITIES IN WYOMING
Currently, there are no projects focused specifically on Short-eared Owl in Wyoming. BBS are conducted annually in Wyoming, and the species has been detected on a total of 31 routes. Accurate abundance or trend estimates cannot be made from these limited data [4]. Additional but

limited data are being collected from ongoing grassland bird survey transects, but these are focused on other species and observations of Short-eared Owl are not documented consistently on all routes [20].

Ecological Information Needs

Accurate population abundance and trend estimates are needed for this species in Wyoming and across its western breeding range. Short-eared Owl is nomadic and the influence of local habitat characteristics (e.g., disturbance, degree of habitat fragmentation, change in vegetation structure, etc.) on site fidelity is not known [3]. The benefits to Short-eared Owl of land conservation programs such as Conservation Reserve Program and Grassland Reserve Program need to be assessed [1, 3].

Management in Wyoming

This section authored solely by WGFD; Susan M. Patla. Short-eared Owl is classified as a Species of Greatest Conservation Need in Wyoming. On-going habitat loss and fragmentation due to human activity are increasing and will likely negatively affect long-term population status and trends [21]. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the North American BBS [4] and the multi-partner Integrated Monitoring in Bird Conservation Regions [22]. However, existing data are not robust enough to support estimates of occupancy, density, or population trend for Short-eared Owl. The Nongame Technical Committee of the Pacific Flyway submitted a multi-state proposal to develop a standardized, region-wide monitoring program for this wide-ranging species in 2015. Although not funded in 2016, Wyoming and other partner states will continue to seek funding for this effort. Conservation of native grasslands and implementation of beneficial management practices on agricultural lands where this species occurs will help to maintain and improve nesting and migration habitat for this species.

Contributors

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Figure 1: Adult Short-eared Owl in Seedskadee National Wildlife Refuge, Sweetwater County, Wyoming. (Photo courtesy of Tom Koerner, USFWS)

Figure 2: North American range of *Asio flammeus*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Potential Short-eared Owl breeding habitat in Thunder Basin National Grassland, Wyoming. (Photo courtesy of Michael T. Wickens)

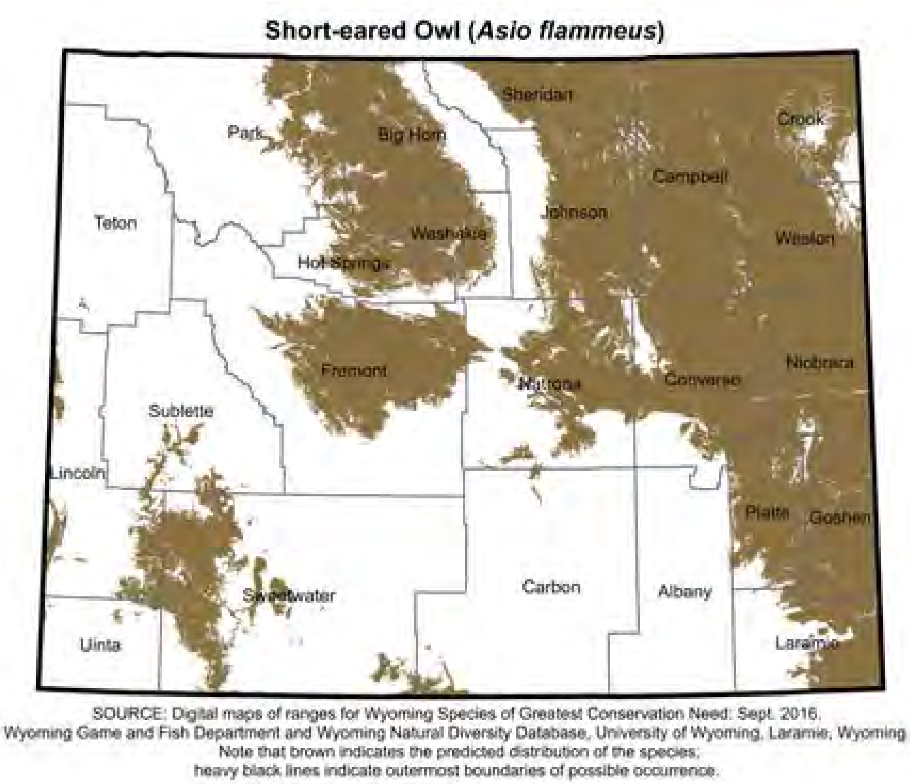

Figure 4: Range and predicted distribution of *Asio flammeus* in Wyoming.

Figure 5: Short-eared Owl in flight in Lacreek National Wildlife Refuge, South Dakota. (Photo courtesy of Tom Koerner, USFWS)

Snowy Egret
Egretta thula

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G5, S1S2
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: Not ranked

STATUS AND RANK COMMENTS
The Wyoming Natural Diversity Database has assigned Snowy Egret (*Egretta thula*) a state conservation rank ranging from S1 (Critically Imperiled) to S2 (Imperiled) because of uncertainty about population trends for this species in Wyoming.

NATURAL HISTORY

Taxonomy:
There are currently two recognized subspecies of Snowy Egret, which are weakly distinguished by minor size differences: *E. t. thula* breeds in eastern North America, the Greater Antilles, and throughout South America, while *E. t. brewsteri* breeds in western North America west of the Rocky Mountains [1, 2]. Both subspecies are likely found in Wyoming [3], but this has not been confirmed.

Description:
Identification of Snowy Egret is possible in the field. It is a medium heron; adults weigh approximately 370 g, range in length from 56–66 cm, and have wingspans of approximately 100 cm [1]. Males are slightly larger, but the sexes are otherwise similar in appearance [1]. Breeding adults have uniform white plumage with long plumes of delicate feathers on the nape, breast, and lower back that are used in courtship displays; a long S-curved neck; yellow eyes; bright lores that range from dark yellow to red; a long black bill; long black legs; and dark yellow or orange feet [1, 4]. In the non-breeding season the plume feathers are lost; lores and feet lighten to yellow; legs lighten to greenish-yellow (although the foreleg may remain black); and the base of the lower mandible lightens to gray [1, 4]. Cattle Egret (*Bubulcus ibis*) is similar in appearance to Snowy Egret, but can be distinguished by its orange-buff breeding plumes and reddish eyes, legs, and bill [4].

Distribution & Range:
Snowy Egret core breeding areas include the East Coast; Gulf Coast; lower Mississippi River watershed; patchily distributed inland marsh and wetland environments throughout the United States; coastal Mexico and Central America; Caribbean Islands; and much of South America [1]. Southwestern Wyoming falls within a large, western, inland breeding area for Snowy Egret, which encompasses parts of Utah, Idaho, Nevada, Oregon, and California. The species migrates through Wyoming in the spring and fall and is also a summer resident [3, 5]. Snowy Egret has been observed at waterbodies across Wyoming; however, confirmed breeding has been document in just 7 of the 28 latitude/longitude degree blocks, primarily in the southern half of the state [3, 5].

Habitat:
Snowy Egret is associated with a wide range of coastal and inland aquatic habitats, including shallow salt-marsh ponds, tidal channels, shallow bays, mangroves, swamps, marshes, reservoirs, lakes, rivers, flooded fields, wet meadows, and irrigation channels [1]. In Wyoming, Snowy Egret is found in low-elevation wetlands, flooded pastures, and along the shores of ponds, lakes, reservoirs, and rivers [3, 5]. This species utilizes a wide variety of nesting substrates depending on habitat and availability, including trees, shrubs, reeds, cactuses, and vines [1, 6]; however, most nests in Wyoming are found in shrubs, bulrushes, and cattails [5]. Nest are constructed out of loosely intertwined sticks and twigs, and may be lined with locally available grass, reeds, and moss [1]. Snowy Egret may also utilize existing nests if they are available [1].

Phenology:
Spring arrival of migrating and breeding Snowy Egrets in Wyoming starts in mid-April [3], but very little is known about the specific nesting and breeding habits of this colonial nesting species in the state. Clutch size typically ranges from 3–5 eggs, and eggs hatch after being incubated by both the male and female for 20 or 21 days [1]. If disturbed, young egrets are able to temporarily leave the nest when they are just 10 days old [1]. Snowy Egret is a single-brood species, but may renest following loss of the first nest [1]. In Wyoming, fall migration to wintering grounds begins in mid-August, with most migrants and residents leaving the state by late September [3].

Diet:
Snowy Egret is a wading bird that typically forages in shallow water, often in groups or in mixed interspecies flocks of wading and aquatic birds [1, 7-12]. Snowy Egret feeds on a wide variety of aquatic and terrestrial prey including fish, crabs, crayfish, shrimp, frogs, toads, lizards, snakes, snails, insects, and worms [1, 5, 13].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD BUT PATCHY
Wyoming: VERY RARE
There are no robust estimates of abundance available for Snowy Egret in Wyoming. The species has a statewide abundance rank of VERY RARE and appears to be rare even within suitable environments in the occupied area [5]. Colonial nesting waterbird surveys conducted from 2002–2006 by the Wyoming Game and Fish Department (WGFD) recorded a range of 0 to 4 individuals annually across all surveyed sites [14-18]. From 1968–2015, annual Wyoming Breeding Bird Survey (BBS) detections of Snowy Egret ranged from 0 to 2, with none recorded in most years [19]. Only 1 Snowy Egret was detected during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [20]. While surveys conducted as

part of the BBS and IMBCR programs may occasional detect this species, neither is specifically designed to capture egret observations.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Robust population trends are not available for Snowy Egret in Wyoming because the species is infrequently detected during monitoring efforts. The species experienced substantial global population declines and local extirpations in the late 1800s and early 1900s from over-hunting for its breeding plumes, but populations rebounded and even expanded in the mid-1900s after the feather trade ceased [1]. Survey-wide trend data from the North American BBS indicate that Snowy Egret numbers increased annually by 1.20% from 1966–2013 and 3.52% from 2003–2013, but neither trend estimate was statistically significant [21].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Snowy Egret has moderate intrinsic vulnerability in Wyoming due to low abundance, a dependence on a narrow range of habitats types, colonial nesting behaviors that can expose large numbers of breeding individuals to disturbance, and inherent risk of bioaccumulation of environmental toxins. Like other wading bird species, Snowy Egret forages in productive shallow-water environments, which is a relatively uncommon and unstable habitat type in Wyoming. Natural or anthropogenic disturbance to breeding colonies could potentially have a large negative impact on local populations of Snowy Egret. Compared to other avian species, Snowy Egret embryos have demonstrated high sensitivity to injected methylmercury during laboratory experiments [22], but it is not known how this translates to natural systems.

Extrinsic Stressors:
MODERATELY STRESSED
Snowy Egret is moderately stressed by extrinsic stressors in Wyoming, where already limited natural aquatic habitat is potentially vulnerable to climate change and drought, invasive plant species, and development for infrastructure, energy, and agriculture [23, 24]. Snowy Egret has demonstrated sensitivity to drought and changing water levels [3, 12, 25]. However, this species will use human-made wetlands and ponds as well as anthropogenic structures for foraging [26-28], which may support the idea that man-made aquatic habitats could help alleviate the loss or contraction of natural habitats in Wyoming [23]. Snowy Egret appears to be less sensitive to disturbance from motorized watercraft and passing vehicles on nearby roads than other waterbird species [29-31]. This species is at risk for bioaccumulation of mercury and other environmental contaminants from feeding in polluted aquatic habitats [25, 32-35].

KEY ACTIVITIES IN WYOMING
Snowy Egret is classified as a Species of Greatest Conservation Need (SGCN) by the WGFD. Current statewide bird monitoring programs are designed for monitoring breeding songbird populations and are unlikely to provide useful information on Snowy Egret. These monitoring programs include the BBS program conducted on 108 established routes since 1968 [21], and the multi-agency IMBCR program initiated in 2009 [20]. Since 1984, WGFD has conducted annual or periodic monitoring at the most important and productive sites for colonial waterbird SGCN to determine species presence and distribution, and to estimate number of nesting pairs. The most

recent effort was the culmination of a multi-year cooperative agreement between the WGFD and the United States Fish and Wildlife Service to conduct an intensive survey of all historic, known, potential, and new colonial waterbird breeding sites statewide as part of a western range-wide effort to track population size, trends, and locations of breeding colonial waterbirds in the western United States [36, 37]. In 2014, an online Atlas of western colonial waterbird nesting sites was produced with data collected and submitted by participating states [38]. Every three to five years, WGFD personnel visit known colonial waterbird nesting sites outside of Yellowstone National Park to evaluate water level conditions, determine species present at each site, and estimate the number of nesting pairs of colonial waterbirds. There are currently no research projects designed specifically for Snowy Egret in Wyoming.

Ecological Information Needs

In Wyoming, Snowy Egret would benefit from research to determine its detailed distribution, the location and habitat characteristics of current breeding colonies, and the annual abundance of migrating and breeding adults. Beyond approximate arrival and departure dates, very little is known about the specific breeding habits of this species in the state, and nothing is known about nest success or fledgling survival at the few known breeding locations. Due to the scarcity and inherent vulnerability of Wyoming's aquatic habitats, it would be valuable to identify current and future anthropogenic and natural stressors to ensure the persistence of breeding and foraging habitat for Snowy Egret.

Management in Wyoming

This section authored solely by WGFD; Zachary J. Walker. Snowy Egret is classified as a SGCN in Wyoming due to limited distribution of breeding sites and breeding site instability due to varying water levels. Colonial water bird surveys are conducted within the state, but existing data are not robust enough to support estimates of occupancy, density, or population trend. Targeted, species-specific survey methods may be warranted. Best management practices or key management recommendations to benefit Snowy Egret include protection of suitable breeding locations, minimize nesting disturbance, and maintenance of stable water levels throughout the nesting season [23].

Contributors

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Figure 1: Adult Snowy Egret in breeding plumage in Jefferson County, Colorado. (Photo courtesy of Bill Schmoker)

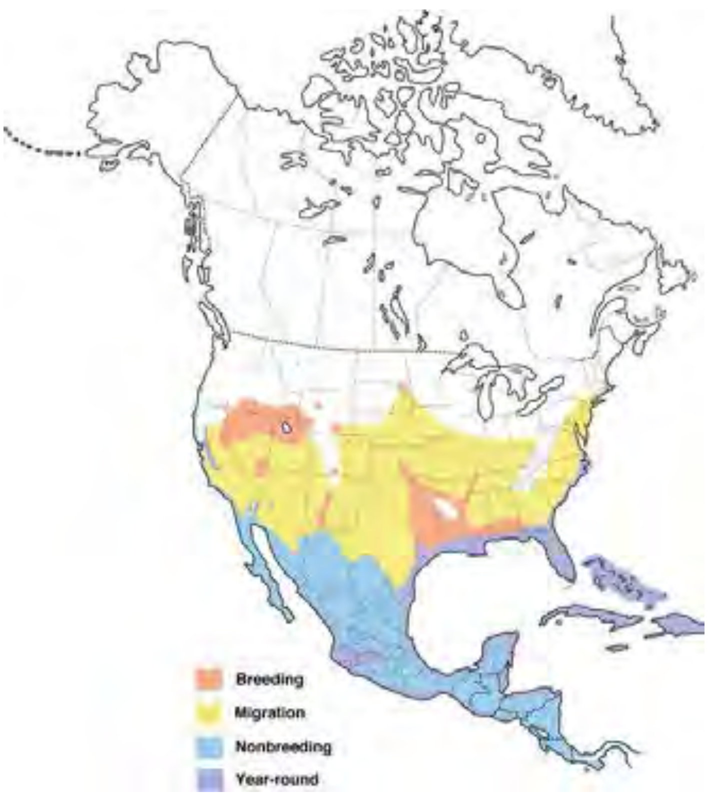

Figure 2: North American range of *Egretta thula*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

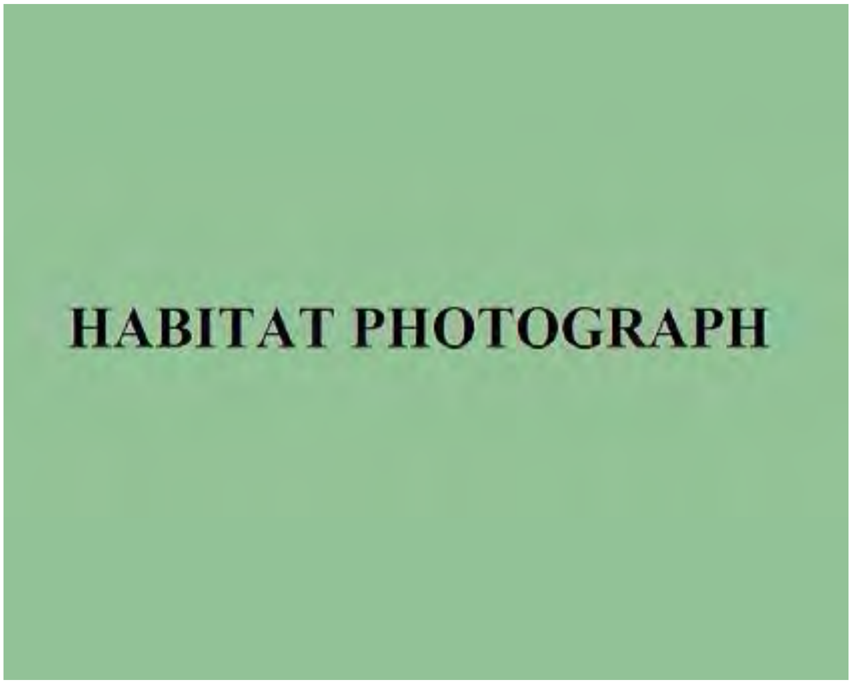

Figure 3: Photo not available.

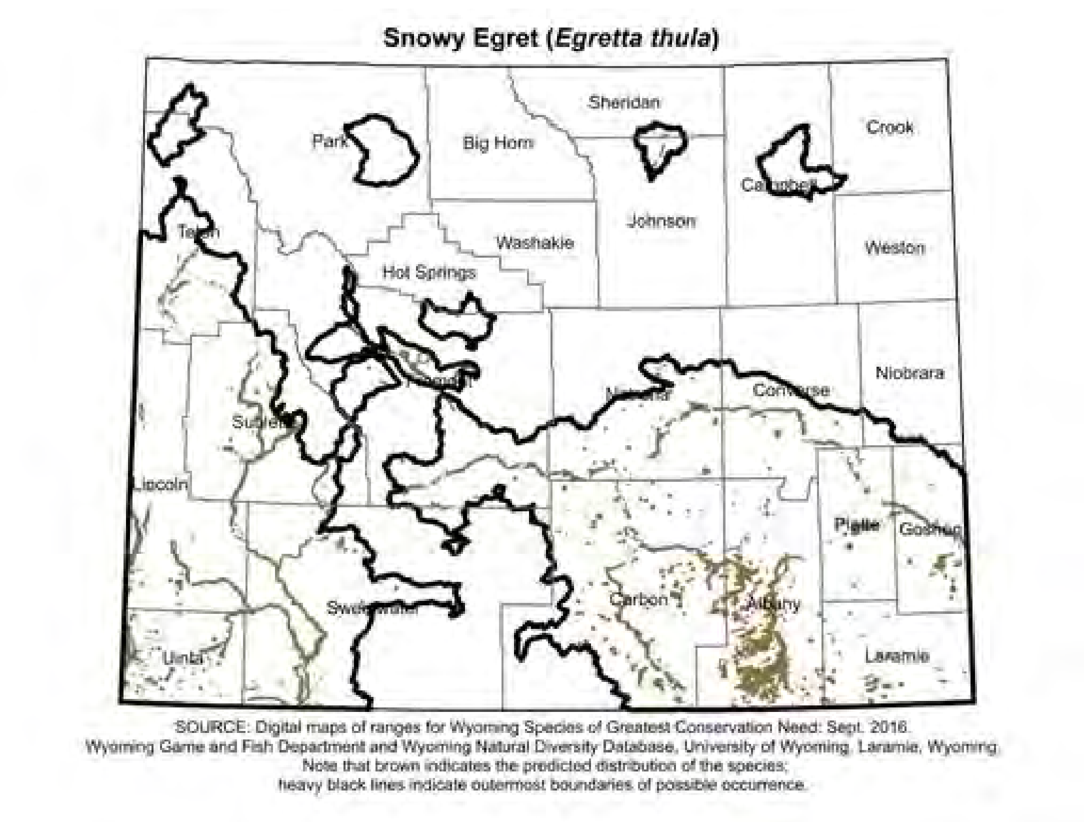

Figure 4: Range and predicted distribution of *Egretta thula* in Wyoming.

Snowy Plover
Charadrius nivosus

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: Bird of Conservation Concern
WGFD: NSSU (U), Tier III
WYNDD: G3, S1
    Wyoming Contribution: LOW
IUCN: Near Threatened
PIF Continental Concern Score: Not ranked

STATUS AND RANK COMMENTS
Snowy Plover (*Charadrius nivosus*) that breed within 50 miles of the Pacific coast in the U.S. and Mexico are listed as Threatened under the Endangered Species Act [1]. However, Snowy Plover in Wyoming have no such regulatory status, nor any other status beyond those listed above.

NATURAL HISTORY
Taxonomy:
Formerly considered conspecific with *C. alexandrinus*, Snowy Plover is now considered a distinct species (*C. nivosus*) based on differences in male calls, morphology, and mitochondrial and nuclear DNA [2, 3]. These differences suggest that *C. alexandrinus* and *C. nivosus* are more closely related to *C. marginatus* than they are to each other [3]. Two subspecies, *C. n. nivosus* and *C. n. occidentalis*, are recognized, supported by genetic differences [4]. *C. n. nivosus* occurs in North America, while *C. n. occidentalis* is found in South America [5].

Description:
Snowy Plover can be identified in the field by its small size (15–17 cm long, 34–58 g), white hind-neck collar, and breast band that is restricted to lateral patches and does not form a complete band [5]. Other characteristics that aid in identification are its pale brown upperparts and dark gray to blackish legs. Males and females are indistinguishable in basic plumage, whereas in alternate plumage, males have a black crown, ear coverts, and foreneck patches [5]. Males often have a distinct rusty cap in the beginning of the breeding season, while females lack the rusty cap and often have brown feathering in one or more of their foreneck patches. Some females can exhibit a black crown, ear coverts, and foreneck patches, resembling males. Juveniles are distinguished from adults by pale edges on mantle feathers and lack of forehead patch [5]. Similar species in Wyoming include Piping Plover (*C. melodus*) and Semipalmated Plover (*C.*

semipalmatus). Snowy Plover is distinguishable from *C. melodus* and *C. semipalmatus* by its small size, dark gray legs, completely black bill, and incomplete breast band [5].

Distribution & Range:
In North America, there are 4 primary population regions: Pacific Coast, Inland, Gulf Coast, and Atlantic. The Rocky Mountains occur in the Inland population region where Snowy Plover breeds at several disjunct locations [5]. In Wyoming, Snowy Plover is known only to breed in a small portion of the southwest to south-central portion of the state. Although Snowy Plover has been observed in 11 of Wyoming's latitude/longitude degree blocks, confirmed or suspected breeding has been documented in only 2 degree blocks [6]. The species has a relatively high degree of site fidelity (ca. 63% re-sighting rate of individuals at a sample of breeding sites outside of Wyoming), but has also been known to disperse to different breeding sites within and between years [5]. Snowy Plover winters outside of Wyoming along the Pacific coast south through Mexico and Central America, along the Florida and Gulf coasts, in the Caribbean, and at a few inland sites in California [5].

Habitat:
In the Rocky Mountains Snowy Plover breeds on barren to sparsely vegetated ground at alkaline or saline lakes, reservoirs, ponds, and riverine sand bars [5, 7, 8]. Man-made features used by Snowy Plover include sewage, salt-evaporation, and agricultural waste-water ponds [9]. Nests are scraped directly into the substrate, and are usually placed next to a shrub, piece of debris, or other object in areas of relatively barren ground. Foraging is concentrated along the margins of water, occasionally ranging into dry flats. Winter habitat is primarily coastal, including beaches, tidal flats, lagoon margins, and salt-evaporation ponds. Some inland birds winter at agricultural waste-water ponds and saline lakes [5]. In Utah, Snowy Plover occupancy was negatively correlated with proximity to water and percent shrub cover [10].

Phenology:
Snowy Plover arrives in Colorado around mid-April [11]; limited records in Wyoming show arrival late April–late May [12]. Fall migration begins in mid-July and extends into early November [11-17]. Compared to other breeding grounds, pair formation is latest in the Great Plains and Great Basin because of later spring arrival dates [5, 14, 18-20]. In the Great Plains, nesting begins in late April, with most eggs laid in May and June [5, 8, 14, 19]. Egg laying occurs during all hours of the day and night, with about 55–62 hours between each laid egg [21]. Clutch size is typically 3 eggs (range 1–6); any clutch of only 1 egg is usually deserted [21, 22]. In the Great Plains, incubation ranges from 23–28 days [14, 19]. Within hours of the last chick hatching, the precocial chicks leave the nest permanently but need periodic brooding for several days [5, 14]. First flight of chicks occurs ca. 31 days post hatching [5]. In Utah, predation, weather, and abandonment were the most common causes of nest failure, respectively. Snowy Plover daily nest survival was higher in vegetated areas or near conspicuous objects compared to barren mudflats and lower areas within 100 m of dikes [23].

Diet:
Snowy Plover feeds on terrestrial, freshwater, brackish, and marine invertebrates. In the Great Plains, Snowy Plover chases down prey or probes in the sand on shores of lakes, reservoirs, ponds, braided river channels, and playas [5]. It is assumed that Snowy Plover in Wyoming eat available invertebrates, but preferences and diet composition here are unknown.

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD BUT PATCHY
Wyoming: VERY RARE
The population size of Snowy Plover in North America is estimated to be 25,869 birds [24]. Of that estimated population size, 16,905 Snowy Plovers are estimated to occur in the interior U.S. and Mexico. None of the survey sites from this study were located in Wyoming; however, Colorado had an estimated 294 and 147 birds on its shortgrass/mixed-grass prairies and Colorado plateau, respectively. The statewide rank of VERY RARE is based on the rather small area of the state known to be occupied in any given season, and the small coverage of suitable habitat within that area. However, within suitable habitat in the occupied area, Snowy Plover appears to be rare, as it occupies only a small percentage of preferred habitat within its range and may not be readily detected during surveys expected to indicate its presence [6]. Detections of Snowy Plover in Wyoming are limited, with only 19 detections recorded in the Wildlife Observation System managed by the Wyoming Game and Fish Department (WGFD).

Population Trends:
Historic: MODERATE DECLINE
Recent: UNKNOWN
Little data are available for Snowy Plover in Wyoming. However, across North America Snowy Plover has experienced a decline in occupied range and breeding numbers over the last 50 years [5, 25, 26].

Intrinsic Vulnerability:
HIGH VULNERABILITY
Snowy Plover is highly vulnerable due to its strong preference for specific habitats – namely, shallow water margins with sparse vegetation – and dependence on aquatic invertebrates as food. Declines in preferred habitat have been clearly documented in all portions of Snowy Plover range, and there are some recorded instances of environmental toxins apparently accumulating in Snowy Plover and depressing survival and reproductive output [5].

Extrinsic Stressors:
MODERATELY STRESSED
Documented stressors to Snowy Plover include invasion of exotic plants, disturbances while nesting, increased predation, and, potentially, environmental toxins in the aquatic food chain. In the Great Basin, stands of the exotic *Phragmites australis* expanded five-fold in five years, reducing large, open areas previously used by Snowy Plovers for nesting (J. Cavitt, in litt.) [5]. In the Great Plains, a *Tamarix* spp. has invaded alkaline flats, which has contributed to Snowy Plover population declines in that area [27]. *Tamarix* can cover formerly barren nesting areas, and predators that prey on Snowy Plover eggs and chicks use *Tamarix* for cover [28]. In publicly-accessible areas, humans and domestic dogs often disturb nesting plovers, which can lead to clutch loss [21]. Cattle have also been known to trample nests in Colorado [7]. At the Great Salt Lake in Utah, increasing numbers of raccoon (*Procyon lotor*) and red fox (*Vulpes vulpes*) have reduced Snowy Plover nest success to near zero (J. Cavitt, in litt.) [5].

KEY ACTIVITIES IN WYOMING

Snowy Plover is classified as a Species of Greatest Conservation Need in Wyoming by the WGFD, and as a Level II Priority Species requiring monitoring action in the Wyoming Bird

Conservation Plan [29]. Only 19 records of Snowy Plover have been recorded in the WGFD Wildlife Observation System. Existing data from ongoing monitoring programs are not robust enough to support estimates of occupancy, density, or population trend in the state. Since 1984, WGFD has conducted annual or periodic monitoring at important and productive waterbird sites to determine species presence and distribution, and to estimate number of nesting pairs. Additionally, in 2014 an online atlas of western colonial waterbird nesting sites was produced with data from a recent multi-year cooperative project with the U.S. Fish and Wildlife Service to survey all historic, known, potential, and new colonial waterbird breeding sites in the western U.S. [30-32]. In Wyoming, Snowy Plover was not detected during these efforts, and there are no new or on-going research or monitoring projects designed specifically for this species in the state. Observations of Snowy Plover are reported to the WGFD and vetted through the Wyoming Bird Records Committee (WBRC). Snowy Plover is a species for which the WBRC requests documentation on all sightings.

ECOLOGICAL INFORMATION NEEDS

Information on basic habitat use, distribution, and population trends within Wyoming is lacking, as the majority of existing research has targeted coastal populations and larger inland breeding centers. Breeding range of Snowy Plover in Wyoming is poorly understood, as are the effects of oil and gas development and other disturbances on nesting habitat and nest success. The effects of climate change on Snowy Plover habitat, breeding success, and population trends are unclear.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Snowy Plover is a rare summer resident in Wyoming, with breeding confirmed in 2 of the 11 latitude/longitude degree blocks in which the species has been documented (out of 28 total degree blocks) [6]. Snowy Plover is classified as a Tier III Species of Greatest Conservation Need in Wyoming with an unknown Native Species Status (NSS) due to limited suitable breeding habitat, susceptibility to predation and human disturbance during the breeding season, and impacts of fluctuating water levels during nesting. Several separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming, including the Breeding Bird Survey [33], Integrated Monitoring in Bird Conservation Regions [34], and species-specific waterbird [35] and marsh bird surveys [36] at key nesting sites in the state. While these monitoring programs provide robust estimates of occupancy, density, population trend, or distribution for many species in Wyoming, Snowy Plover is on the periphery of its breeding range in the state and may need a more targeted survey approach to obtain such data. Short-term management priorities for Snowy Plover will focus on addressing data deficiencies, while longer-term efforts should target gathering information on species presence, distribution, population status, and the impact of potential threats on known or potential nesting sites. Any information gathered will ultimately be used to develop management and conservation recommendations for Snowy Plover, and to designate a known NSS ranking.

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Figure 1: Adult Snowy Plover in breeding plumage in Albany County, Wyoming. (Photo courtesy of Shawn Billerman)

Figure 2: North American range of *Charadrius nivosus*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

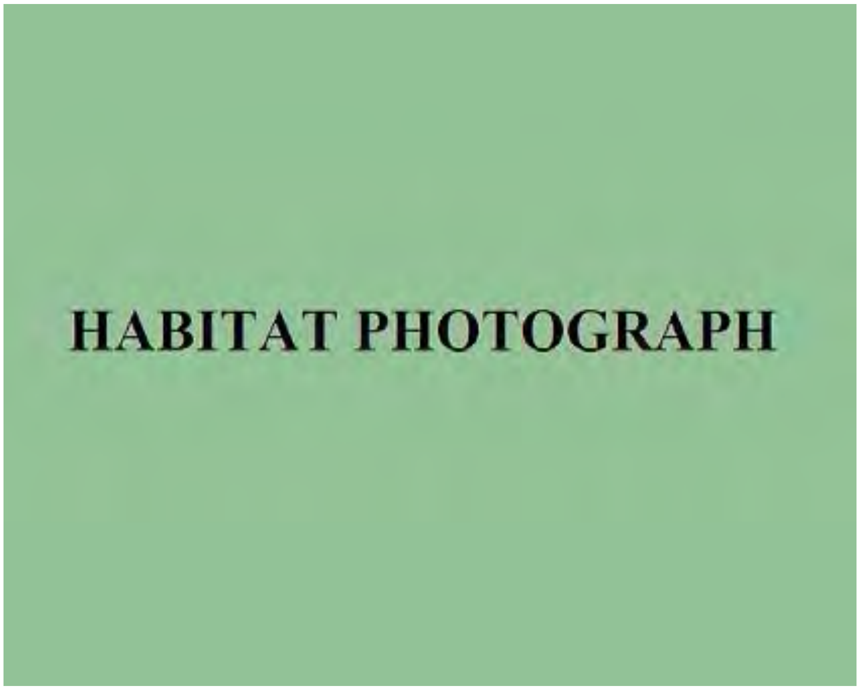

Figure 3: Photo not available.

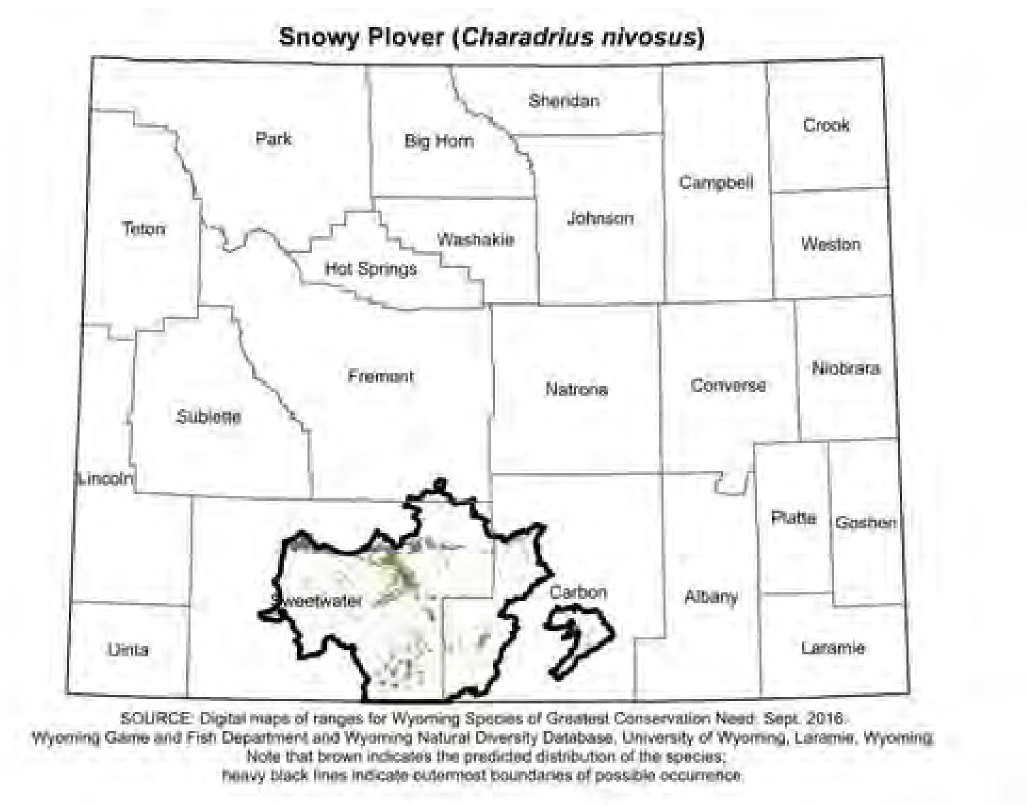

Figure 4: Range and predicted distribution of *Charadrius nivosus* in Wyoming.

Swainson's Hawk
Buteo swainsoni

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: Bird of Conservation Concern
WGFD: NSSU (U), Tier II
WYNDD: G5, S5
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 12

STATUS AND RANK COMMENTS
Swainson's Hawk (*Buteo swainsoni*) has no additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:
Swainson's Hawk is monotypic. No subspecies are currently recognized [1].

Description:
Identification of Swainson's Hawk is possible in the field. Swainson's Hawk measures 48–56 cm from bill to tail and has a wingspan of approximately 130 cm [1, 2]. Females are larger than males but plumage is identical between sexes. However, plumage varies among light, dark, and intermediate morph individuals. In flight, light morph birds have white or pale buff wing-linings (leading edge of wing) with sharply contrasting dark-brown barred flight feathers on the trailing edge of the wing. The tail is grayish brown with narrow dark bands. Light morph birds have a white chin, conspicuous dark-brown or rufous "bib" on the breast, and a white or pale buff belly. Dark morph birds lack a white chin and are uniformly dark-brown to rufous-brown or black-brown, lacking the contrast between the wing-linings and flight feathers when seen in flight. Intermediate morphs may have a range of characteristics of both light and dark morphs, but typically have a white chin and dark-brown bib. The belly of intermediate birds is typically heavily barred rufous or dark-brown. Juveniles are similar in appearance to adults of the same morph but have heavy dark streaking or spotting on the breast and belly and an incomplete bib. In flight, Swainson's Hawk is distinguished from other hawks in Wyoming by the dark flight feathers on the trailing edge of the wing. Red-tailed Hawk (*B. jamaicensis*) differs from Swainson's Hawk in that it has a red tail, dark belly-band instead of a breast bib, and dark

patagial marks on the leading edge of the underside of the wing between the body and wrist [1, 2]. Dark morph individuals of many *Buteo* spp. can be difficult to differentiate.

Distribution & Range:
Swainson's Hawk breeds across much of inland western North America from southern Canada to northern Mexico. Wyoming is centrally located within the breeding range of Swainson's Hawk. Almost the entire population winters in South America on the pampas in Argentina [1]. Swainson's Hawk has been largely extirpated from its former breeding range in southern California [1].

Habitat:
Swainson's Hawk forages in open grasslands, shrub-steppe, and prairies, as well as agricultural areas where crop height does not greatly exceed that of native grasses (e.g., hay, wheat, alfalfa) [1, 3]. In Wyoming, the species generally occurs in these habitats below 2,750 m in elevation [4]. Swainson's Hawk nests in a variety of isolated or scattered trees or tall shrubs within or adjacent to foraging habitat. In the Laramie Plains in Wyoming, nest trees ranged from Narrowleaf Cottonwood (*Populus angustifolia*) to relatively isolated willow shrubs (*Salix* spp.) [5]. Swainson's Hawk seems to tolerate human activity and frequently nests in farmsteads, shelterbelts, and the outskirts of urban areas where trees planted by people can offer nesting structures otherwise limited or absent in the surrounding landscape [4, 6, 7]. The species will occasionally nest on telephone poles and on the ground when trees are absent [1, 5].

Phenology:
In Wyoming, Swainson's Hawk typically returns from wintering grounds beginning in mid-April, with the number of spring migrants peaking in late-April. Nest initiation has been reported from early May to mid-June in Wyoming [4, 5]. Incubation lasts 34–35 days and nestlings fledge at about 43 days of age, typically in early to mid-August [1]. Fall migration typically begins in late August and mid-September, with large flocks moving south feeding on grasshoppers and other prey at stopover locations [1, 4, 8]. Migration may continue through October in Wyoming, but is finished by the beginning of November [4].

Diet:
During the breeding season, Swainson's Hawk feeds largely on vertebrate prey, especially ground squirrels, pocket gophers, voles, and deer mice. Swainson's Hawk also feeds on birds, bats, and reptiles [1]. Outside of the breeding season, the species feeds largely on invertebrate prey, especially grasshoppers, dragonflies, butterflies, and moths. Swainson's Hawk will hunt from either the ground or the air and often follows agricultural equipment to catch prey disturbed by machinery [1].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: COMMON
Based on results from Breeding Bird Survey (BBS) data, Partners in Flight estimated the Wyoming population of Swainson's Hawk to be about 13,000 birds in 2013 [9]. The global population is estimated to be 580,000 birds [9].

Population Trends:
Historic: UNKNOWN
Recent: STABLE

Trend data from BBS routes in Wyoming from 1966–2013 suggest that the overall population is likely stable, however, results are not conclusive due to limited number of detections [10]. Swainson's Hawk suffered extreme declines in Canada and the northern United States by the early 1900's largely due to persecution by settlers; however, shooting is no longer believed to be a significant threat to species [1]. More recently, Swainson's Hawk has declined in California, Oklahoma, southeastern Oregon, Alberta, Saskatchewan, and the central mixed grass prairie, but appears to be relatively stable or possibly increasing elsewhere in its range [1, 7, 10-12].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Swainson's Hawk is moderately vulnerable to extrinsic stressors because the entire North American breeding population winters within a relatively small area in northern Argentina. Thus, any changes to migration or wintering habitat that negatively impact Swainson's Hawk (e.g., habitat loss, misuse of agrochemicals, etc.) could severely threaten the species as a whole [1, 8, 13].

Extrinsic Stressors:
MODERATELY STRESSED
Factors that influence availability of prey threaten Swainson's Hawk persistence. Application of pesticides to control insect or rodent populations has both direct and indirect negative impacts on Swainson's Hawk through toxicity and reduced prey availability. During 1995–1996, application of organophosphate insecticides to control grasshoppers in Argentina resulted in the death of over 20,000 Swainson's Hawks within hours of being sprayed or within days of ingesting poisoned grasshoppers [1]. Although Swainson's Hawk commonly breeds and forages in certain types of agricultural landscapes, the species cannot forage in crops that grow much taller than native grasses or that have dense vegetative cover [1]. Thus, conversion of native grassland, prairie, and shrub-steppe habitat to cropland can negatively impact Swainson's Hawk depending on the type of crops planted [1, 7].

KEY ACTIVITIES IN WYOMING

The Wyoming Game and Fish Department and the Bureau of Land Management (BLM) have cooperatively surveyed for raptors in northeastern Wyoming on BLM lands and the Thunder Basin National Grassland periodically since 1996. Although timing of surveys (April and May) are somewhat early to detect nest initiation by Swainson's Hawk because the species arrives on breeding grounds later than other raptors, these surveys typically detect some Swainson's Hawk nests [14, 15]. Annual monitoring surveys for raptors, including Swainson's Hawk, have been conducted in the Pinedale Anticline oil and gas development area since 2009 [16]. Bird monitoring programs such as BBS and Integrated Monitoring in Bird Conservation Regions also detect Swainson's Hawk in limited numbers [10, 17].

ECOLOGICAL INFORMATION NEEDS

Anthropogenic changes to prairie ecosystems that result in an increase in nesting structures (e.g., planting of shelterbelts around homesteads and crop fields, construction of transmission lines) has increased populations of competitors for both nest sites and prey, such as Red-tailed Hawk and Common Raven (*Corvus corax*) [11, 18]. Because Swainson's Hawk arrives on breeding grounds later than other predatory bird species, information is needed on how changes in abundance of competitors could influence territory and nest site availability for Swainson's Hawk in Wyoming. Knowledge of Swainson's Hawk demographics, especially productivity and recruitment, is needed for Wyoming. Information is also needed on how pesticide use in

Wyoming could be affecting local Swainson's Hawk populations either directly through contamination or indirectly through reduced prey availability. Lastly, the ecology of Swainson's Hawk during migration is poorly understood and information is needed on how changes in land-use and exposure to pesticides along migration routes could impact the species [1].

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Zachary J. Walker. Swainson's Hawk is classified as a Species of Greatest Conservation Need in Wyoming due to extrinsic stressors, and lack of information regarding nesting and current populations within the state. Management priorities for the species in the short-term will focus on addressing data deficiencies. Information should be gathered on nesting success, distribution, population status, and the impact of potential threats. Any information gathered will ultimately be used to develop management and conservation recommendations for this species. Best management practices for this species include the management of nesting habitat to minimize loss of nesting pairs, avoiding pesticide use in nesting habitats during the breeding season, and maintaining functioning grassland and riparian habitats. Existing monitoring data do not support estimates of occupancy, density, or population trend. Targeted, species-specific survey methods may be needed for this species.

CONTRIBUTORS

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Figure 1: Adult Swainson's Hawk near Hutton National Wildlife Refuge, Wyoming. (Photo courtesy of Kimberly Szcodronski, WGFD)

Figure 2: North American range of *Buteo swainsoni*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Shrub-steppe habitat of Swainson's Hawk. (Photo courtesy of Robin Greene)

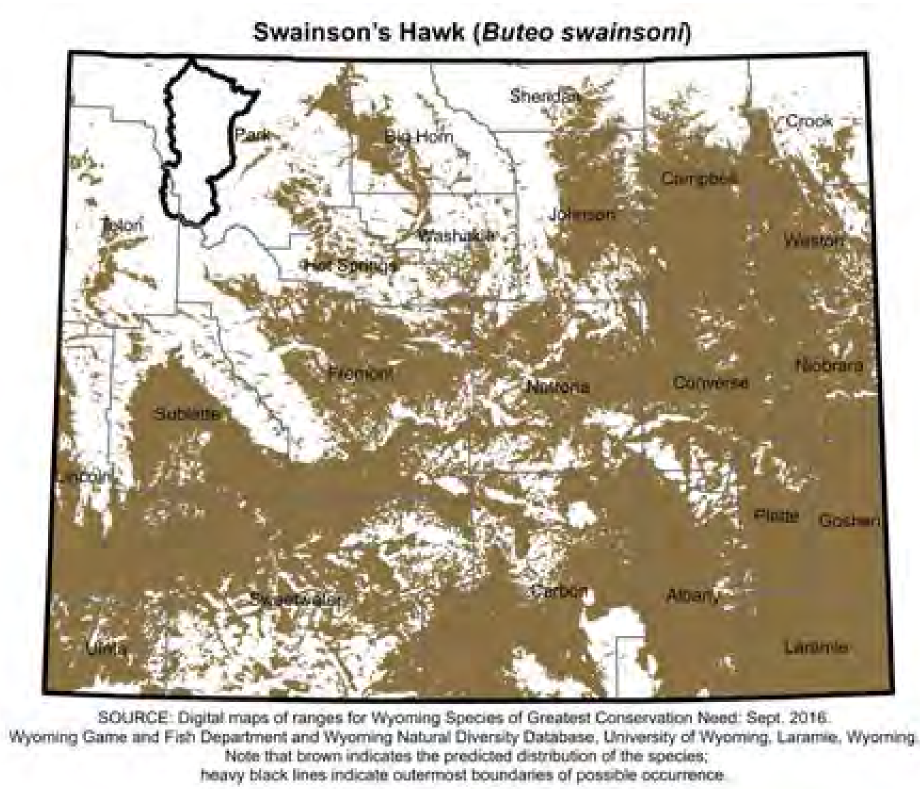

Figure 4: Range and predicted distribution of *Buteo swainsoni* in Wyoming.


Figure 5: Adult Swainson's Hawk in flight in Colorado. (Photo courtesy of Bill Schmoker)

Trumpeter Swan
Cygnus buccinator

Regulatory Status
USFWS: Listing Not Warranted; Migratory Game Bird
USFS R2: Sensitive
USFS R4: Sensitive
Wyoming BLM: Sensitive
State of Wyoming: Game Bird (see regulations); Protected Bird

Conservation Ranks
USFWS: No special status
WGFD: NSS2 (Ba), Tier II
WYNDD: G4, S3
Wyoming Contribution: HIGH
IUCN: Least Concern
PIF Continental Concern Score: Not ranked

Status and Rank Comments
In 1989, the Tri-State Area flock (see Distribution & Range, below) of Trumpeter Swan (*Cygnus buccinator*) was petitioned for listing as a Distinct Population Segment (DPS) under the Endangered Species Act. In 2003, the United States Fish and Wildlife Service determined that listing was not warranted because the Tri-State Area flock did not represent a DPS [1]. Resident Trumpeter Swans in Wyoming are managed through the Pacific Flyway which designates these birds are part of the U.S. segment of the Rocky Mountain Population (RMP) [2].

Natural History

Taxonomy:
There are no recognized subspecies of Trumpeter Swan [3], but swans in the Pacific Coast region show greater genetic diversity than those in the RMP [4].

Description:
Identification of Trumpeter Swan is possible but it can be difficult in the field to distinguish it from its close relative the Tundra Swan (*C. columbianus*), which is an uncommon seasonal migrant in Wyoming [5, 6]. Trumpeter Swan is the largest waterfowl in the world, with a wingspan of 2 to 2.4 m, and a body length of 1.4 to 1.6 m when fully grown [7]. Males and females are similar in appearance but males are larger. It is an all-white bird, except for the feet, legs, and bill, which are all black in most adult birds [8]. It has a long neck, which is held outstretched in flight and vertically when swimming [8]. Young birds have grayish plumage, retaining some gray feathers into their second year, and becoming all-white by their third year.

Distribution & Range:
Trumpeter Swan was formerly widely distributed across North America, with a breeding range extending from Alaska and the Pacific Northwest across to Ontario, Canada, and south into the northern Rockies including Wyoming, across the plains states, and into portions of the northeast

United States [3]. The species was nearly eliminated by market and subsistence hunting by the turn of the 20th century and the current range is much reduced, with three distinct breeding populations. The Pacific Coast Population is the largest and extends from central Alaska south and east into western portions of the Yukon Territory and British Columbia [9]. The restored Interior Population includes birds in the central Canadian provinces, north-central United States, and western Great Plains, including rare stragglers into eastern and possibly central Wyoming [7]. The RMP is composed of two distinct segments. The U.S. resident flock is composed of relatively sedentary individuals that reside year round in western Wyoming, eastern Idaho and southwestern Montana (referred to as the Greater Yellowstone Area flocks) plus other isolated flocks in Nevada, Oregon, and Montana [2, 10]. Current distribution in Wyoming includes Yellowstone National Park (YNP), and the Snake, Salt, and Green River drainages with a small number also in the Wind River drainage [11]. The RMP also includes a large Canadian migratory segment, which winters in the Greater Yellowstone and surrounding areas with a summer range that extends from eastern Yukon and Northwest Territories to Alberta and western Saskatchewan in Canada.

Habitat:
Trumpeter Swan requires freshwater wetlands year round. These include marshes, ponds, lakes, and slow moving areas in streams, and rivers [3]. For breeding, the species requires at least 4 ha of wetland habitat with at least 100 m of open water for takeoff. Breeding habitat must also have abundant accessible aquatic vegetation and aquatic insects. Suitable wetlands are shallow, generally below 1.2 m in depth, with dense emergent vegetation, fairly stable water levels, and minimum human disturbance [12]. Nests are placed on small islands, floating sedge mats, muskrat lodges or on shorelines [3, 13]. Trumpeter swan pairs are highly territorial and aggressively defend nest sites from other swans [3]. Accessibility to adequate foraging habitat in the pre-laying period appears to be related to Trumpeter Swan nest success and productivity [14]. During migration, the species will use a variety of marshes, lakes, inlets, outlets, rivers, and brackish estuaries, often dictated by ice levels [3]. Overwinter habitat includes freshwater springs, streams, rivers, ponds, lakes, and reservoirs that remain unfrozen [3]. Areas used in Wyoming in the winter are dictated by available open water, forage, and ice conditions [3].

Phenology:
The breeding season typically begins in late April although can vary widely depending on annual weather patterns. Often pairs occupy nest sites before the ice has melted from the breeding site and begin nest building. Nest construction takes 11–35 days. Incubation ranges from 32–37 days, and young develop the ability to fly at about 100 days of age [7]. For migratory populations, fall migration may begin in September, but typically occurs from mid-October to late November as waters freeze [3]. Birds of the RMP migratory flock overwinter in the Greater Yellowstone area, arriving in late October through November and departing in March to return north [3].

Diet:
Trumpeter Swan feeds primarily on the leaves, stems, roots, and tubers of submerged, floating, and emergent aquatic plants. Occasionally it will eat fish (*Oncorhynchus* spp.) and fish eggs. Cygnets feed upon aquatic invertebrates until they are about 5 weeks old [3, 7]. In winter, swans in some areas have learned to field feed in grain and potato fields [3]. Most important aquatic plant species in western Wyoming include *Potamogeton pectinatus*, *Elodea canadensis*, *Myriophyllus exalbescens*, and *Chara*, spp. [14].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD BUT PATCHY
Wyoming: VERY RARE
Trumpeter Swan abundance in Wyoming differs between the breeding and non-breeding seasons. Trumpeter Swan numbers increase in late fall through mid-March with an influx of Canadian migrants. In February of 2015, a total of 931 Trumpeter Swans (776 adults and 155 cygnets) were documented in Wyoming compared to a September count, prior to the arrival of migrants, of 303 swans (212 adults and 65cygnets outside of YNP, and 20 adults and 6 cygnets in the park) [15, 16]. This represents a 3-fold increase of swans in winter.

Population Trends:
Historic: LARGE DECLINE
Recent: INCREASE
Trumpeter Swan was eliminated from most of its historic range by the early 1990s, decimated by market and subsistence hunting over the previous century [2]. A remnant flock of fewer than 100 resident birds remained in the vicinity of YNP and a similar number migrated to the Yellowstone area from interior Canada [2]. There were also scattered flocks, of unknown numbers, in areas of Canada and Alaska [2]. Conservation efforts, first started in the 1930s and increasing from the 1980s to the current period have led to increases in Trumpeter Swan numbers range-wide [3]. Management actions have included translocations of both wild and captive-raised swans, reintroductions, wetland habitat conservation and management, and protection from shooting [2, 3]. The RMP Canadian migratory flock has steadily increased since 1972 [16]. The RMP Greater Yellowstone Area flock has fluctuated sporadically with a peak of 601 swans in 1988 and a low of 277 in 1993 [2]. From 2000 to 2014 total numbers have ranged between 326 and 589 birds [17]. Since 2012, the number of adult and subadult birds increased to over 400 for the first time since 1991 [17].

Intrinsic Vulnerability:
HIGH VULNERABILITY
The resident breeding population of Trumpeter Swans remains very small in Wyoming so is vulnerable to stochastic events that could result in catastrophic declines. Trumpeter Swan has very specific habitat requirements during the breeding season and is highly territorial [3]. Also annual productivity is highly variable, and only a small percentage of occupied nest sites consistently produce young year to year [11]. Individuals have strong fidelity to nest sites (even unproductive sites) and to wintering sites [11] which can result in overcrowding in some areas, potentially increasing the risks of disease transmission, food shortage, and mass mortality events [2, 3]. Given its size and weight, Trumpeter Swan is subject to death and injury by collisions especially when taking off or landing.

Extrinsic Stressors:
MODERATELY STRESSED
Principle threats to breeding Trumpeter Swans in Wyoming includes limited high quality shallow water wetland habitat year-round and continued wetland habitat loss as a result of climate change, drought and increasing human development [2, 3, 11]. Increasing number of over-wintering migrants may be depleting forage especially in late winter and early spring for the Wyoming resident, breeding population [11]. The species is sensitive to human disturbance, and increasing recreational activities, especially fishing and boating, can cause appropriate habitat to

be abandoned or unused [7]. All swan species are vulnerable to diseases such as avian influenza, West Nile, avian cholera, and botulism [3]. Collisions with power lines, fences, or bridges are an important mortality factor and resulted in the death of 47 birds in Wyoming between 1991 and 2015 [3, 11]. Though Trumpeter Swan is protected from hunting, accidental shooting by waterfowl hunters and recreational shooters has been documented across the species' range [2, 3]. Lead poisoning through the ingestion of lead shot and fishing tackle, can cause significant mortality [3]. Attempts to establish more migratory behaviors and additional pathways are limited by the lack of available winter and stopover habitat [2]. Although the number of nesting pairs has increased since 2004 in the Green River basin, challenges remain for swans nesting in the Greater Yellowstone area [11, 18]. Winter distribution of swans in Wyoming has increased over the last 30 years as a result of the range expansion efforts but over 50% continue to concentrate in the Jackson area where open water habitat is limited especially in severe winters [11].

KEY ACTIVITIES IN WYOMING

Active monitoring and management of Trumpeter Swan has been performed by the Wyoming Game and Fish Department (WGFD) since the 1980s (WGFD annual reports). Range expansion efforts have resulted in development of new wintering areas in the Salt and Green River drainages, and a new, growing nesting population in the Green River basin [19]. Monitoring efforts have included aerial and ground surveys to track number of resident and migrant swans and number of nesting pairs and annual productivity [11]. An annual fall survey in September in coordination with other state and federal agencies provides a total count of the Greater Yellowstone Area breeding population. Annual, coordinated winter surveys were discontinued after 2015 due to budget constraints [11]. Since 2005, WGFD has focused working with a number of partners to develop additional shallow water wetland habitat in the Green River basin to provide additional summer habitat [12, 20]. WGFD is a member of the Greater Yellowstone Trumpeter Swan Working Group which meets yearly to compile data, and make recommendations to the Pacific Flyway on Trumpeter Swan management issues and allocations of captive-raised swans.

ECOLOGICAL INFORMATION NEEDS

Landscape level wetland habitat inventories and assessments are needed to determine the amount of unoccupied, yet suitable habitat throughout the state [7]. As assessment of site-specific habitat selection by swans in Wyoming would also provide valuable information for modeling habitat availability and for guiding future habitat restoration range expansion work [11]. Data are lacking on dispersal and survivorship of sub-adults.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Susan M. Patla. Trumpeter Swan management efforts by the WGFD since 1994 has resulted in establishment of an expanded nesting and wintering population in the Green River basin in Wyoming. This has more than doubled the distribution and number of nesting pairs in the state and greatly increased cygnet production [20]. In addition, working with willing landowners and other agencies in the Green River basin, the WGFD has helped to fund and create over 60 acres of new shallow water summer wetland habitat for swans on private lands since 2004. While the number of nesting pairs in the Green River area has increased, few nest sites in the Snake River core area of Wyoming show consistent productivity, and loss of historic sites has occurred including in YNP [11, 18]. YNP is currently implementing a

10 year plan to sustain their declining nesting population (D. Smith, pers. comm.). Monitoring and management efforts for swans are coordinated through the Greater Yellowstone Trumpeter Swan Working Group and the Trumpeter Swan sub-committee of the Pacific Flyway. Future priority management actions should include: 1) continue to coordinate with the Greater Yellowstone Trumpeter Swan Working Group and the Pacific Flyway on monitoring efforts, and developing region-wide management strategies; 2) monitor and conserve all productive nest sites in Wyoming; 3) identify potential problems at low productivity nest sites that swans continue to occupy and implement actions such as installing nest platforms or enhancing aquatic vegetation growth; 4) continue to work with partners to identify, fund, and create additional summer wetland habitat capable of supporting nesting swans in Wyoming; 5) complete a habitat selection study of nesting pairs and develop GIS habitat models to identify and quantify potential swan nesting habitat throughout Wyoming; 6) work with land trusts, county conservation districts, and other partners to prioritize and implement wetland conservation strategies identified in the state and regional Wetland Conservation Plans; 7) continue to monitor mortality and work with the state veterinary lab to complete necropsies; and 8) conduct educational programs, wetland seminars, and field trips to involve the public in swan and wetland conservation.

CONTRIBUTORS

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Figure 1: Trumpeter Swan in Seedskadee National Wildlife Refuge, Sweetwater County, Wyoming. (Photo courtesy of Tom Koerner, USFWS)

Figure 2: North American range of *Cygnus buccinator*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Trumpeter Swan habitat in the upper Green River Basin, Wyoming. (Photo courtesy of Mark Gocke, WGFD)

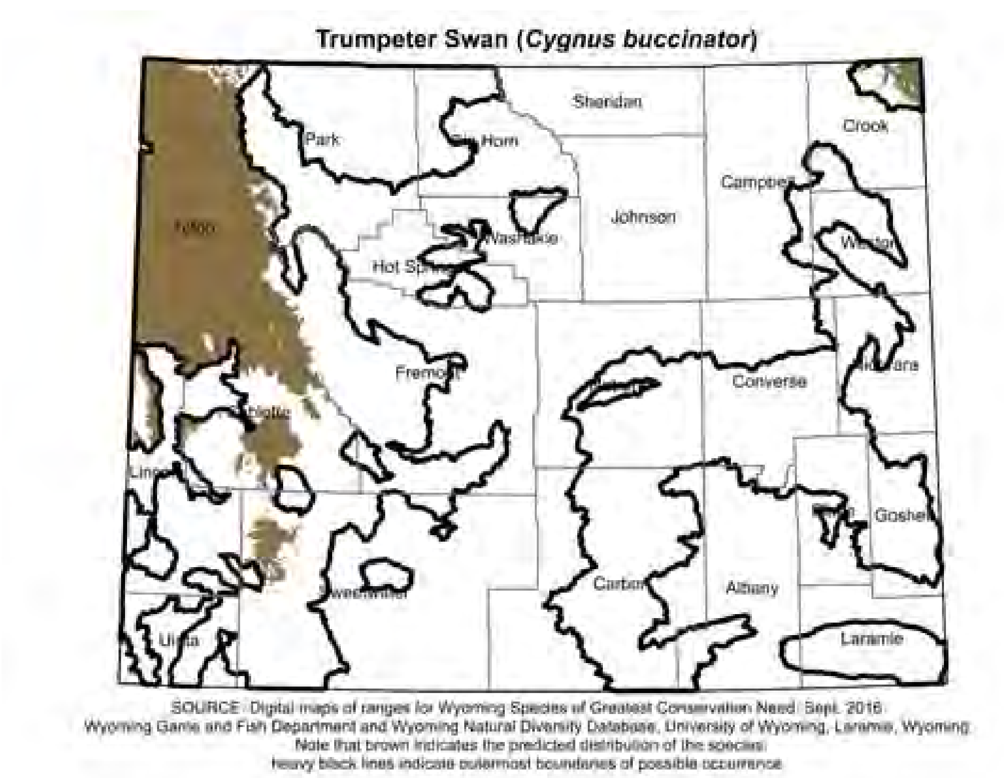

Figure 4: Range and predicted distribution of *Cygnus buccinator* in Wyoming.

ꕥ Wyoming Species Account ꕥ

Upland Sandpiper

Bartramia longicauda

REGULATORY STATUS

USFWS: Migratory Game Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Game Bird (see regulations); Protected Bird

CONSERVATION RANKS

USFWS: Bird of Conservation Concern
WGFD: NSSU (U), Tier II
WYNDD: G5, S4S5
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: Not ranked

STATUS AND RANK COMMENTS

Upland Sandpiper (*Bartramia longicauda*) is assigned a range of state conservation ranks by the Wyoming Natural Diversity Database due to uncertainties over population trends for this species in Wyoming.

NATURAL HISTORY

Taxonomy:

There are currently no recognized subspecies of Upland Sandpiper [1, 2].

Description:

Identification of Upland Sandpiper is possible in the field. It is a medium sized shorebird, 28 to 32 cm long. Males and females are identical in appearance. The species is similar to other shorebirds, possessing long legs, a short neck, and a small head. The bill is yellow with a black tip. The head is dovelike in appearance. Upland Sandpiper has cryptic coloration, with dull olive to brown-buff upperparts, and whitish to dull yellow underparts. It has strong patterns and streaks on the head, neck, back, wings, flanks, and breast. Juveniles are similar in appearance to adults, but have a pale head. In the species' habitat, the only similar species is Mountain Plover (*Charadrius montanus*). Mountain Plover has a short bill, and lacks patterns and streaking to its plumage [1, 3]. Other shorebirds are similar in appearance, but are typically associated with habitats where Upland Sandpiper is unlikely to be found.

Distribution & Range:

During the breeding season, Upland Sandpiper is distributed across North America. The species is most commonly found in the northern Great Plains. Scattered breeding occurs as far northwest as Alaska, west to California, and east to New England. Wyoming is at the western edge of the species distribution in the Great Plains. The species migrates to South America for the winter.

Range contractions have occurred throughout the species range as native grasslands have been lost [1].

Habitat:
Upland Sandpiper is associated with grassland habitats. In particular, native prairie habitats are preferred. Habitat use in Wyoming has not been studied, though is likely similar to habitat use in nearby states. In the Great Plains, the species uses native grasslands, fields held in the Conservation Reserve Program, agricultural fields, grazed pastures, hayfields, and mountain meadows. Suitable breeding habitat is characterized by moderately tall, dense vegetation for nest concealment [1]. The highest concentrations of breeding individuals in Wyoming occur in mixed-grass prairie in the eastern regions of the state [4, 5]. Habitat use is similar during migration, but little is known about habitat associations on the winter grounds [1].

Phenology:
Upland Sandpiper arrives in Wyoming in May [5]. Nest construction occurs about two weeks after arrival and incubation lasts 23 to 24 days on average. Young are precocial upon hatching, and forage for food on their own with the parents until fledging at about 30 days of age [1]. Fall migration in Wyoming is likely in August [5].

Diet:
Upland Sandpiper primarily feeds upon small invertebrates, though small amounts of weed seeds are eaten [1].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: UNCOMMON
There are no robust estimates of abundance for Upland Sandpiper in Wyoming. The species has a statewide abundance rank of UNCOMMON and also appears to be uncommon within suitable environments in the occupied area [6]. From 1968–2015, annual Wyoming Breeding Bird Survey (BBS) detections of Upland Sandpiper ranged from 0 to 60 (average = 22), with 60 recorded in 2015 [7]. Annual detections of Upland Sandpiper ranged from 2 to 59 during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [8]. While surveys conducted as part of the BBS and IMBCR programs do detect this species, neither is specifically designed to capture sandpiper observations.

Population Trends:
Historic: LARGE DECLINE
Recent: UNKNOWN
Historically, Upland Sandpiper experienced large declines in parts of its continental distribution, which are largely attributed to the loss of native prairie habitat [1]. Survey-wide trend data from the North American BBS indicate that Upland Sandpiper increased by 0.49% annually from 1966–2013 and 0.78% annually from 2003–2013; however, neither survey-wide estimate was statistically significant [9]. Wyoming BBS trend data indicate that Upland Sandpiper experienced statistically significant annual increases of 6.14% from 1968–2013 and 5.60% from 2003–2013 [9].

Intrinsic Vulnerability:
MODERATE VULNERABILITY

The habitat specificity of Upland Sandpiper makes the species vulnerable. The species is restricted to grassland type habitats. Additionally, suitable grassland habitats for Upland Sandpiper must have relatively tall and dense vegetation for nest concealment [1].

Extrinsic Stressors:
SLIGHTLY STRESSED
Little is known about Upland Sandpiper habitat use in Wyoming. It is thought that the species' habitat is slightly threatened by human and environmental factors in the state, such as wind and other natural resource development, as well as long term climactic factors such as global climate change [10]. The species is sensitive to habitat alteration and conversion, such as the conversation of native grasslands to cropland. These types of activities may place the species at risk in Wyoming [5].

KEY ACTIVITIES IN WYOMING

Upland Sandpiper is classified as a Species of Greatest Conservation Need (SGCN) by the Wyoming Game and Fish Department (WGFD), and as a Level I Priority Bird Species requiring conservation action in the Wyoming Bird Conservation Plan [11]. In 2015, WGFD initiated a targeted grassland SGCN monitoring program for Upland Sandpiper, Mountain Plover, Long-billed Curlew, and Burrowing Owl [12]. Upland Sandpiper is detected annually during BBS and IMBCR surveys in Wyoming; however, the species is not detected frequently by either program.

ECOLOGICAL INFORMATION NEEDS

Robust estimates of abundance and population trends are lacking for Upland Sandpiper in Wyoming. The species has shown sensitivity to human impacts on the landscape such as agriculture and ranching, and it is unknown how severe these impacts may be on the species in Wyoming.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Zachary J. Walker. Upland Sandpiper is considered a SGCN in Wyoming due to habitat degradation, conversion, and fragmentation. General large-scale bird monitoring programs may not be adequately monitor Upland Sandpiper. It is recommended that species specific monitoring should continue for this species in the long term. Additional work could be conducted to examine landscape impacts of habitat development on this species. Best management practices for Upland Sandpiper include maintenance of large (> 125 acres) tracts of suitable grassland habitat. High intensity grazing and spring mowing should be avoided. If habitat disturbances are required, utilize practices where some habitats reach a climax successional stage and numerous suitable habitat patches are retained. Prescribed burns should occur in the fall and designed to maintain nesting cover. Protect habitat around moist soils where Upland Sandpiper can breed.

CONTRIBUTORS

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Figure 1: Adult Upland Sandpiper in Logan County, Colorado. (Photo courtesy of Bill Schmoker)

Figure 2: North American range of *Bartramia longicauda*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Grassland habitat in Thunder Basin National Grassland, Wyoming. (Photo courtesy of Michael T. Wickens)

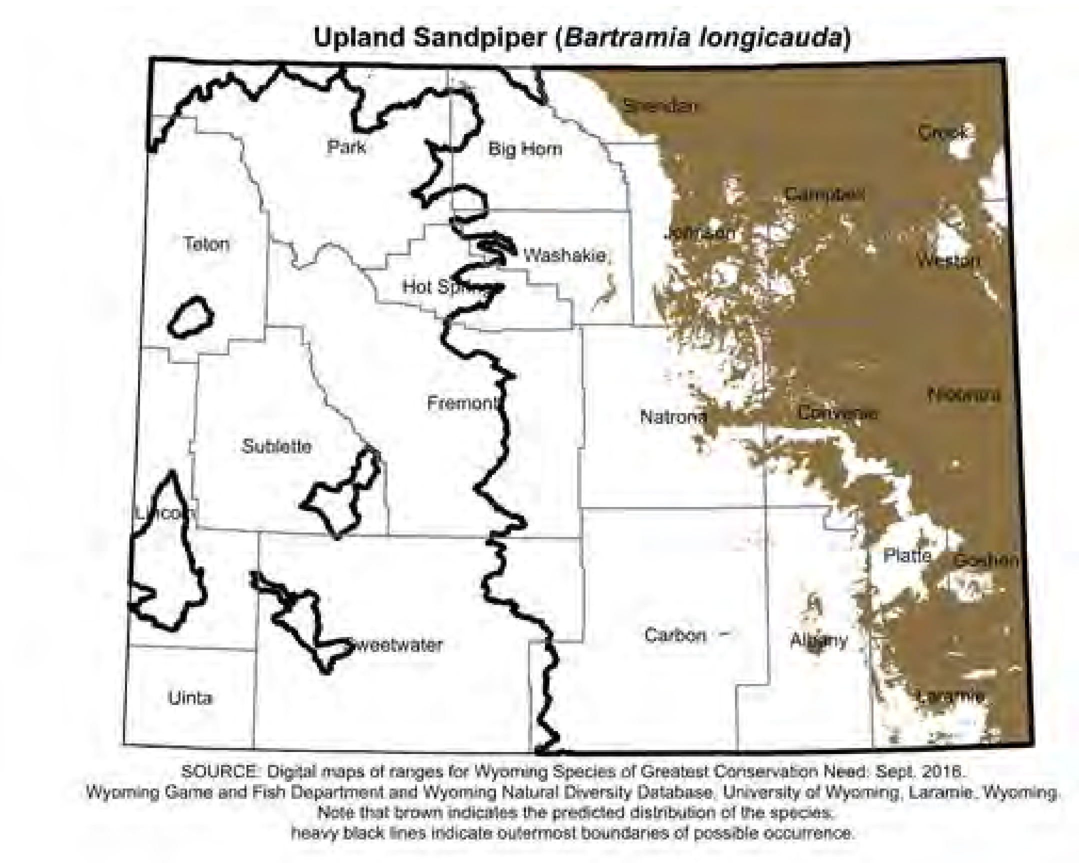

Figure 4: Range and predicted distribution of *Bartramia longicauda* in Wyoming.

Figure 5: Upland Sandpiper in flight in Logan County, Colorado. (Photo courtesy of Bill Schmoker)

Virginia Rail
Rallus limicola

REGULATORY STATUS
USFWS: Migratory Game Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Game Bird (see regulations); Protected Bird

CONSERVATION RANKS
USFWS: No special status
WGFD: NSSU (U), Tier III
WYNDD: G5, S2S4
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: Not ranked

STATUS AND RANK COMMENTS
The Wyoming Natural Diversity Database has assigned Virginia Rail (*Rallus limicola*) a state conservation rank ranging from S2 (Imperiled) to S4 (Apparently Secure) because of uncertainty about the abundance, state range, proportion of range occupied, population trends, and extrinsic stressors for this species in Wyoming.

NATURAL HISTORY

Taxonomy:
There are two recognized subspecies of Virginia Rail, but only *R. l. limicola* is found in the United States [1].

Description:
Identification of Virginia Rail is possible in the field. It is a small waterbird with a laterally compressed body; adults weigh approximately 55–124 g, have a total length of 22–27 cm, and a wingspan of approximately 33 cm [2, 3]. The sexes are similar in appearance, although males average slightly larger than females [2, 4]. Virginia Rail has a brown crown; gray face; reddish-brown throat and breast; back streaked with light and dark brown; chestnut brown wings; black and white banded flanks; and a short, upturned tail [2, 3]. The reddish-orange bill is slightly decurved and darkens to dusky brown towards the tip and along the top of the upper mandible [2]. The eyes are red to reddish-brown, the feet and legs are orange-brown, and the toes are distinctly long and thin, which enables it to walk on floating aquatic vegetation [2]. Sora (*Porzana carolina*) is another small rail species that breeds in Wyoming, but it is easily distinguished from Virginia Rail by its dark face, short yellow bill, and greenish-yellow legs [3].

Distribution & Range:
The breeding distribution of Virginia Rail extends from coast to coast across the northern and western United States and north into southern Canada [2]. Most of Wyoming falls within one of

several large gaps in the western portion of this core breeding distribution; however, Virginia Rail migrates through the state in the spring and fall and is also a summer resident [5, 6]. The species has been observed across much of Wyoming in appropriate environments, but breeds primarily in the southern half of the state [2]. Suspected or confirmed breeding has been documented in 11 of the 28 latitude/longitude degree blocks in Wyoming [6].

Habitat:
Virginia Rail is found in natural, freshwater wetland and marsh habitats, as well as brackish or saltwater marshes, and seasonal or semi-permanent ponds and lakes [2, 7, 8]. In Wyoming and across its distribution, Virginia Rail primarily breeds in early-stage, invertebrate-rich, freshwater marshes with thick stands of emergent vegetation, shallow to intermediate water depths, and muddy substrate [2, 9-11]. The structure of emergent vegetation is likely a more important habitat characteristic than dominant plant species [2, 10]. Virginia Rail nests are loosely woven baskets of vegetation that are typically constructed less than 15 cm above the water surface at the base of dense emergent vegetation [2, 10]. Nests are made from the dominant emergent plant species at the nesting site, and standing adjacent vegetation may be bent over the top of the nest to create a concealing canopy [2, 10]. Adults continue to add plant material to nests throughout the breeding season, especially in response to rising water levels [2, 12].

Phenology:
In Wyoming, migrating and breeding Virginia Rails begin to arrive in late April, with most birds arriving by mid-May [5]; however, little is known about the specific nesting and breeding habits of this species in the state. Range-wide, first clutches range from 4–13 eggs (average 8.5 eggs), and Virginia Rail may have two broods per season in some areas [2, 10]. Both sexes take turns incubating the eggs for approximately 19 days and will brood the young for 4–7 days following hatching. Chicks are covered in solid black down and leave the nest in just 3 or 4 days [2]. Young can feed themselves when they are 1 week old and can fly at the age of 4 weeks [2]. The timing of fall migration from Wyoming is not well-documented, but likely occurs in September and October [5].

Diet:
Virginia Rail primarily feeds on a variety of terrestrial and aquatic invertebrates, including many insects, slugs, snails, spiders, worms, larvae, and crayfish, but may also consume frogs, small fish and snakes, aquatic plants, and seeds from emergent vegetation [2].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
There are no robust estimates of Virginia Rail abundance in Wyoming. The secretive nature and densely-vegetated habitat of Virginia Rail make it very difficult to detect using standard visual survey methods [2, 13, 14]. Virginia Rail has an estimated statewide abundance rank of VERY RARE, and its prevalence within suitable environments in the state is unknown [6]. From 1968–2015, annual Wyoming Breeding Bird Survey (BBS) detections of Virginia Rail ranged from 0 to 1, with none recorded in most years [15]. Only 1 Virginia Rail was detected during surveys for the Integrated Monitoring of Bird Conservation Regions (IMBCR) program between 2009–2015 [16]. While surveys conducted as part of the BBS and IMBCR programs may occasionally detect this species, neither is specifically designed to capture rail observations.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Robust population trends are not available for Virginia Rail in Wyoming or across its distribution because the species is infrequently detected during monitoring efforts [17]. The species has experienced population declines in some areas due to loss of wetland habitat [2].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Virginia Rail has moderate intrinsic vulnerability in Wyoming due to a narrow range of breeding habitats which limit its distribution and abundance in the state, and nesting habits that potentially leave the species vulnerable to nest loss. Productive wetland habitats are uncommon in Wyoming, which is one of the most arid states in the country [18, 19]. Virginia Rail nests are constructed near the surface of the water making them vulnerable to damage or loss from surface disturbance and fluctuating water levels [2], which commonly occur on waterbodies in Wyoming.

Extrinsic Stressors:
UNKNOWN
Extrinsic stressors of Virginia Rail in Wyoming are unknown. Natural wetlands in Wyoming are declining in size and number, with less than 2% of the total state area classified as wetland habitat [18, 19]. Existing wetland habitat in the state is potentially vulnerable to invasive plant species, climate change and drought, and development for infrastructure, energy, and agriculture [18, 19]. However, responses of Virginia Rail to similar extrinsic stressors in other parts of its distribution are mixed. While some studies have shown that this species is less abundant in wetland habitats dominated by invasive plants [7, 20], others found that Virginia Rail was positively associated with some invasive plants species [11, 21]. Although Virginia Rail has shown sensitivity to fluctuating water levels [2, 22-24], and typically avoids emergent vegetation that has been left dry by low water conditions [5], in some circumstances variable water levels may increase nest survival by protecting against predation from terrestrial predators [12]. The species may be less likely to use wetland habitats that have been altered or restored [20, 25]. Finally, Virginia Rail is at risk for bioaccumulation of heavy metals and other environmental contaminants from feeding in polluted aquatic habitats [2].

KEY ACTIVITIES IN WYOMING

Virginia Rail is classified as a Species of Greatest Conservation Need by the Wyoming Game and Fish Department (WGFD). Current statewide bird monitoring programs are designed for monitoring breeding songbird populations and are unlikely to provide useful information on Virginia Rail. These monitoring programs include the BBS program conducted on 108 established routes since 1968 [17], and the multi-agency IMBCR program initiated in 2009 [16]. Due to the secretive and solitary nature of Virginia Rail, breeding individuals may not be detected during typical waterbird surveys. In 2015, the WGFD implemented the Standardized North American Marsh Bird Monitoring Protocols [26] at 5 wetland sites across Wyoming, with a total of 10 survey routes that target 4 secretive marsh bird species, including Virginia Rail. Initial survey efforts detected Virginia Rail on 5 of the 10 routes in 3 of the 5 wetland sites [27].

ECOLOGICAL INFORMATION NEEDS

Virginia Rail would benefit from research to determine its detailed distribution, the location and habitat characteristics of current breeding sites, and the annual abundance of breeding adults in

Wyoming. The standard passive methodology used in many bird survey programs is unlikely to be effective in detecting Virginia Rail, so specialized call-response surveys are necessary to accurately predict abundance at known breeding locations [13, 14]. Very little is known about the specific breeding habits of this species in the state, with the exception of approximate arrival dates, and nothing is known about nest success or fledgling survival. Given Virginia Rail's dependence on productive marsh and wetland habitats, which are rare in Wyoming, it would be valuable to identify current and future anthropogenic and natural stressors to these habitat types to ensure the persistence of breeding locations for this species.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Virginia Rail is designated as a game species in Wyoming; however, it is functionally a nongame species in the state. WGFD has been working to identify important wetland habitats for Virginia Rail, and implemented a monitoring program for this species in 2015. Best management practices to benefit Virginia Rail include working with land management agencies to protect key wetland habitats on public lands, using conservation easements to protect important wetland sites on private lands, using available funding and mitigation programs to restore and create wetland habitats, and incorporating habitat needs of Virginia Rail into habitat management activities.

CONTRIBUTORS

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Figure 1: An adult Virginia Rail in Boulder County, Colorado. (Photo courtesy of Bill Schmoker)

Figure 2: North American range of *Rallus limicola*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Virginia Rail marsh habitat with cattails, sedges, and open water in Sublette County, Wyoming. (Photo courtesy of Elizabeth Boehm)

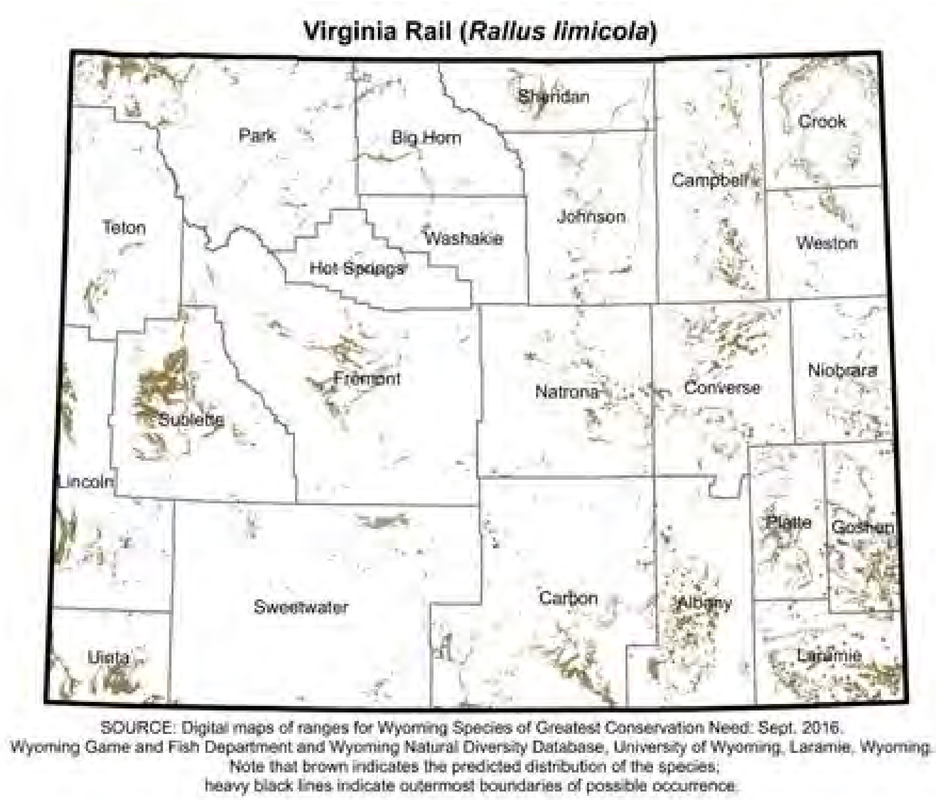

Figure 4: Range and predicted distribution of *Rallus limicola* in Wyoming.

Virginia's Warbler

Oreothlypis virginiae

Regulatory Status

USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

Conservation Ranks

USFWS: No special status
WGFD: NSSU (U), Tier II
WYNDD: G5, S1
  Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 14

Status and Rank Comments

Virginia's Warbler (*Oreothlypis virginiae*) does not have any additional regulatory status or conservation rank considerations beyond those listed above.

Natural History

Taxonomy:
Virginia's Warbler, along with five other wood warbler species in the genus *Verminorva*, were recently placed in the genus *Oreothlypis* [1]. Virginia's Warbler is a close relative of Nashville Warbler (*O. ruficapilla*), but the species have different plumage and breeding habitat requirements [2].

Description:
Virginia's Warbler is a small gray warbler with a bold white eye-ring, rufous-crown patch (not always obvious), yellow-green rump, and long tail that almost constantly pumps. It has a variable sized yellow patch on the breast, pale gray belly, and bright yellow undertail coverts. Sexes are similar, but males tend to have more rufous on the crown and more yellow on the breast [3]. Similar species in Wyoming include Nashville Warbler, Tennessee Warbler (*O. peregrina*), and Orange-crowned Warbler (*O. celata*). However, unlike Virginia's Warbler, Nashville Warbler has a yellow belly, Tennessee Warbler has white undertail covert's, and Orange-crowned Warbler has a broken white eye-ring [4].

Distribution & Range:
Virginia's Warbler reaches the northern extent of its core North American range in southwestern Wyoming [5, 6]. Information on its distribution and breeding status is limited. Virginia's Warbler appears to have a patchy breeding distribution in the rest of the state, including the Laramie Mountains, along the western North Platte River near Casper, and the Big Horn Mountains near Sheridan [5, 6]. Outside of Wyoming, its breeding range extends from southern Idaho through

appropriate montane habitat in Nevada, Utah, Colorado, Arizona, New Mexico, and the Guadalupe Mountains of Texas, plus small populations in eastern California. The discovery of a new breeding population in the Black Hills of South Dakota in 1997 suggests that additional breeding areas may exist [7]. Its main wintering habitat is thought to be in western and southern Mexico [3].

Habitat:
Virginia's Warbler nests on the ground in arid habitats with dense brush on mountain slopes, mostly from 1,219–2,793 m in elevation [3]. Its nest is well-concealed in a hollow or under a clump of vegetation [3]. Dominant shrubs can include serviceberry (*Amelanchier* spp.), mountain mahogany (*Cercocarpus* spp.), manzanita (*Arctostaphylos* spp.), currant (*Ribes* spp.), snowberry (*Symphoricarpos* spp.), Chokecherry (*Prunus virginiana*), and scrub oak (*Quercus* spp.). Over much of its range, Virginia's Warbler is associated with pinyon-juniper (*Pinus* spp.-*Juniperus* spp.) and oak woodlands, but the species can also be found in high altitude environments dominated by large conifers [2]. However, it does not occur in coniferous forests that lack a deciduous component, and the species shows a strong association for breeding in steep draws, drainages, or slopes with shrubby vegetation [8-10].

Phenology:
Virginia's Warbler is first seen in migration stopover sites in Wyoming in mid-May, and singing birds are found on nesting territories from mid- to late May [5]. Females arrive on territories a week later than males, and pair-bonding and nest building follows quickly [2]. The female builds the nest and incubates the eggs. Most clutches contain 3–5 eggs, which hatch within 11–14 days. Young fledge at 10–14 days old and are fed by adults for another 2 weeks. In Wyoming, the main southward movement of adults starts in August [5].

Diet:
Virginia's Warbler feeds on insects gleaned from the foliage of shrubs and trees, or from the air. Prey includes lepidopteran larvae (caterpillars), flying insects, spiders (Araneida), carpenter ants (*Camponotus* spp.), stinkbugs (Pentatomidae), and weevils (Curculionidae) [2].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
Using North American Breeding Bird Survey (BBS) data, the Partners in Flight (PIF) Science Committee estimated the global population of Virginia's Warbler to be 1.1 million birds [11]. Approximately 0.1% of the global population, or around 1,000 birds, is estimated to breed in Wyoming [12]; however, this abundance estimate should be viewed with caution given the low detection rate of this species in the state. The statewide rank of RARE is based on the rather small area of the state known to be occupied in any given season, and the small coverage of suitable habitat within that area. In addition, within suitable habitat in the occupied area, Virginia's Warbler appears to be uncommon, occurring in relatively low densities and requiring intensive survey efforts to detect the species [6]. BBS data show Virginia's Warbler to be most abundant in physiographic regions of piñon-juniper woodlands, while over most of its range it occurs in numbers of < 1 detection per route [13]. From 2009–2015, the Integrated Monitoring in Bird Conservation Regions (IMBCR) program detected just 2 Virginia's Warblers on surveys

conducted in Wyoming [14]. There are no robust estimates of density available for Virginia's Warbler in Wyoming.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Population trends are not available for Virginia's Warbler in Wyoming due to a limited distribution in the state and low detection rates during monitoring surveys. Currently, there are no robust North American BBS trend data for Virginia's Warbler in Wyoming [13]. However, 1966–2013 BBS western region trend analyses for this species suggest a statistically significant annual population decline of 1.37% (N = 132 routes; 95% CI: -2.51 to -0.28).

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Virginia's Warbler is moderately vulnerable to extrinsic threats. The species' primary vulnerability stems from its restriction to a narrow range of mid-elevational habitat in relatively xeric portions of western U.S., which limits its distribution and abundance [2].

Extrinsic Stressors:
MODERATELY STRESSED
Stressors to Virginia's Warbler populations in Wyoming and range-wide are primarily from degradation and long-term drought in mid-elevation, arid, shrubby habitats, which are subject to development, invasive plant species such as Cheatgrass (*Bromus tectorum*), livestock grazing, prescribed burning, and shrub removal treatments. The condition of mountain-foothills shrubland habitat in Wyoming is thought to be in decline as a result of wildfire suppression, as well as over browsing by native ungulates and domestic livestock [15]. However, prescribed burns may be especially harmful to this species. A study of controlled burns to remove the understory in Ponderosa Pine (*Pinus ponderosa*)-oak habitat in Arizona found that Virginia's Warbler nests were eliminated in the burned areas [16]. Additional research in Arizona showed this species exhibited some plasticity in habitat choice in extremely dry years, but also experienced higher nest mortality because of greater nest predation [10]. Considering the potential for future global climate change, this species could face serious demographic hurdles. Virginia's Warbler may be very vulnerable to cowbird (*Molothrus* spp.) parasitism in areas where cowbirds are abundant [2].

KEY ACTIVITIES IN WYOMING

Virginia's Warbler is listed as a Species of Greatest Conservation Need (SGCN) in Wyoming by the Wyoming Game and Fish Department (WGFD), and as a Level III Priority Species in the Wyoming Bird Conservation Plan [15]. Little information exists on this species in Wyoming. Virginia's Warbler is not adequately monitored by current national or regional avian monitoring efforts in Wyoming, including the BBS program conducted on 108 established routes since 1968 [13] or the IMBCR program initiated in 2009 [14]. No additional, targeted, systematic survey of Virginia's Warbler has been conducted in Wyoming. Observations of this species are reported to the WGFD and vetted through the Wyoming Bird Records Committee (WBRC). Virginia's Warbler is a species for which the WBRC requests documentation on first latitude/longitude degree block sightings and all nesting observations.

ECOLOGICAL INFORMATION NEEDS

Virginia's Warbler breeding distribution and population size in Wyoming is not well known [5]. The recent discovery of a nesting population in the Black Hills of South Dakota indicates that other patches of nesting birds may be discovered that are not currently covered by BBS or IMBCR survey efforts. Information is also lacking on the species' migration and winter habits, as well as knowledge of reproductive success in the range of habitat types this species might use in Wyoming and range-wide. Future climate change in the western U.S. may increase the importance of Wyoming as a breeding location for this species. There is demonstrated concern for this species by federal, state, and private agencies; yet, there have been no refined estimates of population trends or methods estimating the overall health of populations [2].

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Susan M. Patla. Virginia's Warbler is classified as a SGCN in Wyoming, as it occurs in low numbers, has a patchy distribution, and information is lacking on population and distribution. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [13] and the multi-partner IMBCR [14]. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, a targeted, species-specific survey method may be warranted to obtain these data for Virginia's Warbler. Surveys for breeding Virginia's Warblers should be conducted prior to habitat treatments or prescribed burns in shrub habitats, especially in southwestern Wyoming. Regional work with the Western Working Group of PIF and the Southern Wings program could help coordinate and increase conversation efforts for this species range-wide.

CONTRIBUTORS:

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Figure 1: Female Virginia's Warbler in hand following capture in El Paso County, Colorado. (Photo courtesy of Bill Schmoker)

Figure 2: North American range of *Oreothlypis virginiae*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

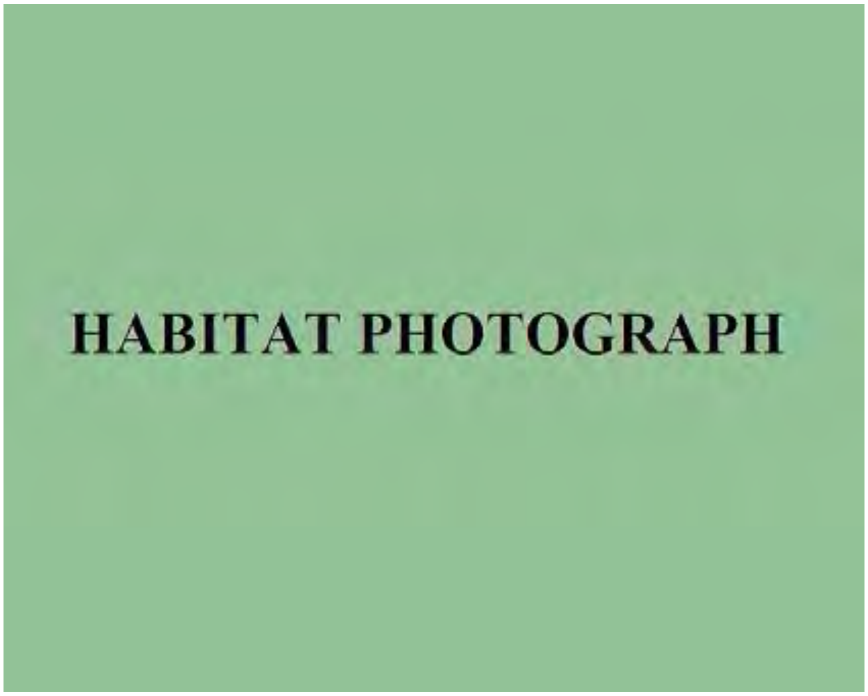

Figure 3: Photo not available.

Figure 4: Range and predicted distribution of *Oreothlypis virginiae* in Wyoming.

Western Grebe
Aechmophorus occidentalis

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: No special status
WGFD: NSSU (U), Tier II
WYNDD: G5, S3S4
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: Not ranked

STATUS AND RANK COMMENTS
The Wyoming Natural Diversity Database has assigned Western Grebe (*Aechmophorus occidentalis*) a state conservation rank ranging from S3 (Vulnerable) to S4 (Apparently Secure) because of uncertainty about historic and recent population trends for this species in Wyoming.

NATURAL HISTORY
Taxonomy:
Two subspecies of Western Grebe are recognized based on size and wing length [1]. *A. o. occidentalis* is larger (male wing chord > 192 mm, female > 178 mm); it occurs in the northern range from southwestern Canada south through the western United States to northern Baja, California, and winters mainly from Puget Sound to west-central Mexico and in the desert southwest [2]. *A. o. ephemeralis* is smaller (male wing chord < 193 mm, female < 178 mm); it occurs in the southern range in Mexico from Chihuahua south to the Valley of Mexico [2]. *A. o. occidentalis* occurs in Wyoming [3]. Clark's Grebe (*A. clarkii*) was believed to be a color morph of Western Grebe until it was recognized as a separate species in 1985 [4].

Description:
Identification of Western Grebe is possible in the field. It is a relatively large, slender waterbird (length 55–75 cm, wingspan 21 cm, weight 800–1,800 g) [5]. Adults have a black crown; a long, sharply pointed bill; a long neck that is black on the upperparts and white on the underparts; a narrow, sooty-black body; and red eyes [2]. Males and females are similar in appearance; however, the female has a smaller body overall and a shorter, thinner, straighter bill that may appear slightly upturned [2]. The species is similar in appearance to Clark's Grebe (*A. clarkii*); however, Western Grebe has a yellowish-green bill, dark coloration on the face that extends below the eyes, and a wider black stripe on the back of the neck. Juveniles are similar to adults, except the dark areas of the face and back are washed with gray or brown, and the lores are pale to dark

gray [2]. The appearance of Western Grebe is distinctly different from the other species of grebe that occur in Wyoming—Pied-billed Grebe (*Podilymbus podiceps*), Horned Grebe (*Podiceps auritus*), Red-necked Grebe (*Podiceps grisegena*), and Eared Grebe (*Podiceps nigricollis*).

Distribution & Range:
Western Grebe is restricted to the western half of North America for both the breeding and non-breeding seasons [2]. The species is found year-round along the western coast of North America, southwestern United States, and inland Mexico; however, some individuals are migratory and breed in the western and mid-western United States and southwestern Canada [2]. Wyoming is centrally located within this migratory breeding distribution. Western Grebe migrates through the state in the spring and fall and is classified as a summer resident, with observations occurring in 27 of the state's 28 latitude/longitude degree blocks, and confirmed or circumstantial evidence of breeding documented in 17 of those 27 degree blocks, primarily in the western and southeast portions of the state [6].

Habitat:
Western Grebe prefers fresh water marshes and lakes that have large areas of open water and emergent vegetation along the borders [2]. In Wyoming, Western Grebe breeds on lakes below 2,438 m in elevation, particularly large lakes with shallow areas and extensive stands of emergent vegetation [3]. Nesting colony sites are somewhat traditional, but can shift from year-to-year depending on habitat conditions such as water level, water quality, and availability of prey [2, 7]. Western Grebe nests are compact, floating platforms of fresh and decayed vegetation constructed near or within stands of emergent plants, where they can be anchored in place and often concealed [2, 8].

Phenology:
In Wyoming, spring arrival of Western Grebe occurs in mid-April, with peak migration occurring in early May [3]. Clutch size is typically 3–4 eggs but can range from 2–7 eggs [8]. Average clutch size in Wyoming is unknown; in Utah average clutch size is 2.5 eggs and in Colorado it is 3.4 eggs [9]. The species usually has 1 brood per year, but renesting can occur if a nest is lost [2]. Fall migration from Wyoming peaks in October, but flocks in reduced numbers can remain on large bodies of water until late November when freeze-up occurs [3].

Diet:
Western Grebe is primarily piscivorous, consuming a variety of small fish species, as well as salamanders (*Ambystoma* spp.), crustaceans, worms, aquatic insects and grasshoppers (*Melanoplus* spp.) [2].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
Global abundance estimates of Western Grebe vary from over 120,000 [10] to less than 110,000 [11] to 130,000 [12]. There are no abundance estimates for Western Grebe in Wyoming. The statewide abundance rank of RARE is based on the rather small area of the state known to be occupied in any given season, and the small coverage of suitable habitat within that area. However, within suitable habitat in the occupied area, Western Grebe appears to be common and is usually encountered during surveys that could be expected to indicate its presence [6]. Western Grebe is

gregarious and has a widespread continental distribution where preferred habitat is present [2]. In Wyoming, colonial nesting waterbird surveys conducted nearly annually from 1997–2010 by the Wyoming Game and Fish Department (WGFD) recorded a range of 4 to 100 breeding individuals annually across all surveyed colonial waterbird breeding sites, indicating that number of nesting Western Grebe pairs fluctuates with water levels and breeding site condition in any given year. Results from annual Breeding Bird Survey (BBS) data combine both the Western and Clark's Grebes, so population trend by species cannot be determined [13]. From 1987–2015, following Clark Grebe's split from Western Grebe, annual Wyoming Breeding Bird Survey (BBS) detections of Western Grebe ranged from 2 to 45 [14]. There is no current information available on abundance, occupancy, or density of Western Grebe in Wyoming from the Integrated Monitoring in Bird Conservation Regions (IMBCR) program [15].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends for Western Grebe in Wyoming are unknown. Robust population trends are not available for the species in Wyoming due to low or inconsistent detection rates during monitoring surveys.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Western Grebe has moderate intrinsic vulnerability in Wyoming due to a narrow range of habitat requirements; uncertain density of breeding occurrence; and susceptibility of nesting sites to human disturbance, stochastic weather events, site contamination, decreased water quality, and prey availability [2, 3]. Western Grebe abundance and breeding distribution is limited by a preference for large, productive wetlands and marshes [3, 16]. These habitat types are naturally uncommon in Wyoming, which is one of the most arid states in the country [16, 17]. As a primarily piscivorous species, Western Grebe is inherently at risk for physiological and reproductive stress caused by bioaccumulation of environmental contaminants [18, 19]. The extent to which Western Grebe is exposed to environmental contaminants in Wyoming is unknown.

Extrinsic Stressors:
MODERATELY STRESSED
Western Grebe is moderately stressed by extrinsic factors in Wyoming, where naturally occurring or high quality human created wetland habitat is limited, disjunct, and potentially vulnerable to climate change and drought, invasive plant species, stochastic weather events that can change habitat conditions, prey availability, and human disturbance that can cause nest abandonment and vulnerability to predation [20]. The availability and suitability of breeding sites can be unstable between years as a result of fluctuating water levels and changes in land use practices [20]. Drought can render previously productive migration, breeding, and foraging sites unsuitable through the contraction or complete loss of wetland habitat and changes to the structure and availability of emergent aquatic vegetation [21, 22]. Winter kill of prey in shallow marshes can be problematic [2].

KEY ACTIVITIES IN WYOMING

Western Grebe is classified as a Species of Greatest Conservation Need (SGCN) by the WGFD, and as a Level III Priority Bird Species in the Wyoming Bird Conservation Plan. Current statewide activities for monitoring annual detections and population trends for Western Grebe in

Wyoming include the BBS program conducted on 108 established routes since 1968 [13], and the multi-agency IMBCR program initiated in 2009 [15]. Since 1984, WGFD has conducted annual or periodic monitoring at the most important and productive sites for colonial waterbird SGCN to determine species presence and distribution, and to estimate number of nesting pairs. The most recent effort was the culmination of a multi-year cooperative agreement between the WGFD and the U.S. Fish and Wildlife Service (USFWS) to conduct an intensive survey of all historic, known, potential, and new colonial waterbird breeding sites statewide as part of a western range-wide effort to track population size, trends, and locations of breeding colonial waterbirds in the western United States [23, 24]. In 2014, an online Atlas of western colonial waterbird nesting sites was produced with data collected and submitted by participating states [25]. Every three to five years, WGFD personnel visit known colonial waterbird nesting sites outside of Yellowstone National Park to evaluate water level conditions, determine species present at each site, and estimate the number of nesting pairs of colonial waterbirds. There are currently no research projects designed specifically for Western Grebe in Wyoming.

Ecological Information Needs

In Wyoming, Western Grebe would benefit from research to determine its detailed distribution, the location and habitat characteristics of all current breeding locations, and the annual abundance of breeding adults. More information is needed on the specific breeding phenology of Western Grebe in Wyoming, nest success, predation risk, fledgling survival, and risk of exposure to aquatic contaminants at known breeding locations in the state. Wyoming's wetland and marsh habitats are scarce and inherently vulnerable, and current and future anthropogenic and natural stressors should be identified to ensure the persistence of breeding habitat for Western Grebe in the state.

Management in Wyoming

This section authored solely by WGFD; Andrea C. Orabona. Western Grebe is classified as a SGCN in Wyoming due to limited information on breeding, distribution, and population status and trends. The colonial nature of Western Grebe and other waterbirds makes these species particularly vulnerable across their range to loss or degradation of nesting sites, stochastic weather events such as drought and flooding, changing land use practices, pollution, and climate change. Less than 2% of the state's total area is classified as wetland habitat [17]. In Wyoming, Western Grebe is classified as a SGCN due to limited suitable aquatic or wetland breeding habitat, sensitivity to human disturbance during the breeding season, and susceptibility of nests to fluctuating water levels [7, 20]. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [13] and IMBCR [15] programs. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, colonial waterbirds are one of the species groups that warrant a targeted, species-specific survey method approach to obtain these data. WGFD conducted inventories of nesting colonial waterbirds, including Western Grebe, from 1984–1986 [26, 27]. In 1990, WGFD summarized all information presently known on colonial nesting waterbirds in Wyoming [28]. Since 1984, WGFD has conducted annual or periodic monitoring at the most important and productive sites for colonial waterbird SGCN. Results have shown confirmed nesting of Western Grebe at a minimum of three sites in Wyoming; Ocean Lake near Riverton, Bucklin Reservoir near Muddy Gap, and Caldwell Lake near Laramie [6]. Due to their sensitivity to human disturbance during the nesting season, the survey technique used for colonial waterbirds is minimally invasive and provides only an estimate of the number of breeding pairs and coarse habitat associations of each waterbird species present in the colony. Actual nests, eggs, or young are not located or counted to prevent colony disruption and reduce predation risk. From 2009–2012, WGFD and USFWS cooperated to conduct a rigorous survey of all historic, known, potential, and new colonial waterbird breeding sites statewide as part of a western range-wide effort to track population size, trends, and locations of breeding colonial waterbirds in the western United States [23, 24]. A total of 90 sites were evaluated in Wyoming; 86 potential colonial waterbird nesting sites and 4 known nesting sites. A lack of adequate emergent vegetation to provide secure nesting areas for colonial waterbirds was noted at most potential sites visited. An online Atlas of western colonial waterbird nesting sites was produced with data collected and submitted by participating states [25]. Best management practices to benefit Western Grebe include maintaining large, high quality wetland complexes, including buffer zones to block siltation, pesticides, and fertilizer runoff into wetlands; keeping water levels stable during the nesting season; installing artificial nest platforms where needed; protecting any colony site used by Western Grebe; keeping human disturbance to a minimum during the breeding season; , and monitoring colony sites every three years to determine Western Grebe presence and estimate number of nesting pairs [20].

CONTRIBUTORS

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Figure 1: Adult Western Grebe in Boulder County, Colorado. (Photo courtesy of Bill Schmoker)

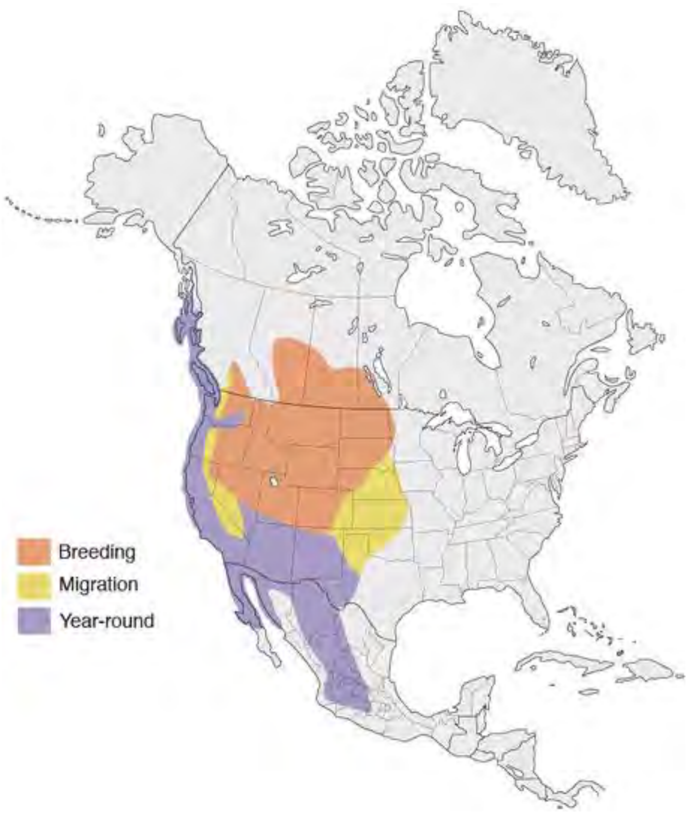

Figure 2: North American range of *Aechmophorus occidentalis* and *A. clarkii*, whose ranges overlap. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

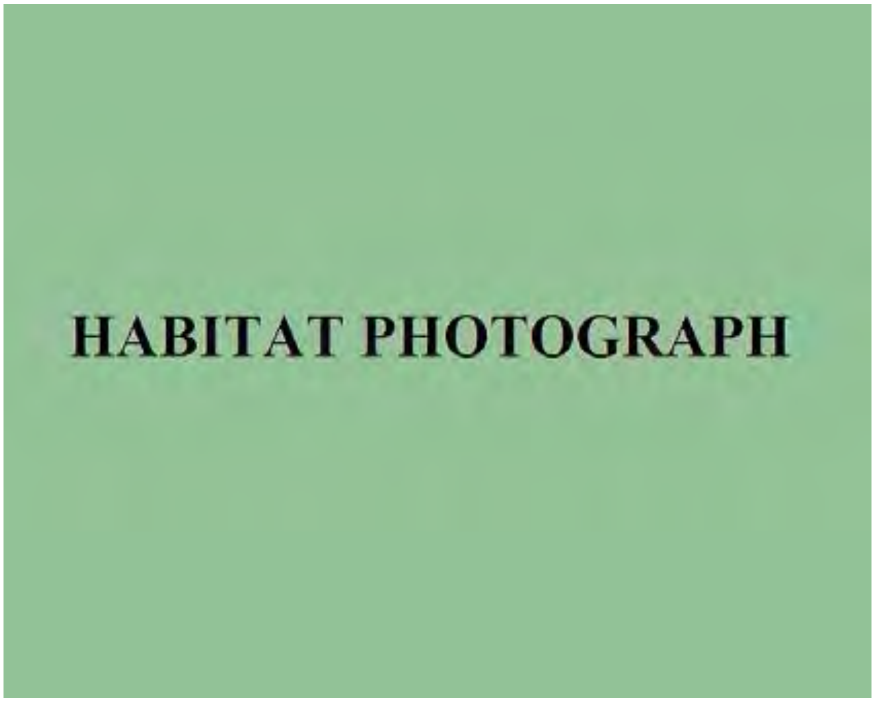

Figure 3: Photo not available.

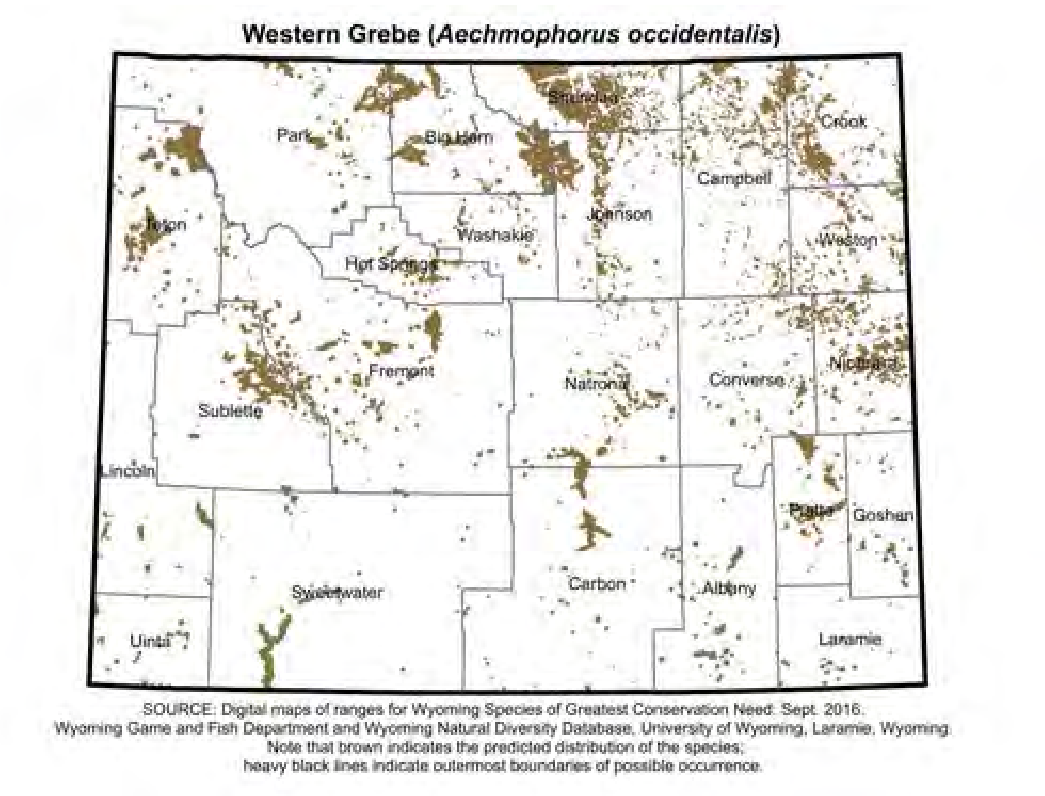

Figure 4: Range and predicted distribution of *Aechmophorus occidentalis* in Wyoming.

White-faced Ibis
Plegadis chihi

<u>REGULATORY STATUS</u>
USFWS: Migratory Bird
USFS R2: No special status
USFS R4 No special status
Wyoming BLM: Sensitive
State of Wyoming: Protected Bird

<u>CONSERVATION RANKS</u>
USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G5, S1
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: Not ranked

<u>STATUS AND RANK COMMENTS</u>
White-faced Ibis (*Plegadis chihi*) has no additional regulatory status or conservation rank considerations beyond those listed above.

<u>NATURAL HISTORY</u>
<u>Taxonomy</u>:
There are currently no recognized subspecies of White-faced Ibis [1, 2].

<u>Description</u>:
Identification of White-faced Ibis is possible in the field. The species is a medium-sized wading bird, smaller than most herons and egrets in Wyoming. Adults have a body length of 45 to 56 cm. Males and females are identical in appearance. The species has a long decurved bill and long neck and legs. In the breeding season, the plumage is dark maroon to brown overall, with a metallic green and bronze iridescence. On the head, reddish-purple bare skin around the eye is surrounded by white feathers. During the non-breeding season, the bird lacks iridescent plumage and the white feathers around the eyes. The bare skin around the eye is dark. Juvenile birds have a pinkish bill and a pale brown head and neck [1, 3]. The species is unlikely to be confused with any other species in Wyoming.

<u>Distribution & Range</u>:
White-faced Ibis is found from the southern United States to South America. The species is locally distributed at breeding colonies during the breeding season across the western United States including Wyoming. The species migrates to Mexico and the southern United States for the winter. Since the early 1980s, the species has recolonized areas where it had been extirpated such as Iowa, South Dakota, and North Dakota [1, 4].

Habitat:
White-faced Ibis is found in a variety of shallow wetland habitats such as marshes, ponds, mudflats, and swamps. In Wyoming, the species is typically associated with marshes, wet meadows, and vegetated shorelines, similar to elsewhere in the species' range. Breeding habitat is typically characterized by islands with emergent vegetation, which are used for nesting and roosting. Habitat use is similar year round [1, 5, 6]. The majority of breeding colonies in Wyoming can be found in the Bear River drainage and in the Laramie Basin.

Phenology:
White-faced Ibis is migratory and arrives in Wyoming in mid-April [6]. In Wyoming, clutch initiation generally begins in June. Incubation averages 20 days. At 10 to 12 days of age, young leave the nest but remain in nearby vegetation. Young leave the nesting colony at 6 to 7 weeks of age [1]. Timing of fall migration is not well known for Wyoming but likely occurs from late August to September [6].

Diet:
White-faced Ibis feeds upon aquatic and moist-soil insects, crustaceans, and earthworms [1].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
There are no robust estimates of White-faced Ibis abundance in Wyoming [7]. The species has a statewide abundance rank of VERY RARE and appears to be uncommon within suitable environments in the occupied area [8]. Colonial nesting waterbird surveys conducted from 2002–2006 by the Wyoming Game and Fish Department (WGFD) recorded a range of 17 to 132 individuals annually across all surveyed sites [9-13]. From 1968–2015, annual Wyoming Breeding Bird Survey (BBS) detections of White-faced Ibis ranged from 0 to 7, with none recorded in most years [14]. A total of 35 White-faced Ibis were detected (all in 2011) during surveys for the Integrated Monitoring of Bird Conservation Regions (IMBCR) program between 2009–2015 [7]. While surveys conducted as part of the BBS and IMBCR programs may occasionally detect this species, neither is specifically designed to capture ibis observations.

Population Trends:
Historic: LARGE DECLINE
Recent: INCREASE
Following pesticide bans in the 1970s, abundance of White-faced Ibis has increased across its range. Survey-wide trend data from the North American BBS indicate that White-faced Ibis numbers experienced statistically significant annual increases of 4.86% from 1966–2013 and 22.27% from 2003–2013 [15]. Robust population trends are not available for White-faced Ibis in Wyoming because the species is infrequently detected during monitoring efforts. Consequently, it is unknown if population trends in Wyoming follow national trends [1, 5, 15].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
White-faced Ibis has specific breeding habitat requirements and relatively low fecundity, making the species moderately vulnerable. The species requires wetlands with islands with emergent vegetation and shallow water for breeding and foraging. Lifetime reproductive output may also

limit the species. White-faced Ibis produce a single clutch per year. Age of first breeding is normally at least two years of age. Average life expectancy is approximately nine years. Reproductive success may have large temporal variation. For example, within a colony, nest success can range from total failure to nearly every nest fledging at least one young. These factors suggest productivity may be a limiting factor for populations in the state [1, 5].

Extrinsic Stressors:
MODERATELY STRESSED
White-faced Ibis habitat is moderately threatened by human and environmental factors. The most significant threat to the species is continued wetland loss. Additionally, wetland habitat degradation can occur from trampling and grazing of wetlands by cattle [5]. Wetland loss may also result from persistent drought conditions. This may reduce the suitability and availability of wetlands for breeding in Wyoming. Drought conditions may become more severe and last for longer periods as a result of global climate change [16]. Human disturbance at nesting colonies can lead to nest abandonment and reproductive failure. The species continues to be exposed to pesticides, such as organochlorine pesticides and polychlorinated biphenyls on breeding grounds and DDT on the winter grounds. Exposure contributes to reduced breeding success through poisoning and eggshell thinning [1, 5, 17, 18].

KEY ACTIVITIES IN WYOMING

White-faced Ibis is classified as a Species of Greatest Conservation Need (SGCN) by the WGFD. Traditional, long-term, songbird monitoring programs such as the BBS [15] and IMBCR [7] have not detected the species with enough frequency to provide meaningful data. Since 1984, WGFD has conducted annual or periodic monitoring at the most important and productive sites for colonial waterbird SGCN to determine species presence and distribution, and to estimate number of nesting pairs. The most recent effort was the culmination of a multi-year cooperative agreement between the WGFD and the United States Fish and Wildlife Service to conduct an intensive survey of all historic, known, potential, and new colonial waterbird breeding sites statewide as part of a western range-wide effort to track population size, trends, and locations of breeding colonial waterbirds in the western United States [19, 20]. In 2014, an online Atlas of western colonial waterbird nesting sites was produced with data collected and submitted by participating states [21]. Every three to five years, WGFD personnel visit known colonial waterbird nesting sites outside of Yellowstone National Park to evaluate water level conditions, determine species present at each site, and estimate the number of nesting pairs of colonial waterbirds. There are currently no research projects designed specifically for White-faced Ibis in Wyoming.

ECOLOGICAL INFORMATION NEEDS

Abundance and population trend estimates of White-faced Ibis in Wyoming are unknown. Breeding success and annual productivity of the species in Wyoming are unknown.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Zachary J. Walker. White-faced Ibis is classified as a SGCN in Wyoming due to historical population declines throughout its range, limited breeding habitat within Wyoming, dearth of state-specific data, and susceptibility to drought and habitat degradation. Colonial waterbird surveys should be continued in order to monitor White-faced Ibis. Additional research should address data deficiencies. This would include breeding success, productivity, and population dynamics. Best management practices for White-faced Ibis include minimizing human disturbance at nesting sites throughout the breeding season, and maintaining stable water levels within breeding habitats. Wetland habitats necessary for White-faced Ibis should be retained and enhanced when possible.

CONTRIBUTORS

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Figure 1: White-faced Ibis feeding in seasonal wetland in Seedskadee National Wildlife Refuge, Sweetwater County, Wyoming. (Photo courtesy of Tom Koerner, USFWS)

Figure 2: North American range of *Plegadis chihi*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Protected marsh in Table Mountain Wildlife Habitat Management Area with White-faced Ibis visible, south of Torrington, Wyoming. (Photo courtesy of Kimberly Szcodronski, WGFD)

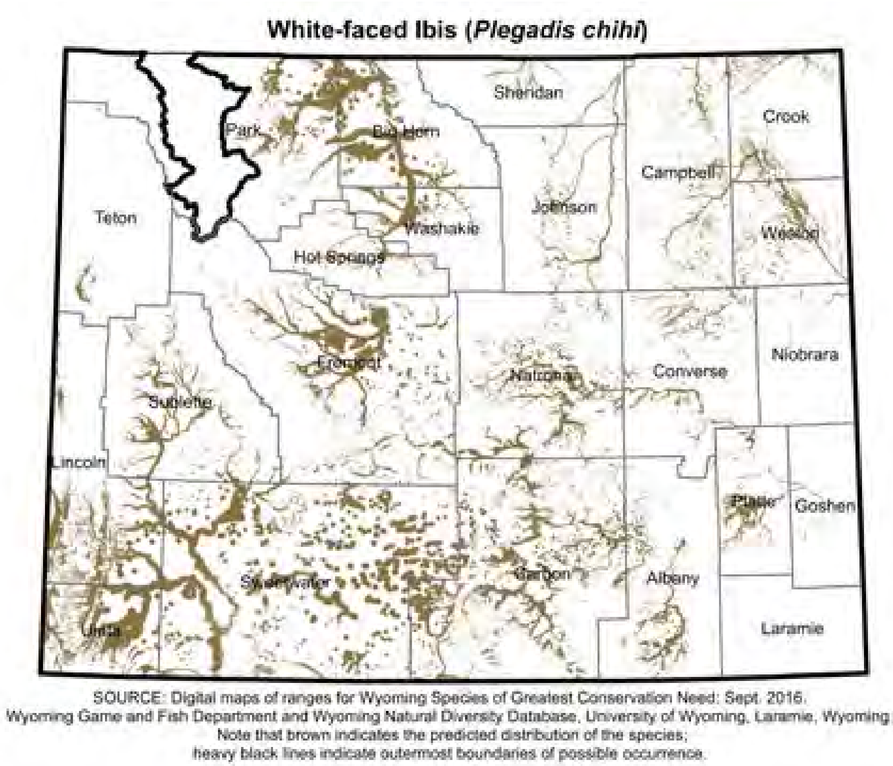

Figure 4: Range and predicted distribution of *Plegadis chihi* in Wyoming.

Williamson's Sapsucker

Sphyrapicus thyroideus

REGULATORY STATUS

USFWS: Migratory Bird
USFS R2: No special status
UWFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: Bird of Conservation Concern
WGFD: NSS3 (Bb), Tier II
WYNDD: G5, S3S4
Wyoming contribution: MEDIUM
IUCN: Least Concern
PIF Continental Concern Score: 13

STATUS AND RANK COMMENTS

The Wyoming Natural Diversity Database has assigned Williamson's Sapsucker (*Sphyrapicus thyroideus*) a state conservation rank ranging from S3 (Vulnerable) to S4 (Apparently Secure) because of uncertainty about the proportion of range occupied and population trends for this species in Wyoming. The species is listed as Endangered in Canada because of small population sizes and habitat loss [1].

NATURAL HISTORY

Taxonomy:

Although two subspecies of Williamson's Sapsuckers were previously recognized, recent genetic and morphometric analyses do not support subspecific designations. Consequently, Williamson's Sapsucker is considered monotypic, with no recognized subspecies [2].

Description:

Williamson's Sapsucker is a medium-sized woodpecker (average 23 cm in length). The species is sexually dimorphic, and bill shape and size varies geographically, with western populations displaying longer, broader, and deeper bills. Adult males are easily distinguished by a bright yellow belly; black breast, head, and back; white malar stripe, eye stripe, wing-coverts, and rump; and a red throat. Juvenile males look like adults but have a white throat and nape. Females also display a yellow belly that is paler than in males, a black breast, and a white rump; however, the head is distinctly brown, and the rest of the body is heavily barred with black, brown, and white. Juvenile females are browner overall than adults [2]. In Wyoming, Williamson's Sapsucker is easily distinguished from other sympatric species, as it is the only woodpecker in the state with a bright yellow belly [3]. The belly of Red-naped Sapsucker (*S. nuchalis*) may be tinted pale yellow, but both sexes have a red crown [4].

Distribution & Range:
Williamson's Sapsucker is distributed throughout southern British Columbia, Canada; the western United States; and central Mexico. Breeding distribution extends from Canada to central Arizona and New Mexico but is patchy and defined by the presence of coniferous forests 1,500–3,200 m in elevation. The species is a year-round resident in much of California, northern Arizona, and northern New Mexico. Wintering distribution extends south to Jalisco and Michoacán, Mexico [2]. In Wyoming, the species is found in the western mountains, where it is most abundant, as well as the Laramie, Sierra Madre, and Bighorn Mountains, where it is relatively rare [3]. Williamson's Sapsucker has been documented in 21 of Wyoming's 28 latitude/longitude degree blocks, with confirmed or suspected breeding occurring in 12 of those blocks [5].

Habitat:
Range-wide, Williamson's Sapsucker breeds in mid- to high-elevation forests (1,500–3,200 m) composed of Western Larch (*Larix occidentalis*), Douglas Fir (*Pseudotsuga menziesii*), Ponderosa Pine (*Pinus ponderosa*), pine-fir (*Pinus* spp.-*Abies* spp.), and mixed deciduous-coniferous forests with Quaking Aspen (*Populus tremuloides*). In Colorado and Wyoming where Williamson's overlaps with Red-naped Sapsucker, sites in or near Ponderosa Pine forests tend to be used more frequently by Williamson's Sapsucker, although other aspects of nest-site preference did not differ between species [6]. Nonbreeding habitat tends to be at lower elevation oak-juniper (*Quercus* spp.-*Juniperus* spp.) and pine-oak forests [2]. Like all woodpeckers, Williamson's Sapsucker builds nests in tree cavities that it excavates at the beginning of each breeding season. Cavities from previous seasons may be reused, but this is relatively uncommon. Tree softness plays a major role in nest-site selection, and soft snags, live aspens, or trees infected with fungus are most often used for nests. Throughout its range, Williamson's Sapsucker nests have been found in Western Larch, Ponderosa Pine, Jeffrey Pine (*Pinus jeffreyi*), Lodgepole Pine (*Pinus contorta*), Douglas Fir, spruce (*Picea* spp.), Grand Fir (*A. grandis*), White Fir (*A. concolor*), Red Fir (*A. magnifica*), Quaking Aspen, White Birch (*Betula occidentalis*), Black Cottonwood (*Populus trichocarpa*), and a utility pole [2]. In Wyoming and Colorado, sapsuckers constructed south-facing nests 2–3 m from the ground in aspens roughly 23 cm diameter at breast height [6]. Nests are placed in larger trees overall [7]. Important nest site characteristics include presence of aspens and density of large snags [8].

Phenology:
Not all Williamson's Sapsuckers are migratory. Populations in most of California, northern Arizona, and northern New Mexico are annual residents. Williamson's Sapsucker is an early spring migrant, although departure dates from nonbreeding grounds in Mexico are not well known. Migration occurs March through early May, with males arriving at breeding grounds ≤ 2 weeks before females [2]. In Wyoming, Williamson's Sapsucker arrives in late April and early May [3]. Pairs begin excavating nests within 3 weeks of pair bonding, with the male doing most nest construction, and nests can take 3–4 weeks to complete. Clutch sizes range from 4–6 eggs, and only a single clutch is laid per season. Eggs hatch within 12–14 days, and young fledge 31–32 days later. Parents may continue to feed fledglings for the first couple of days after leaving the nest, but they quickly disperse after young are fledged. Individuals migrate south from late August through October, depending on latitude [2]. The latest confirmed record of Williamson's Sapsucker in Wyoming is 9 September, although they have been recorded on Christmas Bird Counts in three separate years since 1968 [3]. Females typically migrate farther than males [2].

Diet:
The diet of Williamson's Sapsucker varies seasonally. In the nonbreeding season, sap, phloem fibers, and berries are major food items. Both sap and phloem remain important during the breeding season before young hatch; Douglas Fir, Ponderosa Pine, and, to a lesser extent, Lodgepole Pine are important sources of sap, which is obtained by drilling shallow holes in the trunks of trees [2]. Diet then switches almost exclusively to ants (Hymenoptera), which are gleaned from trunks and branches and consumed by both adults and nestlings. Carpenter ants (*Camponotus* spp.) are preferred and can compose 80% of the nestling diet [9]. Adults and larvae of a variety of other arthropods may also supplement the diet during the breeding season, including beetles (Coleoptera), flies (Diptera), aphids (Homoptera), and false scorpions (Pseudoscorpionidae). Most foraging occurs in live conifers and, to a lesser extent, snags [2].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD BUT PATCHY
Wyoming: UNCOMMON
Williamson's Sapsucker is distributed throughout the western United States, but distribution is patchy and restricted to mountainous, coniferous habitat [2]. Using Breeding Bird Survey (BBS) data, the Partners in Flight (PIF) Science Committee estimated the Wyoming population size of Williamson's Sapsucker to be 4,000 birds, or 1.3% of the global population [10]. The Integrated Monitoring in Bird Conservation Regions (IMBCR) program has detected the species 78 times since the program's inception in 2009 (range 1–14 detections per year) [11]. The statewide rank of UNCOMMON is based on the limited area of the state known to be occupied in any given season and the relatively small coverage of suitable habitat within that area. Within suitable habitat in the occupied area, Williamson's Sapsucker also appears to be uncommon, occurring in relatively low densities and requiring intensive survey efforts to detect the species [5]. In Wyoming, populations are distributed among the mountain ranges, with the exception of the Black Hills. Williamson's Sapsucker is more likely to occur in the western mountains and less likely to occur in the Bighorn Mountains [3].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Population trends of Williamson's Sapsucker range-wide are not well known, and reports differ on the direction and magnitude of trends. Currently, there are no robust North American BBS trend data for Williamson's Sapsucker in Wyoming due to an extremely limited number of rotes with observations (N = 7 routes; 1968–2013) [12]. However, regional BBS data suggest a slight increase in the Great Basin and Southern Rockies regions and a slight decrease in the Northern Rockies region, although the data have been determined to fall within a credibility category with 'deficiencies' or 'important deficiencies'. Low relative abundance and number of routes with Williamson's Sapsucker detections likely contribute to this classification [12]. The PIF Science Committee categorizes Williamson's Sapsucker trends as uncertain or as displaying a stable to significant but small decrease [10].

Intrinsic Vulnerability:
LOW VULNERABILITY

Williamson's Sapsucker has somewhat specialized habitat requirements and may be limited by habitat availability, particularly the availability of suitable nest trees [2]. Aspen stands with large trees are especially important nest sites [6, 7, 13]. The dependence on ants for food during nesting is also important, but the potential as a limiting factor is unknown [9]. Overall nest success is high (> 60%), and successful nests fledge between 3.16 and 3.67 young [2]. Other life history characteristics do not predispose the species to declines from changes in environmental conditions.

Extrinsic Stressors:
MODERATELY STRESSED
PIF assigns Williamson's Sapsucker a threat level of 3, indicating that the species is expected to display a slight to moderate decline in the future suitability of breeding conditions. The factors that may contribute to this decline are variable but, for this species, likely include a moderate vulnerability to human activities and land-use trends and a relative specialization on sensitive habitats or successional stages [10]. Forest management practices, including fire management and logging, may impact the availability of nest trees and snags [2] as well as dead and decaying wood needed to support abundant ant populations [9], although the species has been shown to forage in clearcuts [7]. Low intensity and patchy burns might improve habitat for the species, but, in general, Williamson's Sapsucker demonstrates a negative response to burning [2]. The regeneration of aspen stands is hindered by a disruption of historic disturbance regimes as well as drought and climate change. Similar threats may impact coniferous habitats in Wyoming, including fire suppression, disease and insects, drought, and climate change [14]. The availability of these forest types will remain important for adequate nesting and foraging habitat for Williamson's Sapsucker.

KEY ACTIVITIES IN WYOMING

Little work has been done on Williamson's Sapsucker in Wyoming since the species was first detected in the state. Williamson's Sapsucker is listed as a Species of Greatest Conservation Need (SGCN) in Wyoming by the Wyoming Game and Fish Department and as a Level 2 Priority Species requiring monitoring action in the Wyoming Bird Conservation Plan [15]. Although BBS data analyses are able to determine population trend estimates, these estimates for Williamson's Sapsucker are based on very low sample sizes and have large confidence intervals that overlap [12], which limits the usefulness of estimates for this species. The IMBCR program has similarly low detections of the species [11]. The species is occasionally detected during playback surveys for other woodpeckers [16] but, as with other survey efforts, detections are limited. Overall, Williamson's Sapsucker is not adequately monitored by national or regional avian monitoring efforts in Wyoming, and no additional, targeted, systematic survey of Williamson's Sapsucker has been implemented.

ECOLOGICAL INFORMATION NEEDS

In Wyoming, assessment of the status of Williamson's Sapsucker is hampered by a lack of ecological and population data. Additional information is needed on distribution and habitat use, and estimates of abundance and occupancy rates are needed to assess status, monitor populations, and evaluate trends. Williamson's Sapsuckers, and woodpeckers in general, tend to respond to playback calls but, because this often results in individuals being drawn in from some distance, their usefulness for density estimation is limited. Therefore, a better survey effort may need to be explored to determine population densities and trends. Additionally, the availability of habitat appears to be more widespread than the distribution of the species, and a better understanding of niche requirements is needed to evaluate habitat use and distributional boundaries.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Williamson's Sapsucker is classified as a SGCN in Wyoming due to unknown population status and trends in the state. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [12] and IMBCR [11]. While these monitoring programs provide robust estimates of occupancy, density, or population trends for many species in Wyoming, survey efforts do not tend to detect Williamson's Sapsucker at adequate levels, suggesting targeted, species-specific monitoring efforts are needed. Best management practices to benefit Williamson's Sapsucker include adequate monitoring, retaining mature stands of mixed conifer and aspen where this species occurs, maintaining stands of trees with a minimum 25-cm diameter at breast height, managing for an average to maximum snag density of 0.1 to 4 snags per ha, and avoiding or minimizing insecticide use where this species occurs to ensure an adequate food source exists [15].

CONTRIBUTORS

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Figure 1: Adult Williamson's Sapsucksers: male (left) in Gilpin County, Colorado and female (right) in Jefferson County, Colorado. (Photos courtesy of Bill Schmoker (left) and Shawn Billerman (right))

Figure 2: North American range of *Sphyrapicus thyroideus*. The species also winters irregularly east of the distribution shown above. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

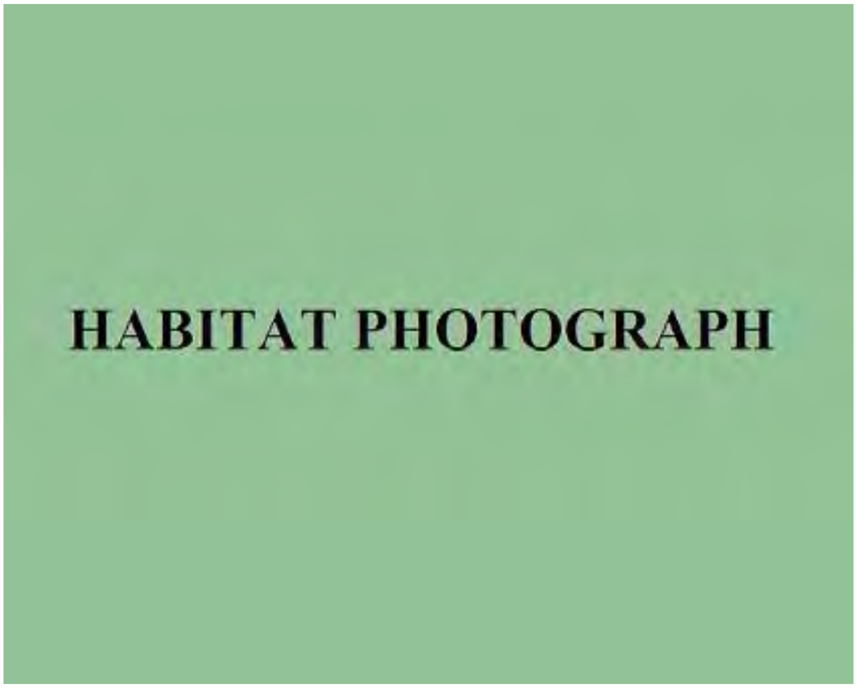

Figure 3: Photo not available.

Figure 4: Range and predicted distribution of *Sphyrapicus thyroideus* in Wyoming.

Willow Flycatcher
Empidonax traillii

REGULATORY STATUS
USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS
USFWS: Bird of Conservation Concern
WGFD: NSS3 (Bb), Tier III
WYNDD: G5, S5
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 10

STATUS AND RANK COMMENTS
Willow Flycatcher (*Empidonax traillii*) has no additional regulatory status or conservation rank considerations beyond those listed above. Southwestern Willow Flycatcher (*E. t. extimus*) is designated as Endangered under the Endangered Species Act, but this subspecies is not found in Wyoming [1].

NATURAL HISTORY

Taxonomy:
There are 4 or 5 recognize subspecies of Willow Flycatcher [2, 3]. *E. t. adastus* and possibly *E. t. campestris* occur in Wyoming [4]; however, some authorities do not recognize the *campestris* subspecies and include those individuals with the *traillii* subspecies [2].

Description:
Identification of the *Empidonax* genus of flycatchers to species is not always possible in the field. In Wyoming, identification of Willow Flycatcher is possible based on vocalization. Willow Flycatcher is a small flycatcher, 13 to 17 cm long. Males, females, and juvenile birds are identical in appearance, and the plumage is the same year-round [2, 5]. Willow Flycatcher differs from other *Empidonax* flycatchers by having plumage that is browner overall and an eye-ring that is very reduced or absent [5]. The species' lower mandible is dull yellow, and the upper mandible is black. The feet are brownish-black to black [6]. The most definitive way to identify Willow Flycatcher is by song. Willow Flycatcher's song is a "FITZ-bew", with the accent on the first syllable. Other vocalizations include a "brit," "creet," and "whit" [2, 5]. The species is most easily confused with other *Empidonax* flycatchers, and the *Contopus* flycatchers. There are seven other species of *Empidonax* flycatchers that can be found in Wyoming, and all but the Alder Flycatcher (*E. alnorum*) have a well-defined eye-ring. Alder Flycatcher, a spring and fall migrant through Wyoming, is distinguishable by song only. *Contopus* flycatchers (Western Wood-pewee

C. sordidulus, and Olive-sided Flycatcher *C. cooperi*) are slightly larger (16–19 cm long), with wings that extend to about halfway down the tail, and have a noticeably peaked crest on the head [2, 5].

Distribution & Range:
Willow Flycatcher is broadly distributed across North America during the breeding season. The species is found across Wyoming in appropriate habitat, but the highest breeding concentrations occur in portions of Grand Teton National Park [4, 7]. In Wyoming, the two subspecies normally found in the state are the *campestris* subspecies, generally found in eastern regions of the state, and the *adastus* subspecies, generally found across the western regions of the state [2, 6]. Willow Flycatcher migrates to Central and South America for the winter [2].

Habitat:
In Wyoming, the Willow Flycatcher is a riparian obligate, using Willow (*Salix* spp.) or Alder (*Alnus* spp.) thickets along river bottoms, especially those by open stands of Cottonwood (*Populus* spp.) [8]. Typical habitat occurs in beaver meadows, borders of forest clearings, brushy lowlands, mountain parks, and along watercourses up to 2,500 m in elevation. In areas outside of Wyoming, it uses mesic riparian sites, xeric uplands, dry upland sites, and riparian forests [2]. The highest concentrations of Willow Flycatcher in Wyoming occur in Grand Teton National Park around Jenny and Jackson Lakes [4, 7]. The species uses similar habitats during migration [2].

Phenology:
Willow Flycatcher arrives in Wyoming during the last week of May and the first week of June [4]. Nest phenology in Wyoming has not been studied. Nest building in Colorado occurs in early to mid-June, and can take from 36 hours to 10 days or longer [2]. Incubation lasts 13 to 15 days. Fledging occurs at 13 to 16 days of age. Young are dependent on the adults for another two weeks after which they disperse from the breeding area [2]. Fall migration out of Wyoming occurs from mid-August to early September [4].

Diet:
The primary diet of Willow Flycatcher consists of insects from a wide variety of orders. Dominant insects consumed vary by habitat and region. Fruits such as blackberries and raspberries (*Rubus* spp.) and dogwood (*Cornus* spp.) are occasionally eaten in the fall [2].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: COMMON
Willow Flycatcher has a statewide abundance rank of COMMON and also appears to be common within suitable environments in the occupied area [9]. In 2013, Partners in Flight estimated the Wyoming population to be around 110,000 individuals, or about 1.20% of the global population [10]; however, this abundance estimate is based primarily on Breeding Bird Survey (BBS) data and should be viewed with caution due to the relatively low detection rate of this species in the state. From 1968–2015, annual Wyoming BBS detections of Willow Flycatcher ranged from 0 to 67 (average = 21), with 23 recorded in 2015 [11]. Annual detections of Willow Flycatcher ranged from 0 to 10 during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [12].

Population Trends:
Historic: MODERATE DECLINE
Recent: STABLE
Wyoming trend data from the North American BBS indicate that Willow Flycatcher declined by 1.18% annually from 1968–2013 and 2.34% annually from 2003–2013; however, neither state estimate was statistically significant [13]. Survey-wide BBS trend data indicate that Willow Flycatcher numbers experienced statistically significant annual declines of 1.46% from 1966–2013 and 0.99% from 2003–2013 [13].

Intrinsic Vulnerability:
LOW VULNERABILITY
Willow Flycatcher is not particularly vulnerable, because its life history characteristics are not very restrictive. However, in Wyoming, the species is largely restricted to riparian corridors for breeding [4, 8]. The species is susceptible to Brown-headed Cowbird (*Molothrus ater*) nest parasitism [14, 15].

Extrinsic Stressors:
SLIGHTLY STRESSED
Though the population of Willow Flycatcher in Wyoming appears stable, there are various threats to the species and its habitat making it slightly vulnerable. Threats to Willow Flycatcher habitat include cattle grazing, elk browsing, and human alterations of the habitat. Cattle grazing causes soil compaction and gullying that dries out the habitat, the grazing of shrubs affects the quality and quantity of shrub cover and can also cause nest destruction [2, 16]. Excessive browsing by elk has been shown to cause habitat degradation [17-19]. Riparian habitat is also subject to damming, dredging, channelization, urbanization, and de-watering, all of which degrade or destroy the habitat, making it unsuitable for the species [2]. Tamarisk (*Tamarix* spp.) invasion can result in lower breeding bird densities and territory productivity [2, 20]. Research performed on the Willow Flycatcher may cause injury or death through banding and marking operations [2].

KEY ACTIVITIES IN WYOMING
Willow Flycatcher is classified as a Species of Greatest Conservation Need (SGCN) by the Wyoming Game and Fish Department (WGFD), and as a Level II Priority Bird Species requiring monitoring in the Wyoming Bird Conservation Plan [21]. Current statewide activities for monitoring annual detections and population trends for Willow Flycatcher in Wyoming include the BBS program conducted on 108 established routes since 1968 [13], and the multi-agency IMBCR program initiated in 2009 [12]. There are currently no research projects designed specifically for Willow Flycatcher in Wyoming.

ECOLOGICAL INFORMATION NEEDS
Most current knowledge of Willow Flycatcher biology is known from studies of the endangered extimus subspecies. Habitat preferences of Willow Flycatcher in Wyoming are not well known. Nest phenology in Wyoming is not known. Knowledge pertaining to the impacts of human activities on Willow Flycatcher in Wyoming are unknown [2].

MANAGEMENT IN WYOMING
This section authored solely by WGFD; Zachary J. Walker. Willow Flycatcher is classified as a SGCN in Wyoming due to restricted habitat, nest parasitism, and habitat fragmentation and

degradation. Large scale monitoring programs, such as BBS and IMBCR, have proved effective in monitoring population trends for this species. These programs should be continued and are valuable for monitoring a wide range of species within the state. If warranted, species specific monitoring could occur for Willow Flycatcher to address specific population questions. Additional research for this species should focus on addressing information needs including nest phenology and impacts of human activities on breeding. Deciduous shrub communities (> 5 acres) within riparian zones and meadows should be maintained that are suitable for Willow Flycatcher nesting.

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Figure 1: Adult male Willow Flycatcher in California. (Photo courtesy of Michael T. Wickens)

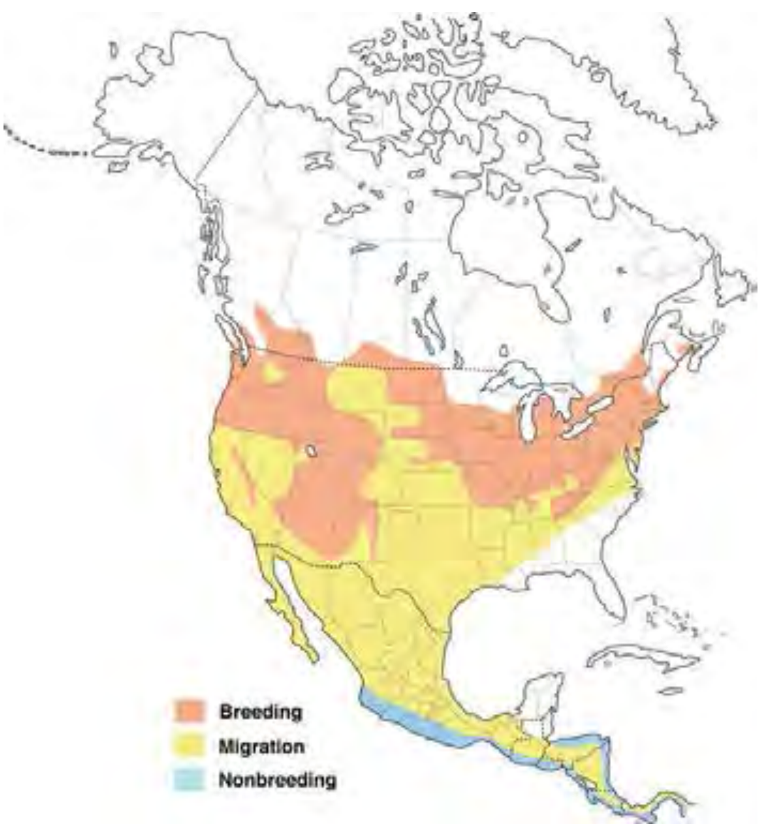

Figure 2: North American range of *Empidonax traillii*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Willow Flycatcher habitat along the McCloud River, California. (Photo courtesy of Michael T. Wickens)

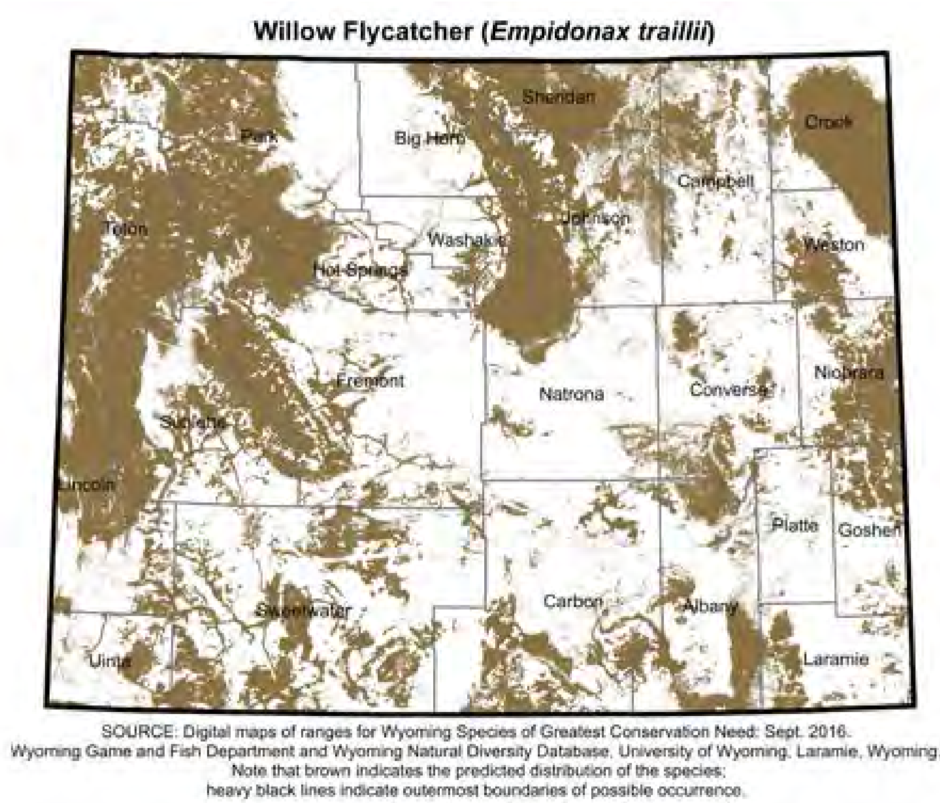

Figure 4: Range and predicted distribution of *Empidonax traillii* in Wyoming.

Figure 5: Top: Willow Flycatcher nest in Willow (*Salix* spp.), McCloud River, California, 2006. Bottom: Willow Flycatcher nest with one host egg (lower right), one Brown-headed Cowbird egg (lower left), and one host young, approximately 1 day old. (Photos courtesy of Michael T. Wickens)

Woodhouse's Scrub-Jay

Aphelocoma woodhouseii

REGULATORY STATUS

USFWS: Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G5, S1
Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 9

STATUS AND RANK COMMENTS

Woodhouse's Scrub-Jay (*Aphelocoma woodhouseii*) has no additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:

In 2016, the American Ornithological Union split Western Scrub-Jay (*A. californica*) into California Scrub-Jay (*A. californica*) and Woodhouse's Scrub-Jay (*A. woodhouseii*) because of morphological, ecological, and genetic distinctions as well as variations in song [1]. Only Woodhouse's Scrub-Jay is found in Wyoming. Western Scrub-Jay previously had fourteen recognized subspecies divided into three groups (i.e., *californica*, *woodhouseii*, and *sumichrasti*) [2,3]. The newly recognized California Scrub-Jay now encompasses the subspecies and distribution of the former *californica* group, while Woodhouse's Scrub-Jay encompasses the subspecies and distributions of the *woodhouseii* and *sumichrasti* groups; however, some have suggested that the *sumichrasti* group, in southern Mexico, should also be recognized as a separate species [1]. Only birds in the *woodhouseii* group occupy Wyoming.

Description:

Identification of Woodhouse's Scrub-Jay is possible in the field. The sexes are identical in appearance: adults range in length from 28–30 cm, weigh 70–100 g, and have a wingspan of about 39 cm [3,4]. Woodhouse's Scrub-Jay is a crestless jay with a blue head, wings, and tail; white streaked throat and breast bordered by faint blue breast bands; gray cheeks and back; pale gray underparts; thin white eyebrows; and black bill and legs [4]. Juveniles have a gray head and sooty-tinged underparts [4,5]. Similar sympatric species in Wyoming are Steller's Jay (*Cyanocitta stelleri*), and Pinyon Jay (*Gymnorhinus cyanocephalus*); however, Steller's Jay has a blackish head with a long crest, while Pinyon Jay is blue overall with no obvious other coloring or markings [4].

Distribution & Range:
The year-round distribution of Woodhouse's Scrub-Jay is patchily distributed in the interior western United States and interior mainland Mexico [3]. Southwestern Wyoming is on the northeastern edge of the species' core distribution. Confirmed or suspected breeding has been documented in just 3 of the 28 latitude/longitude degree blocks in Wyoming, all in the southwestern corner of the state [6]. It has been suggested that the restricted distribution of Woodhouse's Scrub-Jay in southwestern Wyoming may be tied to the local presence of Piñon Pine (*Pinus edulis*), the seeds of which are an important food source for the species in this region of the country [7]. However, Woodhouse's Scrub-Jay occasionally occurs well outside of southwestern Wyoming and has been observed as far away as Sheridan near the state's northern border [7].

Habitat:
In Wyoming, Woodhouse's Scrub-Jay is primarily found in rocky woodlands dominated by Utah Juniper (*Juniperus osteosperma*), with low to moderate tree cover and an understory of shrubs such as Mountain Mahogany (*Cercocarpus montanus*) and sagebrush (*Artemisia* spp.) [7, 8]. Elsewhere across its distribution, the species has been documented in a variety of mostly arid scrub and woodland environments, including piñon-juniper, oak (*Quercus* spp.) and mixed-oak woodlands, desert riparian woodlands, cactus forests, and scrub in tropical deciduous forests [3]. Nesting sites are often well-concealed in trees, shrubs, bushes, or clustered vines. Both males and females participate in the construction of the nest, which is an open cup of large, interwoven twigs lined with finer twigs, plant material, and sometimes hair from livestock [3, 8].

Phenology:
Woodhouse's Scrub-Jay is non-migratory and is a year-round resident in Wyoming [7, 8]. Nesting phenology has not been studied in the state, and most knowledge of the species is from studies in California on the newly recognized California Scrub-Jay. Clutch initiation dates can vary from year to year in California, but most eggs laying occurs in March and April [3]. Incubation time for California Scrub-Jay is 17–18 days, fledging occurs at 20 days of age, and post-fledging dispersal occurs about 6 weeks after fledging. Woodhouse's Scrub-Jay likely has a similar nesting phenology, but slight differences may exist due to regional differences in climate and breeding behavior [3]. The species typically produces one brood per season but may renest multiple times following consecutive clutch losses [3].

Diet:
Woodhouse's Scrub-Jay primarily feeds on arthropods and fruit during the breeding season and acorns and pine seeds during the non-breeding season; however, the species is omnivorous and will opportunistically consume caterpillars, small reptiles and amphibians, mice, bird eggs, nestlings, fledglings, adult birds, carrion, and ecto-parasites preened from live deer. Excess food is scatterhoarded, with birds caching a single food item at each location, and retrieved for consumption at a later date [3].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD BUT PATCHY

Wyoming: VERY RARE
There are no robust population estimates for Woodhouse's Scrub-Jay in Wyoming. The species has a statewide abundance rank of VERY RARE and appears to be uncommon within suitable environments in the occupied area [6]. Woodhouse's Scrub-Jay was not detected by the Wyoming Breeding Bird Survey (BBS) program between 1968–2015 [9], and just 1 individual was detected during surveys for the Integrated Monitoring in Bird Conservation Regions (IMBCR) program between 2009–2015 [10]. More targeted surveys in juniper woodland habitat may be necessary to adequately detect Woodhouse's Scrub-Jay in Wyoming.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Robust population trends are not available for Woodhouse's Scrub-Jay in Wyoming because the species is infrequently detected during monitoring surveys. Survey-wide trend data from the North American BBS indicate that Woodhouse's Scrub-Jay numbers declined annually by 0.09% from 1966–2013 and increased annually by 0.31% from 2003–2013, but neither trend estimate was statistically significant [11].

Intrinsic Vulnerability:
HIGH VULNERABILITY
In Wyoming, Woodhouse's Scrub-Jay has moderate intrinsic vulnerability due to its low abundance and dependence on a narrow range of habitat types. Woodhouse's Scrub-Jay utilizes a variety of habitats across its continental distribution; however, the species is strongly associated with Utah Juniper woodlands within its very restricted Wyoming distribution. Only 2.2% of the total land area in Wyoming is classified as juniper woodlands [12], and Woodhouse's Scrub-Jay is not known to breed in any other environments in the state. Therefore, the species would have limited opportunity for range expansion within Wyoming should disturbance or loss of existing habitat occur.

Extrinsic Stressors:
MODERATELY STRESSED
Habitat loss and degradation could negatively impact Woodhouse's Scrub-Jay in Wyoming. Piñon and juniper woodlands have been expanding in many areas of the western United States since the mid-1800s [13]; however, Wyoming is predicted to lose a majority of its Utah Juniper woodlands over the next century due to changing climate [14]. Existing juniper woodlands in the state are potentially vulnerable to changes in fire regime; invasive species such as Cheatgrass (*Bromus tectorum*); drought and climate change; habitat fragmentation; and human disturbance, including juniper removal and thinning programs [12]. In addition, juniper woodlands in southwestern Wyoming are often associated with rocky habitats, which are threatened by potential energy development and exposure to anthropogenic disturbances from recreational activities [12, 15]. In other parts of its range Woodhouse's Scrub-Jay inhabits disturbed and successional habitat and appears relatively tolerant of human presence [3]; however, the species showed significantly lower abundance in piñon-juniper woodlands with continuous light grazing than in piñon-juniper with long-term grazing exclusion in New Mexico [16]. Currently, it is not known how potential extrinsic stressors impact Woodhouse's Scrub-Jay in Wyoming.

KEY ACTIVITIES IN WYOMING

Woodhouse's Scrub-Jay is classified as a Species of Greatest Conservation Need by the Wyoming Game and Fish Department (WGFD), and as a Level 2 Priority Bird Species requiring monitoring in the Wyoming Bird Conservation Plan [17]. Current statewide activities for monitoring annual detections and population trends for Woodhouse's Scrub-Jay in Wyoming include the BBS program conducted on 108 established routes since 1968 [18], and the multi-agency IMBCR program initiated in 2009 [19]. In 2016, the WGFD began a two-year project designed to collect data on the distribution, relative abundance, and habitat use of piñon-juniper obligate species, including Woodhouse's Scrub-Jay, in the woodlands of southwestern Wyoming.

ECOLOGICAL INFORMATION NEEDS

In Wyoming, Woodhouse's Scrub Jay would benefit from research to determine its actual abundance and population trends. Very little is known about the specific breeding habits of this species in the state, and nothing is known about nest success or fledgling survival. The detailed distribution and proportion of habitat occupied by the species in Wyoming is not well understood, especially when it comes to vagrant reports in other parts of the state. Finally, additional research is needed to determine how Woodhouse's Scrub-Jay populations in Wyoming might respond to natural and anthropogenic disturbances to existing habitat.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Andrea C. Orabona. Woodhouse's Scrub-Jay is classified as a Species of Greatest Conservation Need in Wyoming due to a need for robust information on breeding status and population trend in Wyoming; limited distribution of required breeding habitat; loss, degradation, and fragmentation of Utah Juniper habitat due to industrial developments; and incompatible management practices [12]. Two separate but compatible survey programs are in place to monitor populations of many avian species that breed in Wyoming; the BBS [11] and IMBCR [10]. While these monitoring programs provide robust estimates of occupancy, density, or population trend for many species in Wyoming, Woodhouse's Scrub-Jay needs a targeted, species-specific survey method approach to obtain these data. Initial work and written species accounts on avian Utah Juniper obligate species, including Woodhouse's Scrub-Jay, occurred in 1988 [20]. However, higher priorities and limited personnel and funding precluded conducting additional work on these species. Best management practices to benefit Woodhouse's Scrub-Jay include implementing a sufficient monitoring technique; maintaining mature stands of Utah Juniper habitat where Woodhouse's Scrub-Jay nest, including herbaceous vegetation and shrubs for foraging; implementing prescribed and natural fire management to maintain savannah-like stands of juniper woodlands in areas occupied by Woodhouse's Scrub-Jay; and coordinating Utah Juniper management to provide a mosaic of juniper woodland conditions [21].

CONTRIBUTORS

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Figure 1: Adult Woodhouse's Scrub-Jay in Jefferson County, Colorado. (Photo courtesy of Shawn Billerman)

Figure 2: North American range of *Aphelocoma woodhouseii*. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Woodhouse's Scrub-Jay habitat in southwestern Wyoming, dominated by Utah Juniper. (Photo courtesy of Leah H. Yandow, WGFD)

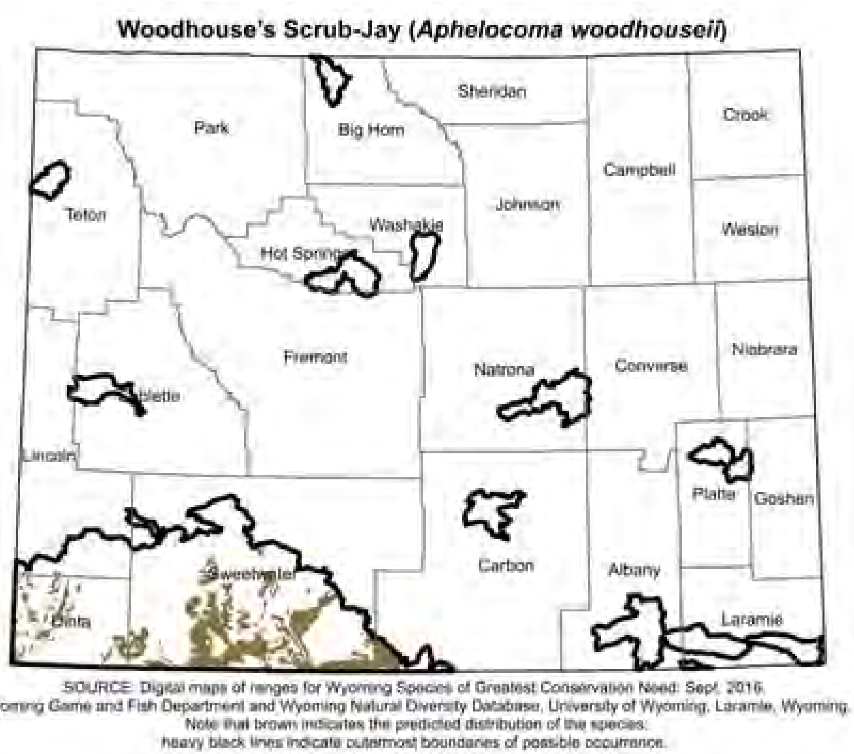

Figure 4: Range and predicted distribution of *Aphelocoma woodhouseii* in Wyoming.

Yellow-billed Cuckoo

Coccyzus americanus

REGULATORY STATUS

USFWS: Threatened; Migratory Bird
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: Sensitive
State of Wyoming: Protected Bird

CONSERVATION RANKS

USFWS: Bird of Conservation Concern
WGFD: NSSU (U), Tier II
WYNDD: G5, S1
  Wyoming Contribution: LOW
IUCN: Least Concern
PIF Continental Concern Score: 12

STATUS AND RANK COMMENTS

Yellow billed Cuckoo (*Coccyzus americanus*) populations west of the Continental Divide were first proposed for protection under the Federal Endangered Species Act (ESA) in 1986 [1]. Following several warranted but precluded findings, western Yellow-billed Cuckoos were proposed for listing as a Threatened Distinct Population Segment (DPS) by the U.S. Fish and Wildlife Service in 2013 [2]. In 2014, the Yellow-billed Cuckoo western DPS was officially designated as Threatened under the ESA [3]. In this context it is important to note that the species occurs on both sides of the Continental Divide in Wyoming (see Distribution and Range, below), but the ESA status applies only to individuals occurring west of the Divide.

NATURAL HISTORY

Taxonomy:

There are currently no recognized subspecies of Yellow-billed Cuckoo [1, 4]. Two subspecies were previously suggested based on differences in size, vocalizations, behavior, and ecology in populations east and west of the Continental Divide; however, diagnostic analyses do not support the designation of subspecies based on these differences [1].

Description:

Identification of Yellow-billed Cuckoo is possible in the field. The species is similar in size to most jays [5]. The sexes are identical in appearance. The species is a slender, long tailed bird, with a grayish-brown head and upperparts, and dullish white underparts. The tail is about half the length of bird and is brown above and black below. The undertail has an alternating black and white pattern [1, 5]. The species has a pale yellow to dusky eye ring. The base of the lower mandible of the bill is at least 40% yellow. Juveniles of the *occidentalis* subspecies have a dark lower mandible, while juveniles of the *americanus* subspecies have yellow at the base of the lower mandible [6]. In Wyoming, the species is most similar to Black-billed Cuckoo (*C.*

erythropthalmus). Yellow-billed Cuckoo is identified by its yellow to dusky eye ring, yellow lower mandible, and larger white spots in the undertail. In contrast, Black-billed Cuckoo has a red-eye ring in adults, all black lower mandible, and only small white undertail spots [5, 6].

Distribution & Range:
Historically, Yellow-billed Cuckoo bred across most of North America. Range contractions in western North America have resulted in extirpations from some states and Canadian provinces, and a patchy distribution overall [1, 7]. In Wyoming, it is found in the southwestern portion of the state, as well as portions of the great plains in the eastern part of the state, and scattered localities elsewhere [8, 9]. The species migrates to South America for the winter [1, 7].

Habitat:
Yellow-billed Cuckoo prefers to nest in open woodlands with a densely vegetated understory, especially near water. On the Great Plains, favored nesting habitat includes well-wooded river valleys and associated deciduous forests. In the southwest, riparian woodlands are preferred, particularly those with an ungrazed understory. Occasionally, other riparian-associated woodlands and orchards are used. The species requires dense patches of broad-leaved trees for nest placement. In the western portion of their range, this habitat type is typically only found along riparian corridors [7]. In Wyoming, suitable habitat is found along the Green River and potentially along the Bighorn, Powder, Tongue, Cheyenne, Belle Fourche, Little Missouri, Laramie, and North Platte River drainages [7, 8]. The species may use upland areas dominated by Piñon Pine (*Pinus* spp.), oak (*Quercus* spp.), Juniper (*Juniperus* spp.), and Manzanita (*Arctostaphylos pungens*) for 2–3 weeks prior to breeding [1].

Phenology:
Phenology of Yellow-billed Cuckoo has not been studied in Wyoming. Yellow-billed Cuckoo is a relatively late spring migrant, especially in the west, arriving on the breeding grounds in mid to late May. Some individuals may arrive as late as June or mid-July [1]. In Colorado, birds in the western portion of the state began to breed in early July, while those in the eastern part of the state began in mid-July [7]. The breeding season is long, and the species has bred as late as September in South Dakota. Fall migrants in the west leave 2–3 weeks earlier than eastern populations, with departure beginning in August, with nearly all birds gone by mid-September [1, 7].

Diet:
Yellow-billed Cuckoo primarily feeds upon large insects such as katydids, caterpillars, cicadas, grasshoppers, and crickets, taking particular advantage of large outbreaks of gypsy moth caterpillars and periodical cicadas [1, 10, 11]. Occasionally, small vertebrates such as frogs, lizards, and young birds are taken. The species will sometimes eat fruits and seeds, though these foods are more commonly eaten in winter [1].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
There are no robust estimates of Yellow-billed Cuckoo abundance in Wyoming [12]. In 2013, Partners in Flight estimated that Yellow-billed Cuckoo had a global population of approximately 9 million individuals, and a Wyoming population of approximately 1,400 [13]; however, this state

estimate is based primarily on Breeding Bird Survey (BBS) data and should be viewed with caution due to the low detection rate of this species in Wyoming. Yellow-billed Cuckoo has a statewide abundance rank of VERY RARE and appears to be uncommon within suitable environments in the occupied area [14]. From 1968–2015, annual Wyoming BBS detections of Yellow-billed Cuckoo ranged from 0 to 10, with none recorded in most years [15]. Yellow-billed Cuckoo was not detected during surveys for the Integrated Monitoring of Bird Conservation Regions program between 2009–2015 [12].

Population Trends:
Historic: LARGE DECLINE
Recent: LARGE DECLINE
Robust population trends are not available for Yellow-billed Cuckoo in Wyoming because the species is infrequently detected during monitoring surveys. However, survey-wide trend data from the North American BBS indicate that Yellow-billed Cuckoo numbers experienced statistically significant annual declines of 1.75% from 1966–2013 and 2.18% from 2003–2013 [16].

Intrinsic Vulnerability:
HIGH VULNERABILITY
In Wyoming, Yellow-billed Cuckoo is restricted to riparian woodland habitat greater than 15 hectares in size, with at least 3 hectares of closed canopy, a canopy height of 5 to 30 m, and a vegetated understory 1 to 6 m in height [7, 8]. In the western portion of the species' range, only one brood per season is produced. Reproductive success is highly variable [1].

Extrinsic Stressors:
HIGHLY STRESSED
Little is known about Yellow-billed Cuckoo in Wyoming. Loss and reduced quality of riparian habitat led to reduced numbers in the western range of the species. Elsewhere in its range, pesticide use on breeding and winter grounds has led to population declines. These effects are from the reduction of food availability and bioaccumulation of chemicals in the cuckoo's body tissues. These both can cause reproductive failure [7]. Evidence suggests that reproductive success decreases with increasing local temperature [17]. Tamarisk (*Tamarix* spp.) invasion reduces habitat quality for the species [1, 18]. Alteration of hydrology due to dam construction and irrigation impacts the species. Dam construction may produce dense riparian woodlands the cuckoo prefers, while drawdowns for irrigation cause riparian habitat degradation. Livestock grazing in riparian woodlands reduces habitat quality, and has led to local extirpations [7]. Noise from roads has been shown to negatively impact the species [19].

KEY ACTIVITIES IN WYOMING

Yellow-billed Cuckoo is classified as a Species of Greatest Conservation Need (SGCN) by the Wyoming Game and Fish Department (WGFD), and as a Level II Priority Bird Species requiring monitoring in the Wyoming Bird Conservation Plan [20]. Surveys for the presence of Yellow-billed Cuckoos were conducted along the Bighorn and Shoshone Rivers in northern Wyoming in 2009, with only one detection [21]. Annual songbird monitoring programs in the state, such as the BBS and IMBCR, have failed to adequately detect Yellow-billed Cuckoo in Wyoming [12, 16]. WGFD biologists have attended U.S. Fish and Wildlife Service training to survey for Yellow-billed Cuckoo within the state. Surveys are planned within the western DPS of Yellow-billed Cuckoo to monitor this species. Collaborative regional surveys are currently being planned which will standardize species monitoring across the western DPS.

ECOLOGICAL INFORMATION NEEDS

A clear understanding of the subspecies taxonomy and distribution is needed for Yellow-billed Cuckoo. For example, individuals from the North Platte River in Nebraska show genetic similarities to the western subspecies [8]. Additionally, current taxonomy is based on a small sample size and studies that evaluated more individuals have found no genetic evidence for subspecies designations [22, 23]. Basic phenology of the species is unknown, especially in western North America [1, 7]. Basic demographic knowledge of the species is unknown [1, 7, 8]. Distribution, abundance, and population trends of the species in Wyoming is unknown [7, 8]. The impacts of restricting or eliminating livestock grazing in the species' habitat in Wyoming is unknown [7].

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Zachary J. Walker. Yellow-billed Cuckoo is classified as a SGCN in Wyoming due to limited distribution and breeding habitat, national population declines, lack of Wyoming specific population data, and susceptibility to human disturbance. Species-specific monitoring should be conducted for Yellow-billed Cuckoo within the state. Additional monitoring should occur in designated Yellow-billed Cuckoo critical habitat along the Henry's Fork and Seedskadee National Wildlife Refuge. Wyoming should engage in regional efforts to conserve and monitor for this species as funding allows. Additional research should focus on site-specific population trends and habitat utilization. The WGFD should work cooperatively with willing landowners and other land management agencies to ensure Yellow-billed Cuckoo habitat is maintained. Critical habitat should also be managed to promote Yellow-billed Cuckoo populations within the state. This could include minimizing pesticide application, promoting multi-storied canopies in riparian zones, and enhancing suitable upland habitat.

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Figure 1: Adult Yellow-billed Cuckoo in Cape May, New Jersey. (Photo courtesy of Bill Schmoker)

Figure 2: North American range of *Coccyzus americanus*. The full extent of the species' western range is unknown. (Map courtesy of Birds of North America, http://bna.birds.cornell.edu/bna, maintained by the Cornell Lab of Ornithology)

Figure 3: Yellow-billed Cuckoo habitat at Bill Williams River National Wildlife Refuge, Arizona. (Photo courtesy of Lauren B. Harter)

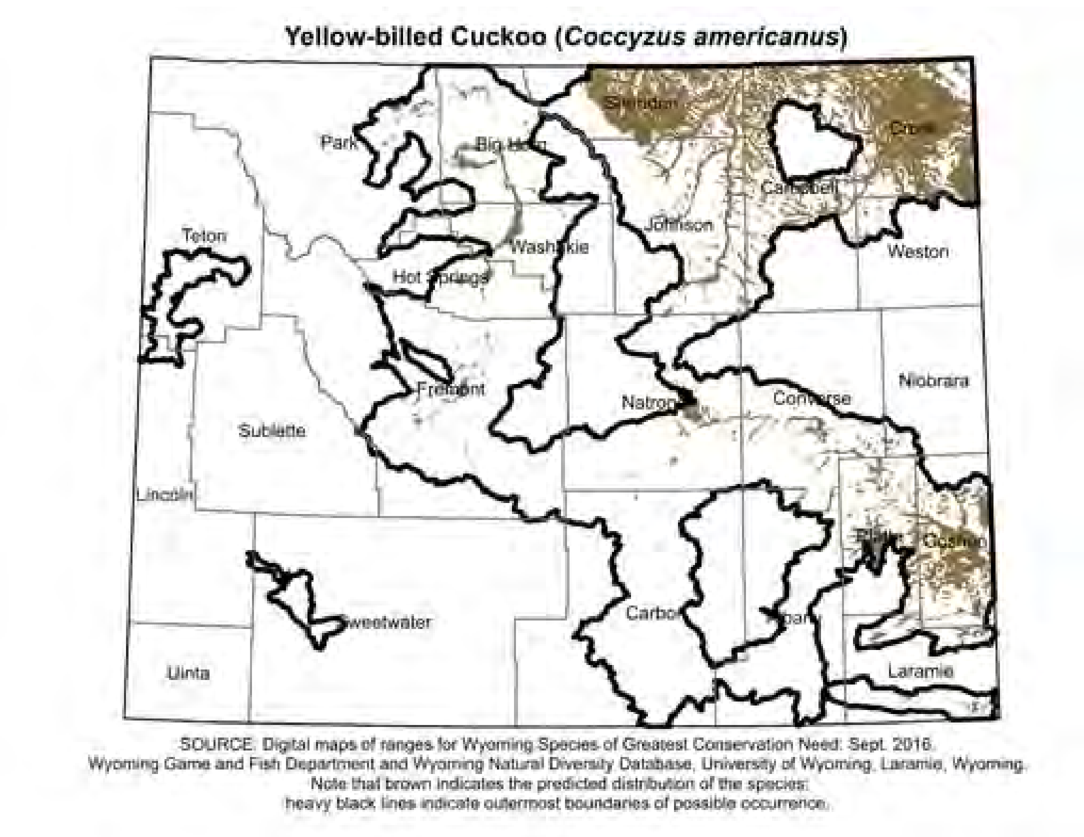

Figure 4: Range and predicted distribution of *Coccyzus americanus* in Wyoming.

Figure 5: Adult Yellow-billed Cuckoo on nest in an oak tree, Knob Noster State Park, Missouri. (Photo courtesy of Michael T. Wickens)

Beavertail Fairy Shrimp - Thamnocephalus platyurus

Abundance: Unknown

Status: NSSU NatureServe: G5 SNR

Population Status: Unknown

Limiting Factor: Unknown

Comment:

Introduction

Fairy shrimp are aquatic crustaceans in the class Branchipoda and order Anostraca. The beavertail fairy shrimp have translucent, elongate and delicate bodies (Dodson et al. 2010) that vary in color from white, gray, blue, green, orange or red depending on their diet (Maedamartinez et al. 1995). Their abdomen is broad and shaped like a paddle leading to their common name (Thorp and Rogers 2011). The species have 11 pairs of legs and lack a carapace. Individuals can grow up to 5.5 cm (2.2 inches) in length. Fairy shrimp swim upside-down and live in temporary aquatic habitats (rock pools, playas, roadside ditches, etc.) often with several other species of Branchipoda (Maeda-Martinez et al. 1997). They are distributed from Missouri to California and Montana to Texas (NatureServe 2016; Belk and Brtek 1995). Oklahoma ranked the fairy shrimp as apparently secure but this invertebrates is not ranked in other states (NatureServe 2016). Across their range, the beavertail fairy shrimp is ranked as secure. Fairy shrimp are typically filter feeders and can develop from egg to adult in 6 to 45 days depending on the temperature of the water and other conditions (Dodson et al. 2010). Beavertail fairy shrimp can survive in water up to 40°C (Hillyard and Vinegar 1972). Generally, these fairy shrimp complete one generation and produce resting eggs during the time that a temporary habitat is inundated with water (Dodson et al. 2010). The eggs of many species requires diapause before hatching. Temperature, daylight length, dissolved oxygen concentration and salinity may trigger encysted eggs to release from dormancy. Eggs can be produced parthenogenetically or sexually. The cysts of fairy shrimp are easily crushed, especially when they are wet (Hathaway et al. 1996). Minimizing off road vehicle and foot traffic on playas and other temporary aquatic habitats during the dry and wet season would reduce the risk of crushing fairy shrimp cysts.

Habitat

Beavertail fairy shrimp can live in temporary wetlands such as rock pools, vernal pools, seasonal wetlands, alpine pools and alkali lakes.

Problems

- A lack of basic knowledge of the species, their distributions and ecology precludes status assessments in Wyoming.

Conservation Actions

- More records are needed to accurately assess the species' status.

Monitoring / Research

The Wyoming Game and Fish Department and the Wyoming Natural Diversity Database have collected specimens of fairy shrimp since 2010 to estimate the distribution of beavertail fairy shrimp in Wyoming.

Recent Developments

The Wyoming Game and Fish Department and the Wyoming Natural Diversity Database collected beavertail fairy shrimp from 9 locations in Wyoming during 2013.

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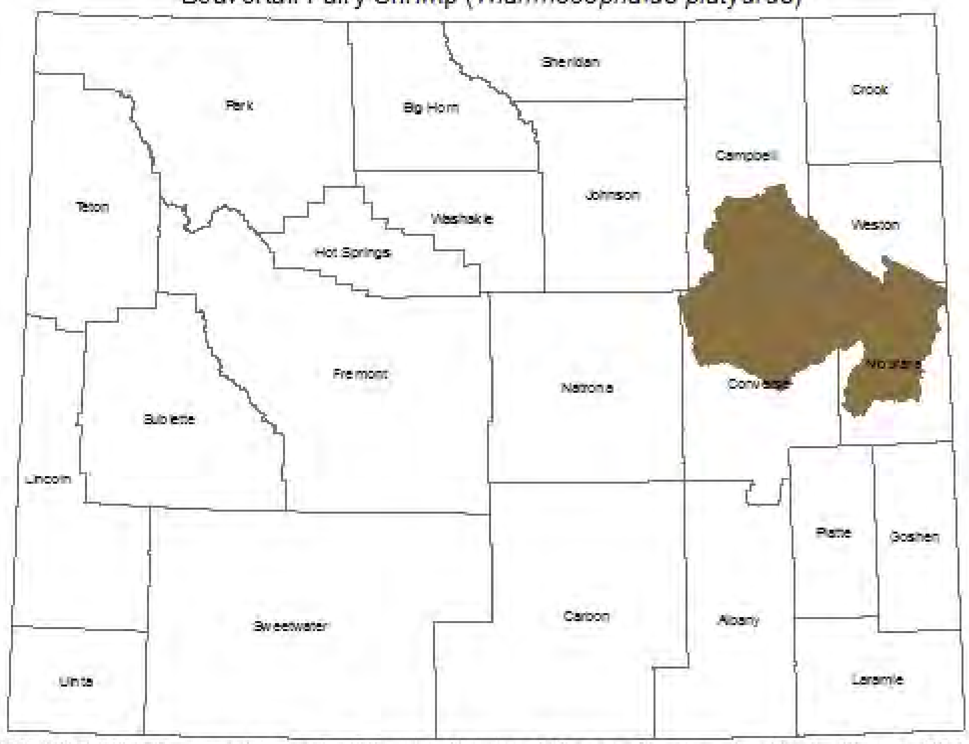
Beavertail Fairy Shrimp (*Thamnocephalus platyurus*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Calico Crayfish - Orconectes immunis

Abundance: Common

Status: NSS4 (Bc) NatureServe: G5 SNR

Population Status: This species was sampled in most of Wyoming's major river drainages other than the Bear and Snake rivers during a 2007-2009 survey. However, O. immunis was apparently displaced by O. virilis in multiple waters since a 1985-1987 survey of crayfishes.

Limiting Factor: We do not have enough information to assess the limiting factors; however, the loss, degradation or alternation of habitat, chemical pollution, introduction of non-native species, and overexploitation are the main causes for decline in North American crayfish (Taylor et al. 2007).

Comment:

Introduction

The calico crayfish or papershell crayfish (Orconectes immunis) is typically dark gray with an olive or purple tint (Pflieger 1996). The pincers tend to be light gray with white tubercles and purple or pink fingers. Males and females are similar in size (adults 4.3 to 8.9 cm (1.7-3.5 inches) in length). The calico crayfish has a large native range, including the Ohio, Mississippi, and Missouri River drainages. The calico crayfish is native from Quebec to Tennessee and New York to Wyoming and Montana; however, the crayfish is exotic in the northeastern United States (Pennsylvania to Maine; NatureServe 2016). In the crayfish's native range, this species is considered vulnerable (North Dakota) to secure (Illinois, Indiana, and Tennesse). The calico crayfish is not ranked in Wyoming but is ranked as secure across its native range. The calico crayfish primarily eats algae, but may also consume detritus and aquatic invertebrates (Pflieger 1996). To avoid freezing or drying conditions, this crayfish will make simple burrows in the substrate. Mating occurs during the active season and eggs may be laid in the fall or spring. In Wyoming, the calico crayfish is native to the Missouri River drainage, where the crayfish was the most commonly collected species east of the continental divide (Hubert 1988). However, the calico crayfish was introduced in the Green River drainage of Wyoming and is present in Flaming Gorge Reservoir where no crayfish are native.

Habitat

Ditches, floodplains, pools, and intermittent streams are habitats where the calico crayfish may occur (Pflieger 1996). The crayfish inhabits the floodplains of medium to large rivers and intermittent prairie headwater streams. Aquatic habitats with mud bottoms and lacking strong current are places the calico crayfish may live. Aquatic vegetation, flooded terrestrial vegetation, or high turbidity often provides cover for this species.

Problems

- The calico crayfish was introduced in the Green River drainage (Hubert 1988). The absence of predatory fish may be associated with higher densities of the calico crayfish (Pflieger 1996).

Conservation Actions

- None.

Monitoring / Research

Incidental observations would help refine range maps and the NSS rank.

Recent Developments

In 2009, the Wyoming Game and Fish Department personnel completed new statewide collections of crayfish to expand upon and update the survey by Hubert (1988). Hubert (2010) found that the calico crayfish was collected in the Green River, North Platte River, and Big Horn River drainages of Wyoming. Orconectes virilis appears to be displacing the calico crayfish in some locations.

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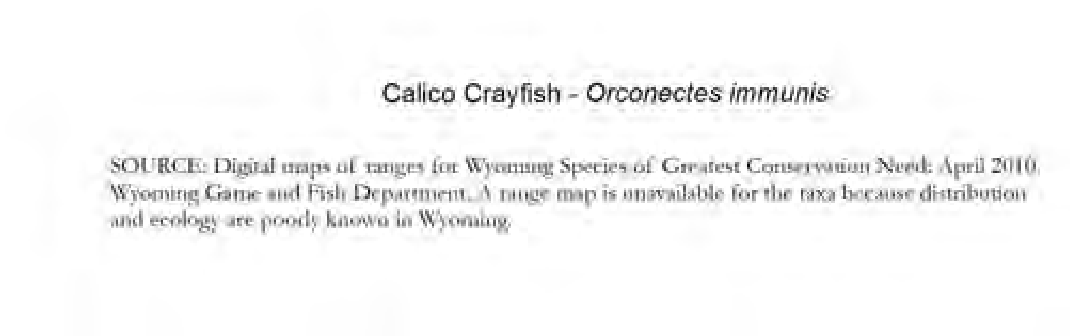

2017

Constricted Fairy Shrimp - Branchinecta constricta

Abundance: Unknown

Status: NSSU NatureServe: G2 S4

Population Status:

Limiting Factor:

Comment:

Introduction

Fairy shrimp are aquatic crustaceans in the class Branchipoda and order Anostraca. The constricted fairy shrimp has a translucent, elongate, delicate body (Dodson et al. 2010). The species have 11 pairs of legs and lack a carapace. Individuals can grow up to 1.6 cm (0.6 inches) in length. Fairy shrimp swim upside-down and live in temporary aquatic habitats (rock pools, playas, roadside ditches, etc.) often with several other species of Branchipoda (Maeda-Martinez et al. 1997). Branchinecta constricta is known from 3 counties in Wyoming and two counties in Idaho (NatureServe 2016; Rogers 2006; Rogers and Hill 2013). The fairy shrimp has a state rank of apparently secure in Wyoming and a range-wide rank of critically imperiled (NatureServe 2016). Fairy shrimp are typically filter feeders and can develop from egg to adult in 6 to 45 days depending on the temperature of the water and other conditions (Dodson et al. 2010). Generally, fairy shrimp complete one generation and produce resting eggs during the time that a temporary habitat is inundated with water (Dodson et al. 2010). The eggs of many species requires diapause before hatching. Temperature, daylight length, dissolved oxygen concentration and salinity may trigger encysted eggs to release from dormancy. Eggs can be produced parthenogenetically or sexually. The cysts of fairy shrimp are easily crushed, especially when they are wet (Hathaway et al. 1996). Minimizing off road vehicles and foot traffic in temporary aquatic habitats during the dry and wet season would reduce the risk of crushing fairy shrimp cysts.

Habitat

Problems

- A lack of basic knowledge of the species, their distributions and ecology precludes status assessments in Wyoming.

Conservation Actions

- More records are needed to accurately assess the species' status.

Monitoring / Research

The Wyoming Game and Fish Department and the Wyoming Natural Diversity Database have collected specimens of fairy shrimp since 2010 to estimate the distribution of these species.

Recent Developments

The constricted fairy shrimp was described in 2006 based on individuals collected in the 1980s and 1990s and thought to be endemic to Wyoming (Rogers 2006). Rogers and Hill (2013) recently discovered constricted fairy shrimp in Idaho. The Wyoming Game and Fish Department and the Wyoming Natural Diversity Database collected fairy shrimp from across Wyoming since 2010 and did not find the constricted fairy shrimp.

References

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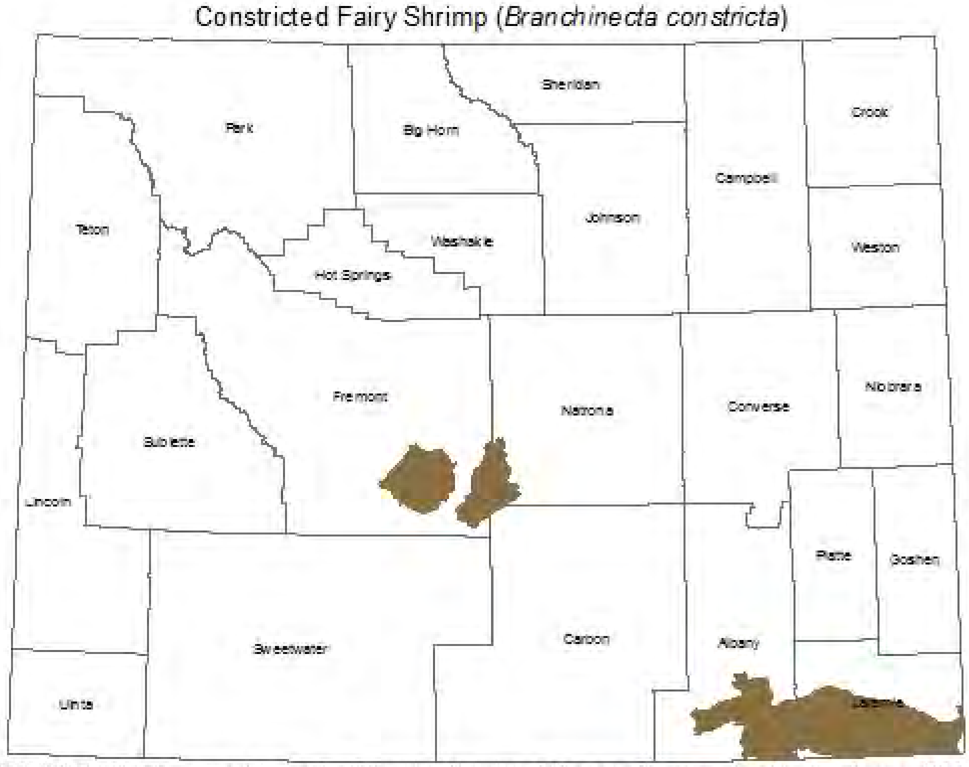
Rogers, D. C. and M. A. Hill. 2013. Annotated checklist of the large branchipod crustaceans of Idaho, Oregon and Washington, USA, with the "rediscovery" of a new species of Branchinecta (Anostraca: Branchinectidae). Zootaxa 3694:249-261.

Constricted Fairy Shrimp (*Branchinecta constricta*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Devil crayfish - Cambarus diogenes

Abundance: Unknown

Status: NSSU NatureServe: G5 S3

Population Status: Unknown

Limiting Factor: We do not have enough information to assess the limiting factors; however, the loss, degradation or alternation of habitat, chemical pollution, introduction of non-native species, and overexploitation are the main causes for decline in North American crayfish (Taylor et al. 2007).

Comment: None

Introduction

Devil crayfish (Cambarus diogenes) are olive or tan in color (Pflieger 1996). These crayfish may have orange or red tips on their pincers and along the margins of their body (for example, rostrum, abdominal segments, and tail). Some specimens have one or three stripes along the midline of their abdomen. Form I males (breeding males) are 7.9 to 12.2 cm (3.1 to 4.8 inches) in length, whereas mature females are smaller (7.1 to 10.2 cm or 2.8 to 4.0 inches in length). Devil crayfish have a large native range, extending from Ontario to Texas and Wyoming to North Carolina (NatureServe 2016). This crayfish is considered imperiled (New York) to secure (Illinois, Louisiana, Alabama, Georgia, and Tennessee) across the range and vulnerable in Wyoming. The devil crayfish is ranked as secure across its entire range. The devil crayfish is not found outside its native range. Little is known about the life history of the devil crayfish, because this species lives in burrows. These crayfish construct burrows with one to multiple entrances along streams or in wetlands (Pflieger 1996). At the burrow entrance, devil crayfish can build chimneys up to 30.5 cm (12 inches) in height. The devil crayfish is thought to eat terrestrial vegetation and other organic matter while out of the burrow on moist nights. During dry times, the crayfish seals burrow entrances to retain moisture and exclude predators. Mating and rearing young may occur in burrows or in open water. Mating may occur in the fall and eggs likely hatch in spring. In Wyoming, the devil crayfish was collected in a tributary of the North Platte River (Horse Creek; Hubert 1988), but few collections were made in suitable habitat in eastern Wyoming. Furthermore, the burrowing nature of the devil crayfish makes this species difficult to collect.

Habitat

The devil crayfish builds burrows in forested habitats near temporary or permanent water, or where the water table is near the surface (Pflieger 1996). Females with young can be found in shallow surface waters until the young disperse and build burrows. Because of their burrowing nature, these crayfish are typically found in areas with fine sediment.

Problems

- Females tend to rear young in temporary waters without fish.

Conservation Actions

- None.

Monitoring/Research

Incidental observations would help refine range maps and the NSS rank.

Recent Developments

In 2009, the Wyoming Game and Fish Department personnel completed new statewide collections of crayfish to expand upon and update the survey by Hubert (1988). Hubert (2010) did not identify any devil crayfish; however, Horse Creek was not re-sampled in the recent survey nor any other streams in the North Platte River drainage.

References

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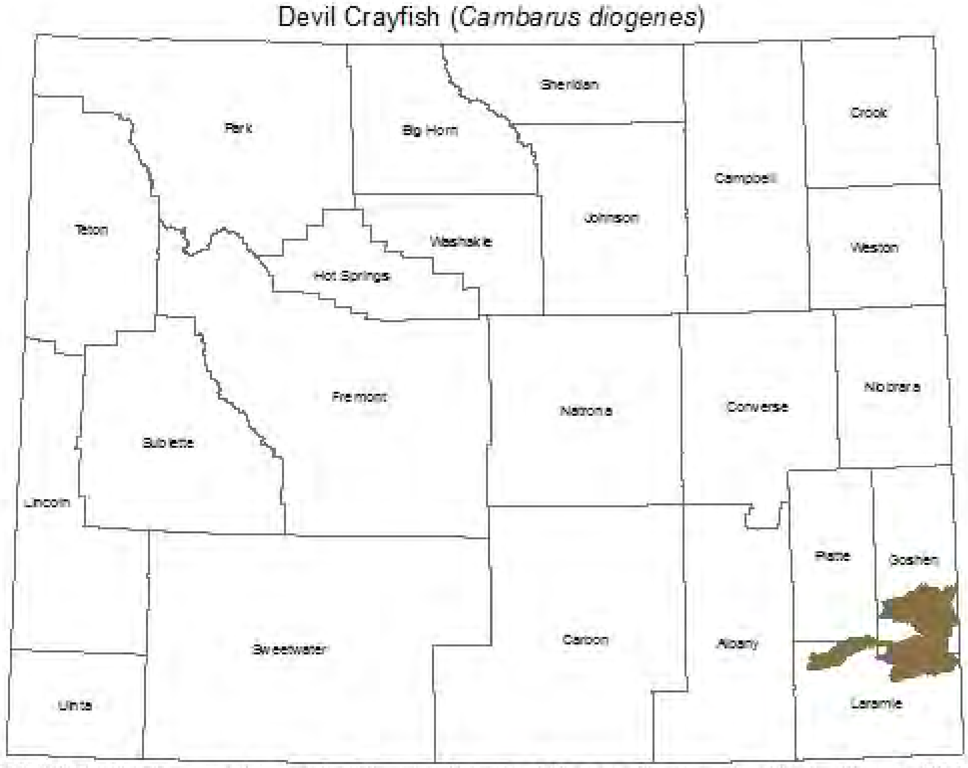
Taylor, C. A., G. A. Schuster, J. E. Cooper, R. J. DiStefano, A. G. Eversole, P. Hamr, H. H. Hobbs III, H. W. Robison, C. E. Skelton & R. F. Thoma. 2007. A reassessment of the conservation status of crayfishes of the United States and Canada after 10+ years of increased awareness. Fisheries 32:372-389.

Devil Crayfish (*Cambarus diogenes*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Fairy and Tadpole Shrimps - spp.

Abundance: Unknown

Status: NSSU NatureServe: G5 SNR

Population Status: Unknown

Limiting Factor: Unknown

Comment: None

Introduction

Fairy, tadpole and clam shrimp are aquatic crustaceans in the class Branchipoda. Fairy shrimp (order Anostraca) have a translucent, elongate and delicate body (Dodson et al. 2010). The species in North America have 11 pairs of legs except the genus Polyartemiella which has 17 pairs of legs. Individuals are typically 1 to 6 cm (0.4 to 2.4 inches) in length with two species that can reach 18 cm (7 inches) in length. Fairy shrimp swim upside-down and lack a carapace. They are distributed throughout North America and Wyoming is home to 5 genera (Eubranchipus, Artemia, Branchinecta, Steptocephalus and Thamnocephalus). Fairy shrimp are typically filter feeders and can develop from egg to adult in 6 to 45 days.

Tadpole shrimp (order Notostraca) have a flat, broad carapace that covers the head and thorax, and a pair of dorsal compound eyes (Dodson et al. 2010). Tadpole shrimp have 35-70 trunk legs that may be hidden by the carapace and are 1 to 5.8 cm (0.4 to 2.3 inches) in length. The carapace may be yellow, green, brown or black. Tadpole shrimp are located west of the Mississippi and in the Arctic of North America. Two genera of tadpole shrimp have been collected in Wyoming (Triops and Lepidurus). Tadpole shrimp eat detritus from the bottom of pools and can also be carnivorous. Tadpole shrimp generally develop from egg to adult in 2 to 3 weeks.

Clam shrimp (orders Laevicaudata and Diplostraca) have a carapace that resembles the shell of a small clam (Dodson et al. 2010). Inside the carapace, clam shrimp have 10-32 pairs or more of thoracic legs, a head with eyes and an abdomen. These two orders can be separated by the carapace: Laevicaudata lack growth lines on the carapace and Diplostraca have them. They range in size between 2 and 16 mm in length and their carapace can be brown, yellow or green in color. Both orders are widely distributed across North America and 4 genera of clam shrimp are known in Wyoming (Eulimnadia, Lynceus, Cyzicus and Leptestheria). Clam shrimp eat algae and phytoplankton in temporary habitats and can develop from egg to adult in 4 to 11 days depending on water temperature.

The life histories of fairy, tadpole and clam shrimp are similar. Generally, these animals complete one generation and produce resting eggs during the time that a temporary habitat is inundated with water. The eggs of many species require diapause before hatching. Temperature, daylight length, dissolved oxygen concentration and salinity may trigger encysted eggs to release from dormancy. Eggs can be produced parthenogenetically or sexually.

Fairy, tadpole and clam shrimp are present in Wyoming. According to NatureServe (2016) 15 species of fairy shrimp are known from Wyoming, including Branchinecta serrata is endemic to Wyoming (Rogers 2006). Four tadpole shrimp are known from Wyoming, including Lepidurus bilobatus that is known from seven states in the western United States (Rogers 2001; NatureServe 2016), and considered imperiled across their range (NatureServe 2016).

Habitat

Fairy, tadpole and clam shrimp usually live in temporary wetlands such as rock pools, vernal pools, seasonal wetlands, playas, alpine pools, stock tanks and alkali lakes. Some species can also live in permanent waters such as fishless lakes, salt lakes, wetlands that freeze solid in winter, or wetlands that are reduced to damp soil during dryer periods.

Problems

- A lack of basic knowledge of the species that inhabit the state, their distributions and ecology precludes status assessments in Wyoming. The taxonomy of Triops (tadpole shrimp) is currently in revision and the taxonomy of many clam shrimp are in need of revision.

Conservation Actions

- Samples are currently being collected to estimate what species live in Wyoming and where they occur.

Monitoring / Research

Specimens of fairy, tadpole and clam shrimp are being collected each year to estimate what species live in Wyoming and how they are distributed.

Recent Developments

Three recently described species of fairy shrimp were found in Wyoming, including Branchinecta constricta, B. serrata, and B. lateralis (Rogers 2006). B. lateralis was subsequently collected in four western states. B. constricta is a species endemic to southeastern Wyoming, though it may be present in northern Colorado. Additionally, B. serrata is endemic to the Crook Mountains of Wyoming.

References

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Dodson, S. L., C. E. Caceres, and D. C. Rogers. 2010. Cladocera and other Branchiopoda. Pages 773-827 in J. H. Thorp and A. P. Covich, editors. Ecology and Classification of North American Freshwater Invertebrates. Academic Press, New York.

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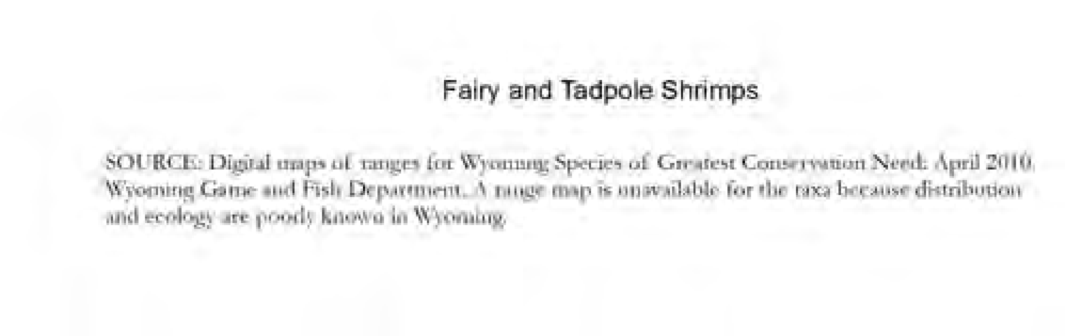
Rogers, D. C. 2006. Three new species of Branchinecta (Crustacea: Branchiopoda: Anostraca) from the Nearctic. Zootaxa 1126:35-51.


Fairy and Tadpole Shrimps
SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: April 2010. Wyoming Game and Fish Department. A range map is unavailable for the taxa because distribution and ecology are poorly known in Wyoming.

2017

Mackin Fairy Shrimp - Streptocephalus mackini

Abundance: Unknown

Status: NSSU NatureServe: G5 SNR

Population Status:

Limiting Factor:

Comment:

Introduction

Fairy shrimp are aquatic crustaceans in the class Branchipoda and order Anostraca. The mackin fairy shrimp have translucent, elongate, delicate bodies (Dodson et al. 2010) that can be white, green, blue, yellow, or red in color (Thorp and Rogers 2011). The species have 11 pairs of legs and lack a carapace. Individuals can grow up to 3.5 cm (1.4 inches) in length. Fairy shrimp swim upside-down and live in temporary aquatic habitats (rock pools, playas, roadside ditches, etc.) often with several other species of Branchipoda (Maeda-Martinez et al. 1997). The mackin fairy shrimp is known from 4 states (NatureServe 2016; Tronstad, unpublished data) but is not ranked. The fairy shrimp is ranked as secure across their range. Fairy shrimp are typically filter feeders and can develop from egg to adult in 6 to 45 days depending on the temperature of the water and other conditions (Dodson et al. 2010). Generally, fairy shrimp complete one generation and produce resting eggs during the time that a temporary habitat is inundated with water (Dodson et al. 2010). The eggs of many species requires diapause before hatching. Temperature, daylight length, dissolved oxygen concentration and salinity may trigger encysted eggs to release from dormancy. Eggs can be produced parthenogenetically or sexually. The cysts of fairy shrimp are easily crushed, especially when they are wet (Hathaway et al. 1996). Minimizing off road vehicles and foot traffic in temporary aquatic habitats during the dry and wet season would reduce the risk of crushing fairy shrimp cysts.

Habitat

The mackin fairy shrimp lives in temporary pools, seasonal wetlands, vernal pools and playas (Thorp and Rogers 2011).

Problems

Conservation Actions

Monitoring / Research

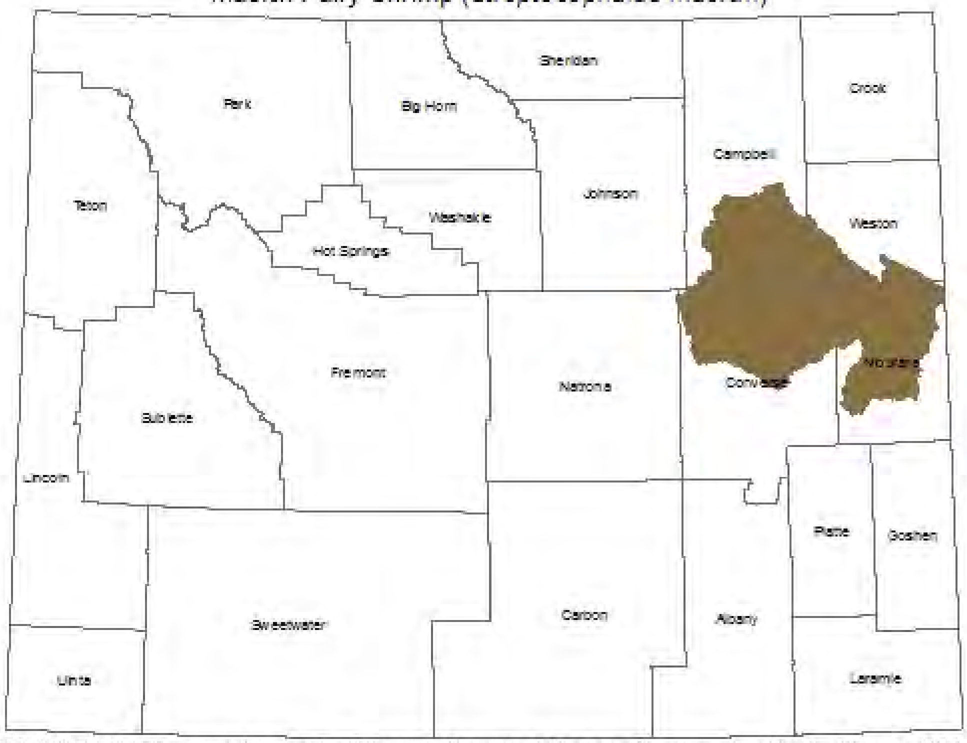
The Wyoming Game and Fish Department and Wyoming Natural Diversity Database collected specimens of fairy shrimp since 2010 to estimate the distribution of these species.

Recent Developments

The Wyoming Game and Fish Department and the Wyoming Natural Diversity Database collected fairy shrimp from across Wyoming between 2010 and 2013 and mackin fairy shrimp were collected from 9 locations.

References

Mackin Fairy Shrimp (*Streptocephalus mackini*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Pilose crayfish - Pacifastacus gambelii

Abundance: Unknown

Status: NSS2 (Ab) NatureServe: G4G5 S3

Population Status: Unknown

Limiting Factor: We do not have enough information to assess the limiting factors; however, the loss, degradation or alternation of habitat, chemical pollution, introduction of non-native species, and overexploitation are the main causes for decline in North American crayfish (Taylor et al. 2007).

Comment: NSSU to NSS2 (Ab)

Introduction

The pilose crayfish (Pacifastacus gambelii) is a pigmented species with the margins of the rostrum converging (Hobbs 1972). This species is native to the western United States from California to Montana and Wyoming to Oregon (NatureServe 2009). The pilose crayfish is considered critically imperiled (Montana) to apparently secure (California and Idaho). Crayfish are generally considered omnivores feeding on plants, animals, and detritus (Smith 2001; Hobbs and Lodge 2010). The pilose crayfish probably mate in the spring and are nocturnal (NatureServe 2009). However, limited information about the life history of the pilose crayfish is known. In Wyoming, the pilose crayfish is native to the Snake and Bear River Drainages (Hubert 1988).

Habitat

The pilose crayfish can be found in lentic and lotic habitats (NatureServe 2009). This species may not tolerate warm water habitats or fish populations.

Problems

- Introduced crayfish and sport fish may displace or eliminate the pilose crayfish.

Conservation Actions

- None.

Monitoring/Research

None.

Recent Developments

In 2009, the Wyoming Game and Fish Department personnel completed new statewide collections of crayfish to expand upon and update the survey by Hubert (1988). The pilose crayfish was collected in the Snake River Drainage; however, O. virilis appears to have displaced the pilose crayfish in the Bear River drainage (Huber 2010). Larson et al. (in review) sequenced DNA from crayfish in the genus Pacifastacus, including individuals from two populations in Wyoming and found that Pacifastacus gambelii is a valid species.

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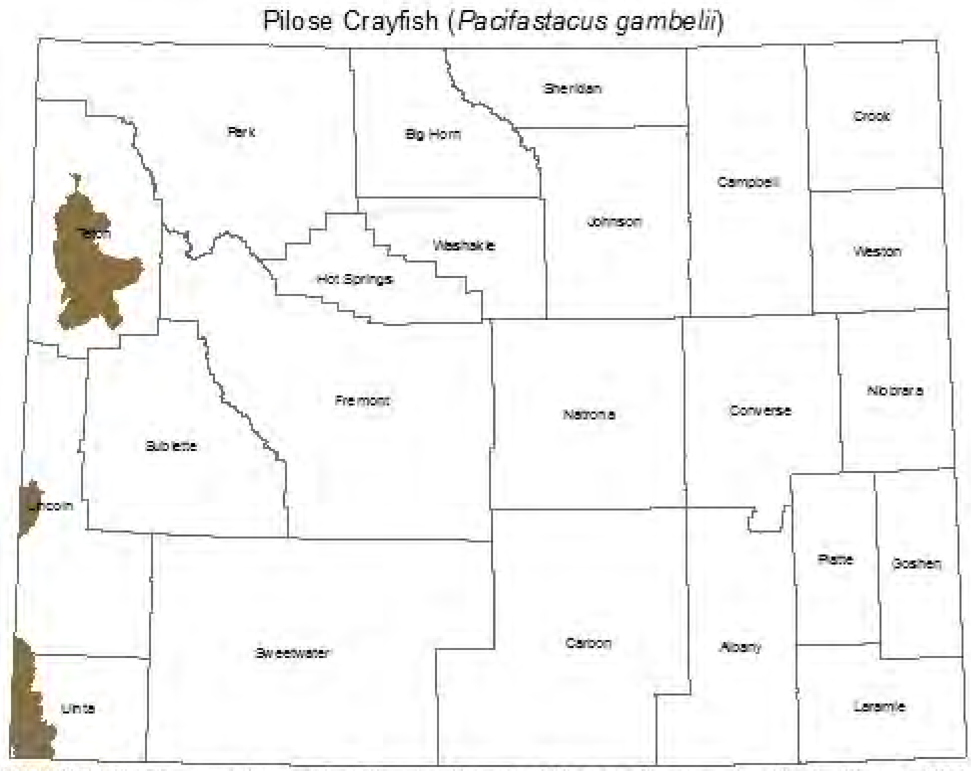

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Ringed crayfish - Orconectes neglectus

Abundance: Unknown

Status: NSS3 (Bb) NatureServe: G5 S3

Population Status: Unknown

Limiting Factor: We do not have enough information to assess the limiting factors; however, the loss, degradation or alternation of habitat, chemical pollution, introduction of non-native species, and overexploitation are the main causes for decline in North American crayfish (Taylor et al. 2007).

Comment: NSSU to NSS3 (Bb)

Introduction

The ringed crayfish (Orconectes neglectus) is olive or red in color with characteristic black or brown rings near the end of their pincers (Pflieger 1996). The subspecies O. n. neglectus is olive in color with a black stripe down the lateral edge of the abdomen. The claws of this subspecies have orange tips with black rings. Adult crayfish are 3 to 9.7 cm (1.2 to 3.8 inches) in length. The ringed crayfish is native to the central United States from Nebraska to Arkansas and Missouri to Wyoming (NatureServe 2016). Within the native range, the crayfish is considered imperiled (Colorado and Kansas) to apparently secure (Oklahoma) and is ranked as vulnerable in Wyoming. The crayfish is ranked as secure across its entire native range. The ringed crayfish is exotic in Oregon and New York. The ringed crayfish makes burrows under rocks in streams (Pflieger 1996). This species tends to remain in burrows during the day, but comes out at night to feed on algae and coarse benthic organic matter (Pflieger 1996; Evans-White et al. 2001). Breeding can occur from late fall to spring and eggs are typically laid in late spring to early summer (Pflieger 1996). Individuals live 2.5 years on average but can live up to 5 years. In Wyoming, a subspecies of the ringed crayfish (Orconectes neglectus neglectus) was collected from Crystal Lake Reservoir on the headwaters of Crow Creek in the South Platte River drainage near Cheyenne (Hubert 1988) in its native range (Williams 1954).

Habitat

The ringed crayfish lives in small to large permanent streams that have clear water and rocky substrate. The crayfish may be found in both riffle and pool habitats that are free of fine sediments.

Problems

- None.

Conservation Actions

- None.

Monitoring/Research

Incidental observations would help refine range maps and the NSS rank.

Recent Developments

In 2009, the Wyoming Game and Fish Department personnel completed new statewide collections of crayfish to expand upon and update the survey by Hubert (1988). Hubert (2010) found the ringed crayfish in Crystal and Granite Resrvoirs in the South Platte River drainages.

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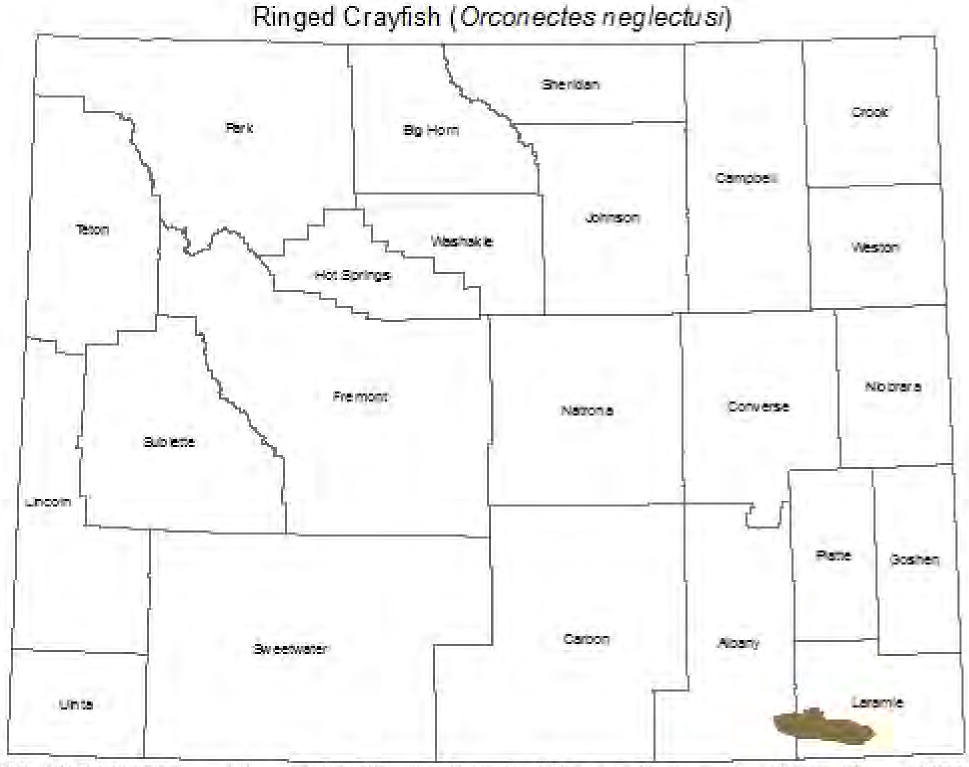
Taylor, C. A., G. A. Schuster, J. E. Cooper, R. J. DiStefano, A. G. Eversole, P. Hamr, H. H. Hobbs III, H. W. Robison, C. E. Skelton & R. F. Thoma. 2007. A reassessment of the conservation status of crayfishes of the United States and Canada after 10+ years of increased awareness. Fisheries 32:372-389.

Ringed Crayfish (*Orconectes neglectusi*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Bigmouth Shiner - Notropis dorsalis

Abundance: Common

Status: NSS4 (Cb) NatureServe: G5 S5

Population Status: Stable. Appear to be widespread and abundant with no apparent population declines over last decade.

Limiting Factor: Habitat: severe due to extensive fragmentation.

Comment: NSS Ranks are reviewed and revised with each SWAP revision. No changes were made for this species in this revision.

Introduction

Bigmouth shiner core distribution extends from northern Minnesota to eastern Illinois, and west to central Wyoming. Disjunct populations are in western New York and Pennsylvania, northern West Virginia, northern Ohio, western Michigan, and Manitoba. In Wyoming they are found in the North and South Platte river drainages.

Bigmouth shiners search stream bottoms during night for aquatic insects, apparently using taste to locate food (Pflieger 1997). Little is known about their reproductive behavior although they are thought to spawn in July and August (Baxter and Stone 1995). Bigmouth shiner may exhibit similar reproductive behavior as other species in their genus, which spawn in open water over fine sand, with fertilized eggs sent drifting in the water column (Baxter and Stone 1995). Eggs will develop and hatch out in one or two days (Weitzel 2002).

Habitat

Bigmouth shiners prefer low gradient streams with perennial flows and sand substrates and open waters free of vegetation or other cover (Weitzel 2002). In Wyoming they were found in perennial streams throughout much of their historic range at sites with sand and gravel substrates present and light to heavy aquatic vegetation (Moan et al. 2010).

Problems

- There is a relative absence of basic reproductive information for the species.
- Altered flow regimes, habitat fragmentation, and impacts to aquatic and riparian habitat associated with agricultural practices.
- Lack of connectivity resulting from low flows or other physical barriers (natural and man made) may significantly limit access to upstream habitats.

Conservation Actions

- Continue efforts to educate landowners and the public about the importance of native fish and their habitats.
- Continue efforts to maintain flows and connectivity.

Monitoring / Research

Continue to identify and record observations while conducting fisheries management sampling.

Recent Developments

Detailed fish and habitat surveys were conducted in tributaries to the North Platte River between 2005 and 2009 to establish a baseline for future trend analysis in the North Platte drainage (Gerrity 2009, Moan et al. 2010). In 2005 and 2007, the Casper Region Fish Management crew conducted non-game fish surveys in the lower sections of the mainstem North Platte River (WGFD 2006, WGFD 2008).

The Casper Fisheries Management Crew found BMS in low abundance during surveys of North Platte River side channels, backwaters, and streambank margins during 2012-2013. These native fish surveys were conducted at various sites from Casper downstream to the Nebraska state line (WGFD 2012, 2013).

The Laramie Fisheries Management Crew found a single BMS in the Laramie River downstream of Grayrocks Reservoir in 2012 (WGFD 2012).

Multiple surveys on Lodgepole and Horse creeks and the Laramie River were conducted by the Aquatic Assessment and Laramie Fish Management crews in 2014-2015 as part of the Eastern Wyoming Intermittent Streams project. Bigmouth Shiner were found in low abundance on both streams. Results are on file and will be detailed in a forthcoming administrative report.

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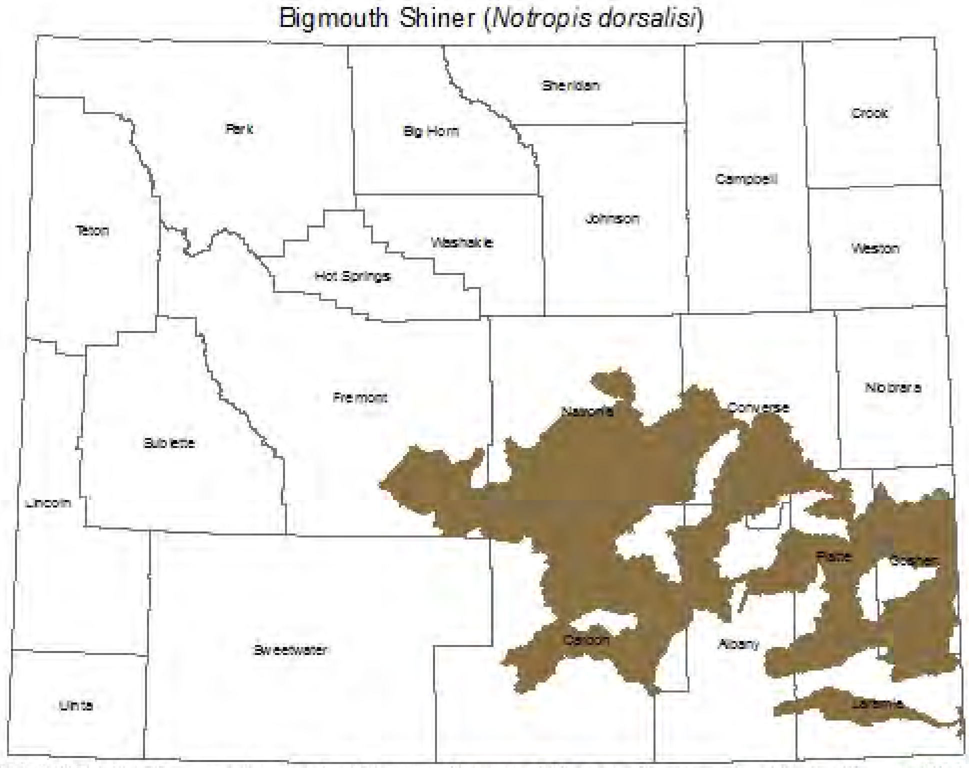

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Bluehead Sucker - Catostomus discobolus

Abundance: Extremely rare

Status: NSS1 (Aa) NatureServe: G4 S3

Population Status: Greatly restricted in numbers and distribution and extirpation is possible.

Limiting Factor: Genetics: species declining in genetic purity over the majority of its range in Wyoming due to introgression with nonnative sucker species.

Comment: NSS Ranks are reviewed and revised with each SWAP revision. No changes were made for this species in this revision.

Introduction

Bluehead sucker, along with flannelmouth sucker Catostomus latipinnis, and roundtail chub Gila robusta are all relatively large-bodied species of imperiled Colorado River fish. The three are collectively called "the three species" and their conservation is a cooperative effort which spans state lines (Colorado River Fish and Wildlife Council 2004). Bluehead suckers are native to the Colorado River Basin and the Upper Snake, Weber, and Bear Rivers of Idaho, Wyoming, and Utah (Sigler and Miller 1963). This species currently occupies 50% of its historic Upper Colorado River basin range (Bezzerides and Bestgen 2002). Hybridization with native and nonnative sucker species poses the greatest risk to the persistence of Wyoming populations (Douglas and Douglas 2008; McDonald et al. 2008; Gelwicks et al. 2009). Although genetically pure individuals still exist throughout the Green River drainage in Wyoming, only those in Ringdahl Reservoir are isolated from non-native, hybridizing sucker species (Gelwicks et. al. 2009). Until 2010, it was believed that no non-native suckers were present in the Snake River drainage, however a white sucker was found in the Snake River in 2009 (verified in 2010) and recent genetic work (Mandeville, 2015) has confirmed the presence of white suckers in the drainage. At the current time, bluehead sucker populations in the Bear River drainage are presumed to be free from non-native, hybridizing sucker species. Adult and juvenile bluehead suckers are benthic algivores and use chisel-like mouth parts to scrape algae, organic and inorganic debris, and aquatic invertebrates from hard substrates (Muth and Snyder 1995). Spawning occurs from mid to late summer at higher elevations (Bezzerides and Bestgen 2002). Eggs are deposited into shallow redds (Maddux and Kepner 1988), and larvae drift downstream to backwater nursery habitat (Childs et al. 1998). Within larger rivers, bluehead suckers exhibit both downstream movement and sedentary patterns (Cavalli 2000; Beyers et al. 2001; Hines 2013). Similar observations have been made in smaller systems (Beatty 2005; Compton 2007; Sweet 2007).

Habitat

Bluehead suckers occupy the mainstem and tributaries of large rivers. They are more frequently found in headwaters than flannelmouth suckers (Baxter and Stone 1995). Large adults are associated with deep pools, undercut banks, moderate to fast current velocities, and rocky substrates (Sigler and Miller 1963, Sweet 2007, Hines 2013).

Problems

- Hybridization between native bluehead and flannelmouth sucker and non-native white sucker Catostomus commersoni, longnose sucker Catostomus catostomus, and Utah sucker Catostomus ardens is occurring. Some combinations are fertile and will lead to introgression.
- Competition with and predation by nonnative species (i.e., Catostomus sp., creek chub Semotilus atromaculatus, redside shiner Richardsonius balteatus, burbot Lota lota, brown trout Salmo trutta, and lake trout Salvelinus namaycush) further limit bluehead and flannelmouth sucker populations.
- The effects of water development and reservoir construction exacerbated by drought have cut off this species' migratory corridors, degraded its habitat, and encouraged the spread of nonnatives.

Conservation Actions

- Continue as a signatory to the "Rangewide Conservation Agreement for Roundtail Chub, Bluehead Sucker and Flannelmouth Sucker" (Colorado River Fish and Wildlife Council 2004).
- Chemically treat Big Sandy River, Little Sandy and Muddy Creeks to remove nonnative species and reduce the risk of hybridization.
- Continue efforts to maintain flows and connectivity.
- Investigate the viability of hybrids.
- Develop methods for holding and spawning in captivity.

Monitoring / Research

Continue regular monitoring of drainages containing the three species to track population trends, hybridization rates, and the abundance and ranges of nonnative species.

Conduct monitoring before and after chemical treatments and transplants to determine the success of removal efforts.

Conduct a project to determine juvenile abundance and habitat use.

Recent Developments

A survey from 2002-2006 of the three species throughout the Green River drainage in Wyoming has been completed and summarized in an Administrative Report (Gelwicks et al. 2009). Surveys indicate that the most imminent threat to the persistence of bluehead suckers in the Green River drainage is genetic introgression with white suckers.

Genetics analyses reveal that Wyoming populations of the three species contain unique haplotypes not found in downstream populations (Douglas and Douglas 2008), that hybridization with white suckers enables further backcrossing among native and nonnative sucker species (Douglas and Douglas 2008; McDonald et al. 2008), and that the level of hybridization varies among drainages (Mandeville 2015).

Six studies were completed describing three species populations, habitat, and/or movement in Snake River, Big Sandy River, and Little Sandy and Muddy Creeks (Bower 2005; Beatty 2005; Compton 2007; Sweet 2007; Banks 2009; Hines 2013).

Nonlethal methods for precisely aging native and nonnative sucker species and their hybrids were developed (Quist et al. 2007) and used to age bluehead suckers in Snake River, Big Sandy River, and Little Sandy and Muddy Creeks (Sweet et al. 2009; Hines 2013).

Methods for salvage, transport, holding, and repatriation of native species were investigated (Compton 2013).

Bluehead suckers were documented in the Buffalo Fork, Gros Ventre, Fish Creek, and Spread Creek drainages in the Snake River drainage.

Chemical treatments to remove nonnative species in Sculpin Creek and Long Draw (Big Sandy drainage) and Muddy Creek have begun.

A barrier is being constructed on the Big Sandy River to prevent recolonization of treated stream reaches by nonnative fish. Barrier design was influenced by research on the jumping capabilities of burbot and white suckers (Gardunio 2014). Barrier location was influenced by research on the larval drift of Catostomids in the Big Sandy River (Zelasko et. al. 2011).

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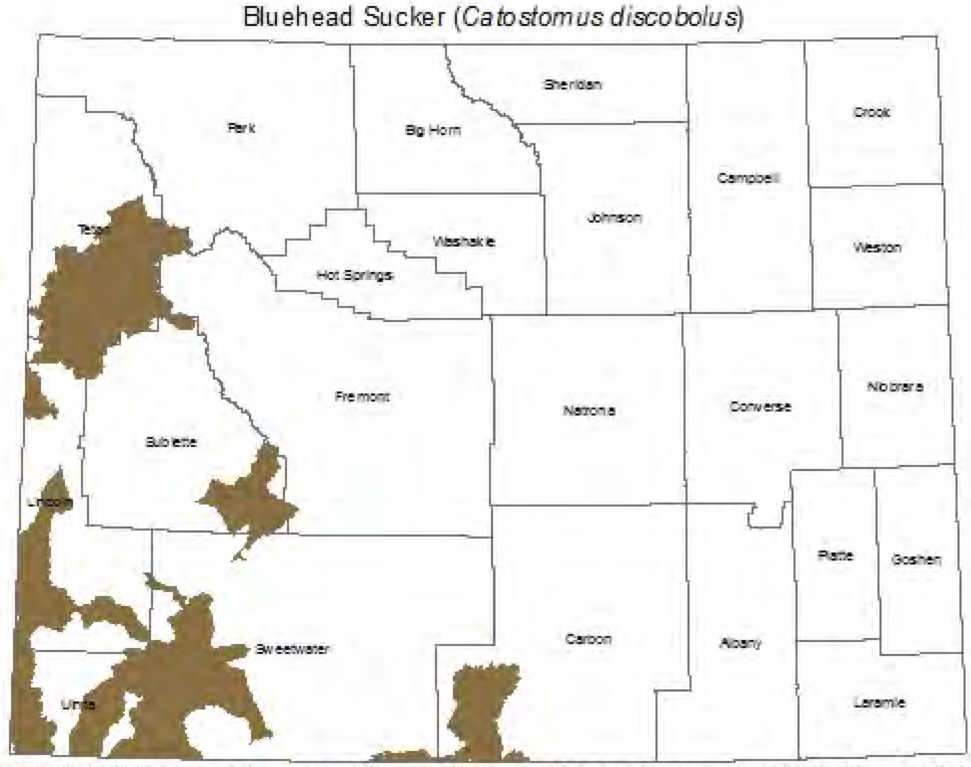
Bluehead Sucker (*Catostomus discobolus*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

Bonneville Cutthroat Trout - Oncorhynchus clarkii

Abundance: Common within a limited range

Status: NSS3 (Bb) NatureServe: G4T4 S1

Population Status: Restricted in numbers and distribution, but relatively stable. Extirpation is not imminent. Population status is vulnerable.

Limiting Factor: Limiting factors are severe but not increasing significantly. Habitat: habitat availability is limited by land management activities (grazing, irrigation diversion, energy development, and municipal water diversion), but habitat conditions have not worsened over the past decade.

Comment: Changed from NSS2 in 2005 due solely to changes in the matrix. No change was made for the 2017 update

Introduction

Bonneville cutthroat trout (BRC) are native to the Bear River drainage in Wyoming. The distribution and abundance of BRC has declined from historical levels. It has been estimated that BRC occupied 6,758 miles of habitat within Utah, Idaho, Wyoming and Nevada. They currently occupy an estimated 2,380 miles of historical habitat (May and Albeke 2005). Interagency management plans have been developed for this species since 1993 which focused on population and habitat monitoring, increasing BRC range, watershed improvements, and developing public awareness (Remmick et al. 1993, Lentsch et al. 2000, May and Albeke 2005).

This cutthroat trout subspecies is distinguished from other subspecies by a more uniform distribution of spots. Life history information for BRC has been described by Baxter and Stone (1995), Binns (1981), and Remmick (1982). This subspecies primarily feeds on aquatic and terrestrial insects, but is an opportunistic feeder. Large BRC are piscivores. Maturity is typically reached around 3 years old. Spawning typically occurs after runoff which is usually during June. Both resident and fluvial populations of this subspecies still exist.

Several factors have contributed to the decline of BRC, including introductions of non-native species, and habitat modification and fragmentation. Bonneville cutthroat trout tend to tolerate and survive in degraded habitats with warmer water temperatures better than other cutthroat trout.

See the Bear River Basin aquatic basin chapter in the current SWAP for more information relative to this fish

Habitat

Cutthroat trout prefer gravel-bottomed creeks and rivers as well as lakes. The Bonneville cutthroat trout is well known for its ability to survive in harsh and often degraded (mostly anthropogenic impacts) habitats. In Wyoming, the Bonneville cutthroat is found in the Smith Fork, Thomas Fork and the Bear River watersheds. A lentic population is located in Lake Alice. Detailed information on life history, movement patterns, habitat requirements, and temperature requirements can be located in several thesis and peer reviewed professional publications (White 2003, Johnstone 2000, Robert 2004, Schrank 2002, Collier 2002, Carlson 2006). Though there has been efforts to decrease entrainment and improve fish passage, there are still some irrigation canals that are impacting BRC, particularly during low flows. This subspecies of cutthroat trout is also native to some drainages in Idaho, Utah and Nevada with the bulk of its historic range within Utah. The subspecies has been introduced as a sport fish to many waters outside its historic range.

Problems

- Entrainment in irrigation canals has been identified as a major source of mortality for BRC.
- Habitat fragmentation and degradation are major threats to the persistence of Bonneville cutthroat trout.
- Irrigation diversions have impacted migration patterns of Bonneville cutthroat trout, particularly during low flows.
- Competition and hybridization with nonnative trout are impacting some populations.
- Domestic grazing, roads, culverts, and removal of willows have negatively impacted Bonneville cutthroat trout.
- Potential development of impoundments (e.g., Sublette Reservoir and Dry Fork Reservoir) could impede migration of Bonneville cutthroat trout.

Conservation Actions

- Increase publics awareness and support for native fish species.
- Prevent stocking with non-native species that are likely to negatively influence populations.
- Protect and manage riparian areas for native riparian vegetation, that will filter runoff, maintain a higher water table, provide late season stream recharge, and stabilize stream banks. Use riparian fencing, grazing management, fire management, and invasive species control to promote native vegetation.
- Continue efforts to maintain flows and connectivity.
- Continue to educate landowners and the public about the importance of maintaining habitat for native fish
- Continue to work towards meeting the goals and objectives as identified in the BRCT Conservation Agreement and Strategy.
- Continue to work with private landowners and other agencies to reduce entrainment issues.
- Represent the WGFD on the interagency Bonneville cutthroat trout conservation team and help implement the Range-wide Conservation Agreement and Strategy for Bonneville cutthroat trout (Lentsch et al. 2000).
- Implement a grazing regime that would be beneficial to the species.

Monitoring / Research

Continue monitoring populations and habitats every five years, or as needed based on project opportunities.

Evaluate fish passage problems throughout the Bear River, Thomas Fork and Smith Fork watersheds.

Continue to work with the federal agencies, trout unlimited and permittees with monitoring habitat condition. This includes but not limited to PFC and greenline monitoring.

Continue to monitor water temperature.

Recent Developments

Amplified fragment length polymorphism analyses were done on tissue samples from BRC populations in the Thomas Fork (Giraffe Creek), Twin Creek (Rock Creek), and Smiths Fork (Grade Creek) in 2009. Submitted additional tissue samples from Lake Alice in 2010. These three populations were determined to be genetically pure with no significant influence from rainbow trout, Yellowstone cutthroat trout or Colorado River cutthroat trout.

Submitted genetic samples from the mainstem Bear River for genetic analyses in 2010. Results indicated small amount of introgression with YCT in two samples.

Monitored BRC movement in Twin Creek, Hobble Creek and Thomas Fork.

Monitored BRC populations and habitat in several watersheds, including but not limited to Dipper, Coal, Raymond, Giraffe, Huff, Thomas Fork, and Smiths Fork.

Constructed upstream bypass channels on several irrigation diversions (examples include Taylor, Peterson, Mumford).

Graduate project completed on BRC entrainment in canals (Carlson 2006), temperature tolerance (Johnstone et al 2000, 2002), effects of irrigation canals (Robert 2004), movement patterns (Schrank 2002), and habitat requirements (White 2003).

Constructed and maintained riparian exclosures.

Implemented fish passage projects (culverts primarily) throughout the Bear, Smiths Fork, and Thomas Fork watershed.

Worked with private landowners to improve fish passage issues in the Twin Creek watershed.

This species was petitioned for listing as threatened under the Endangered Species Act in 1998. A decision in 2001 showed this to be not warrented, and a series of subsequent decisions and lawsuits ultimately led to another not warrented finding in 2008 (U.S. Fish and Wildlife Service 2008)

Working with the BLM in monitoring water temperature in the Smithsfork Allotment. Streams include Coal, Little Muddy, Mill, Huff and Raymond creeks.

Coal Creek road and habitat improvements

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Bonneville Cutthroat Trout (*Oncorhynchus clarkii utah*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Brassy Minnow - Hybognathus hankinsoni

Abundance: Rare

Status: NSS4 (Bc) NatureServe: G5 S5

Population Status: Vulnerable due to declining populations and decreasing distribution. Appear to be declining throughout range in Wyoming and surrounding states.

Limiting Factor: Habitat: vulnerable with increases in habitat loss likely.

Comment: NSS Ranks are reviewed and revised with each SWAP revision. No changes were made for this species in this revision.

Introduction

The range of the brassy minnow includes the Missouri and upper Mississippi river drainages, extending from eastern Wyoming and Montana across the northern states to Ontario and New York and south to Kansas and Missouri (Baxter and Stone 1995). In Wyoming, this species is most common in the southeast (Moan et al. 2010; Niobrara, North Platte, and South Platte drainages), where water is less turbid (Baxter and Stone 1995). However, brassy minnow have been found in the Cheyenne (Barrineau et al. 2007; McGree et al. 2010), Little Missouri (Patton 1997), and Powder (Fleischer 1978; Davis 2008) river drainages and may be present in the Belle Fourche River drainage (Simon 1951; Mueller and Rockett 1966). Brassy minnow look similar to other Hybognathus spp. in Wyoming, and may be distinguished by dissection or, in the field, by eye position and diameter (Scheurer et al. 2003). To ensure proper identification of field-collected Hybognathus specimens, subsets are positively identified by Colorado State University's Larval Fish Laboratory. Because brassy minnow prefer small, clear streams with low velocity, larger eyes and a more upturned ventral profile could be advantageous (Scheurer et al. 2003). The spawning of brassy minnow involves male courtship behaviors and takes place in and over vegetation (Baxter and Stone 1995; Pflieger 1997). Females expel somewhat adhesive eggs (Baxter and Stone 1995) and may spawn during a single period of the summer (Scheurer et al. 2003). The diet of this species is almost strictly herbivorous; algae and organic material are the primary food items (Baxter and Simon 1995; Pflieger 1997). Brassy minnow are known to move large distances for survival and reproduction (Scheurer et al. 2003), so retaining stream flow and connectivity is critical to their persistence. Additional investigation into the life-history and habitat requirements of brassy minnow is needed.

Habitat

Brassy minnow prefer clear water and weedy ponds and streams (Baxter and Stone 1995; Pflieger 1997). They are typically found in slow runs or pools with mud bottoms (Baxter and Stone 1995) and often are associated with the fathead minnow (Pimephales promelas) and other shiner species (Pflieger 1997).

Problems

- Natural and human-caused habitat degradation occurring in drainages within the range of this species may have detrimental effects on populations.
- Lack of connectivity resulting from low flows or other physical barriers (natural and man made) may significantly limit access to upstream habitats.
- Altered flow regimes, habitat fragmentation, and impacts to aquatic and riparian habitat associated with agricultural practices.

Conservation Actions

- Continue efforts to educate landowners and the public about the importance of native fish and their habitats.
- Continue efforts to maintain flows and connectivity.

Monitoring / Research

Revisit selected sites in the range of the brassy minnow sampled by Patton (1997), Barrineau et al. (2007), Bear and Barrineau (2007), McGree et al. (2010), and Moan et al. (2010) to continue monitoring species presence/absence and distribution.

Recent Developments

Prairie stream surveys were completed in 2004-2005 (Barrineau et al. 2007; Bear and Barrineau 2007) and 2008-2009 (McGree et al. 2010; Moan et al. 2010) to assess the distribution of this species in eastern Wyoming and to identify conservation actions.

The Laramie Fisheries Management Crew conducted extensive surveys in Lodgepole Creek upstream of WY HWY 213 in 2011 and 2012. Over a mile of Lodgepole Creek was sampled in 2011 upstream from HWY 213 and brassy minnow were found at 12 of the 16 sampling sites. A total of 225 brassy minnow were collected in the >1 mile of Lodgepole Creek surveyed in 2011. Surveys in 2012 occurred upstream of the 2011 surveys and 46 brassy minnow were collected. Brassy minnow appear to be common in Lodgepole Creek from HWY 213 upstream about 9 miles, especially in their preferred habitat (WGFD 2012, 2013).

From June 29, 2012 to August 5, 2012 the Arapaho Fire burned over 100,000 acres (153 square miles) in Albany, Platte and Converse counties. Roughly 46 miles of the North Laramie River were directly affected by the fire. Six stations on the North Laramie River and headwater streams (Bear Creek and Friend Creek); above, below and within the fire affected area were sampled in 2013. Limited numbers and narrow distributions of these fish were found in 2013 CKC, CHS, FHM, LND, STR, STC, and WHS. No BMN were captured in 2013 in the North Laramie River. Four sampling events and two fish transplants occurred on various North Laramie River sections in 2014 and BMN were found below the North Laramie Diversion in 2014 (WGFD 2014, 2015).

Multiple surveys on Lodgepole and Horse creeks and the Laramie and Niobrara rivers were conducted by the Aquatic Assessment and Laramie Fish Management crews in 2014-2015 as part of the Eastern Wyoming Intermittent Streams project. Brassy Minnow were found in all four streams in moderate abundance. These recent surveys have documented an apparent rebound in these populations following low abundances encountered by Moan et al. (2010) Results are on file and will be detailed in a forthcoming administrative report.

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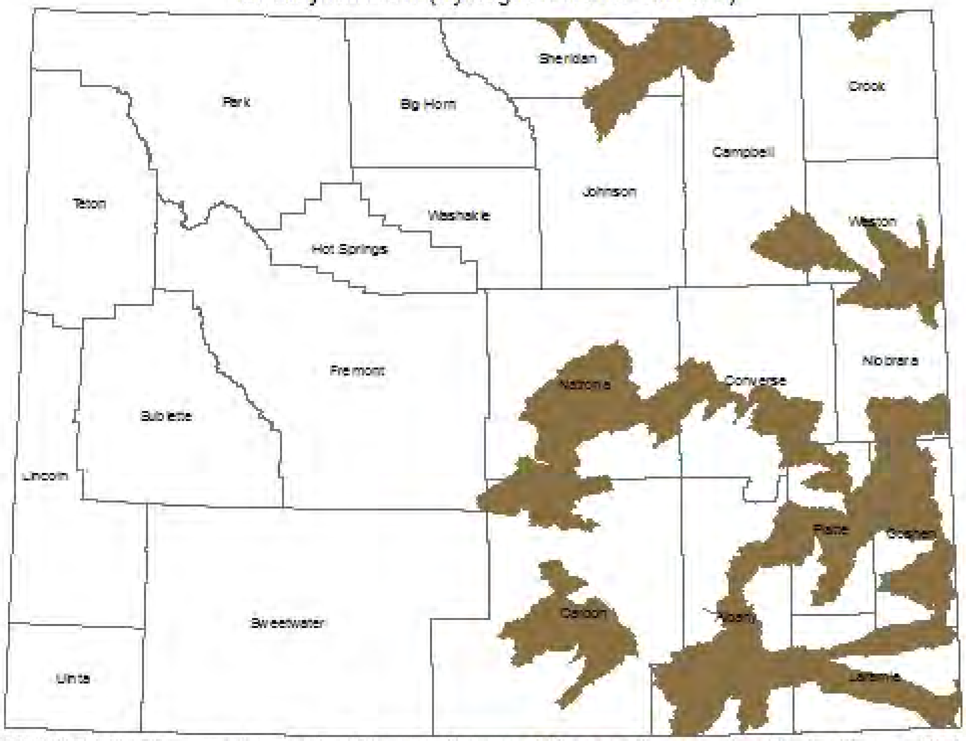
Brassy Minnow (*Hybognathus hankinsoni*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Burbot - Lota lota

Abundance: Rare

Status: NSS3 (Bb) NatureServe: G5 S3S4

Population Status: Population size and distribution restricted within native range.

Limiting Factor: Habitat: habitat fragmentation due to irrigation diversions and dams has impacted populations. Population numbers and length structure are thought to be vulnerable to angling pressure.

Comment: NSS Ranks are reviewed and revised with each SWAP revision. No changes were made for this species in this revision.

Introduction

The burbot is the only member of the Gadiforme order that spends its entire life in freshwater. Burbot spawning behavior is unique among freshwater fishes, spawning mid-winter under the ice. They have a strong association with the bottom of lakes and are described as benthic (McPhail and Paragamian 2000). Burbot have a strong preference for cold water and avoid water temperatures exceeding 55 degrees Fahrenheit (Hackney 1973). They are most active during the winter and in Wyoming they become nearly dormant during the summer months. Burbot are voracious predators. Miller (1970) observed that large burbot fed primarily on non-game fish in lakes and reservoirs in Wyoming. Wyoming represents the southwestern extreme of burbot distribution in North America. Burbot historically occurred in the Wind-Bighorn River drainage and the Tongue (Baxter and Stone 1995) and the Powder (Hubert 1993) rivers. Currently, burbot populations within their native range in Wyoming are found only in the Wind-Bighorn River and lakes and reservoirs within the watershed. Illegal introductions of burbot have occurred within the Green River drainage and the species has become well established in Big Sandy and Green rivers, as well as Fontenelle, Big Sandy, and Flaming Gorge reservoirs.

Habitat

The burbot lives in cold, deep lakes and large rivers. Burbot are cover oriented and prefer areas with rock substrate having numerous crevises or with aquatic vegetation (Robins and Deubler 1955; Edsall et al. 1993; Dillen et al. 2008). Lentic spawning occurs during January or February over gravel substrate in shallow, near-shore waters (Boag 1989; McCrimmon 1959) or over reefs or shoals in deeper water (McCrimmon 1959). Burbot may also ascend tributary streams to spawn (Bjorn 1939).

Problems

- Habitat degradation (e.g., dewatering, loss of connectivity) and introduced species pose the most serious threats to this species' persistence.
- This species appears to be expanding outside of its native range and could be adversely impacting native fish populations through competition and predation.
- Burbot population densities and length structures are vulnerable to high angling harvest rates in some areas within their native range.
- In the long term, trends in increased global temperatures could negatively impact the habitat and persistence of burbot in waters that may already have temperatures that are on the edge of the species preferred limits.

Conservation Actions

- Entrainment in canals needs evaluation
- A better understanding of juvenile habitat requirements is needed.
- A better understanding of the habitat and flow requirements of this species is needed to assess the impacts of water and land use activities.
- A better understanding of the "source and sinks dynamics" of natural recruitment maintaining various stocks is needed
- Isolate sources of production in the Bighorn-Wind watershed by examining drift/migration patterns.
- Continue to collaborate with Shoshone and Arapaho tribes and the USFWS to gain better understanding of factors influencing burbot populations within the Wind River drainage.
- Continue efforts to maintain flows and connectivity.
- Determine the effects that nonnative species are having on native burbot populations

Monitoring / Research

Continue established trend monitoring programs at Boysen Reservoir and Torrey Lake.

Investigate the utility of bioenergetics modeling to help explain predator-prey relationships and identify management options for enhancing the availability of prey for burbot (Abrahamse 2009).

Continue to identify and record observations while conducting fisheries management sampling.

Recent Developments

Outmigration and entrainment in irrigation diversions were not factors influencing burbot populations in the upper Wind River Drainage. The results are summarized in a masters thesis at the University of Wyoming Cooperative Fish and Wildlife Research Unit (Underwood 2015).

Burbot exploitation was determined to be variable and not a limiting factor in most lakes in the upper Wind River Drainage. The results are summarized in a masters thesis at Montana State University Fish and Wildlife Research Unit (Lewandoski 2015).

Abundance and structure of burbot populations in the Wind River drainage were summarized in a masters thesis at the University of Wyoming Cooperative Fish and Wildlife Research Unit (Abrahamse 2009).

Microchemisty profiles of otiliths collected throughout the Wind River drainage are currently being analyzed to determine drift/migration patterns of burbot in the watershed. The study is being conducted by Scott Carleton a post-doctoral researcher at the University of Wyoming.

In 2006, the statewide creel limit within the burbot's native change was decreased from 6 fish to 3 fish.

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Burbot (*Lota lota*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Colorado River Cutthroat Trout - *Oncorhynchus clarkii*

Abundance: Rare

Status: NSS2 (Ba) NatureServe: G4T3 S1

Population Status: Greatly restricted in numbers and distribution - extirpation is not imminent.

Limiting Factor: Other: habitat availability is limited by the presence of introduced, non-native salmonids and introgression continues to be an issue. Although significant population gains have been made by eliminating introduced, non-native species and reintroducing Colorado River cutthroat trout, non-native species still occupy much of the historic range of Colorado River cutthroat trout.

Comment:

Introduction

The Colorado River cutthroat trout (CRC) is the only trout native to the Green and Little Snake river drainages in Wyoming. This subspecies of cutthroat trout is also native to Utah and Colorado. At the completion of the systematic review by members of the Colorado River cutthroat trout interagency team in 2005 determined that 21,386 miles of stream habitat were identified has habitat historically (circa 1800) occupied by CRC (Hirsch et al. 2006). The recent update indicates only 20,088 miles of stream were historically occupied by CRC (Hirsch et al. 2013) . The estimated amount of historical range in Wyoming is 4,059 miles and currently CRC conservation populations occupy 13% of the historic range (Hirsch et al. 2013).

Colorado River cutthroat trout were petitioned for listing under the endangered species act (ESA) in 1999. The FWS concluded in a 90-day finding in 2004 that the petition did not have sufficient or substantial information to warrant listing (FR 69(76):21151-21158, 04/20/04).

Colorado River cutthroat trout are spectacularly colored during spawning. The spots are large and somewhat concentrated in the caudal area (Baxter and Stone 1995). Spawning typically starts after peak flows which is usually during June and as late as early July for higher elevation streams and lakes. They feed mostly on aquatic and terrestrial invertebrates. Colorado River cutthroat trout historically occupied large rivers and lakes but are now typically found in headwater streams.

See the Green River Basin aquatic basin chapter in the current SWAP for more information relative to this fish.

Habitat

In Wyoming, the Colorado River cutthroat trout can be found in the Green River, Black's Fork and Little Snake River drainages. Some of the healthiest and purest populations of this subspecies occur in small stream tributaries of the Little Snake River in Carbon County and in the Wyoming Range of Sublette County. Colorado River cutthroat trout prefer clear, cold water, naturally-fluctuating flows, low levels of fine sediment, and complex habitats.

Problems

- Nonnative species have contributed to the decline of this fish either through hybridization, competition for habitat, or competition for food and spawning sites.
- Past and current livestock grazing practices have altered riparian and in-stream habitat, water quality and sediment transport regimes. Ramifications of this practice includes loss of instream cover and channel complexity, increased water temperature, bank erosion and loss of preferred substrate.
- Land management actions such as oil and gas exploitation, roads, culverts, domestic grazing, and timber harvest have had negative impacts to watersheds.
- Lack of aspen regeneration has impacted beaver persistence in these watersheds.
- Habitat fragmenation caused by dams, road crossings, grade control structures, diversions, etc. are in some cases limiting gene flow and threatening the persistence of this fish.

Conservation Actions

- Prevent stocking with non-native species that are likely to negatively influence populations.
- Continue to work with private landowners and other agencies to reduce entrainment issues.
- Work with other agencies with implementation of the CRC Conservation Agreement and Strategy.
- Complete genetic analysis of all potential CRC populations
- Maintain the North Piney Lake CRC brood source
- Implementation of the Conservation Strategy for Colorado River cutthroat trout will eliminate or reduce threats to this subspecies of cutthroat trout (CRCT Coordination Team 2006).
- Represent the WGFD on the interagency Colorado River cutthroat trout conservation team and help implement the Range-wide Conservation Agreement and Strategy for Colorado River cutthroat trout (CRCT Coordination Team 2006). Complete CRC accomplishment reports annually and present this information to the CRCT Coordination Team annually..
- Complete next 5 year CRC Status Assessment.
- Evaluate potential restoration opportunities on public and private lands.
- Identify populations of Colorado River cutthroat trout or habitat that will support Colorado River cutthroat trout that would benefit from isolation by a fish migration barrier and/ or chemical rehabilitation to remove non-native species.
- Increase publics awareness and support for native fish species.
- Complete Bare Creek piscicide treatment and reintroduce CRC
- Investigate options to use transplants or streamside spawning operations for future restoration projects.

Monitoring / Research

Continue to complete basin wide habitat and population surveys for those watersheds that support CRC populations.

Continue to supplement some CRC populations with hatchery fish as needed and continue to monitor the success of those stocks.

Continue to monitoring the success of stocked CRC in the LaBarge watershed.

Continue to complete WHAM habitat surveys for all CRC watersheds and identify potential restoration opportunities.

Complete genetic analysis for all CRC populations

Recent Developments

Wyoming Game and Fish summarized actions, including changes to historic and current range that have been discovered, habitat enhancement that have occurred (whether those actions were completed by the WGFD or in cooperation with other state and federal agencies), current harvest regulations to protect CRC, current fish disease status, threats to CRC populations from exotic organism such as Myxobolus cerebralis (Whirling Disease parasite, WD), and other management actions taken to protect or enhance existing CRC populations (WGFD 2007).

Colorado River cutthroat trout have been reestablished in the LaBarge watershed which includes 58 stream miles. More information on this watershed and restoration plan can be located in the LaBarge Watershed Fisheries Management Plan for Colorado River Cutthroat Trout (Sexauer 2000) and the LaBarge Creek Rehabilitation Plan (Sexauer 2006). WHAM surveys were completed in the LaBarge watershed (Roadifer and Sexauer 2010). Fish passage issues in LaBarge watershed restoration area are being addressed.

The conservation agreement and strategy for Colorado River cutthroat trout was updated (CRCT Coordination Team 2006).

The 2005 - 2010 Colorado River Cutthroat Trout Status Assessment was completed in 2013.

Supplementation of Colorado River cutthroat trout in several tributary streams located within the Wyoming Range and Wind River mountain range.

Continue to implement piscicide treatment in Bare Creek, tributary to South Cottonwood Creek. Fish migration barrier was constructed on Bare Creek in 2015.

Entrainment studies will be implemented in 2015 on a couple diversions located in South Cottonwood watershed. This work will be completed by WGFD and TU.

Investigate the use of transplants or streamside spawning operations for the reintroduction of CRC in Bare Creek, post piscicide treatment.

Wyoming Range forage reserve and Triple Peak Forage reserve are providing protection to the headwaters of several Colorado River cutthroat trout streams.

Graduate research project: Investigate stocking options (timing of stocking, size of fish at stocking, and months of domestication in the hatchery), emigration, and survival of stocked CRC in LaBarge watershed. This work is being completed by a graduate student at the University of Wyoming.

AFLP analysis completed for several streams in the Wyoming Range. Wyoming reference populations have been established.

M.S. Graduate research project completed in the South Fork, Middle Fork and North Fork Beaver creeks. Girard, Carlin E., The Effects of Oil and Natural Gas Development on Water Quality, Aquatic Habitat, and Native Fish in Streams along the Wyoming Range. M.S., Department of Zoology and Physiology, August 2015.

Dissertation proposal: Ecological Responses to Stressors in Headwater Streams of the Wyoming Range. This project is a continuation of the work completed by Carlin Girard. Specifically, this project will assess the effects of stressors related to energy development, livestock grazing, and annual hydrologic differences on fish physiology and immunology, fish population dynamics, and macroinvertebrate community structure and function. Richard Walker is a PhD candidate at the University of Wyoming.

Completed Basin Management Plans for all watersheds supporting Colorado River cutthroat trout.

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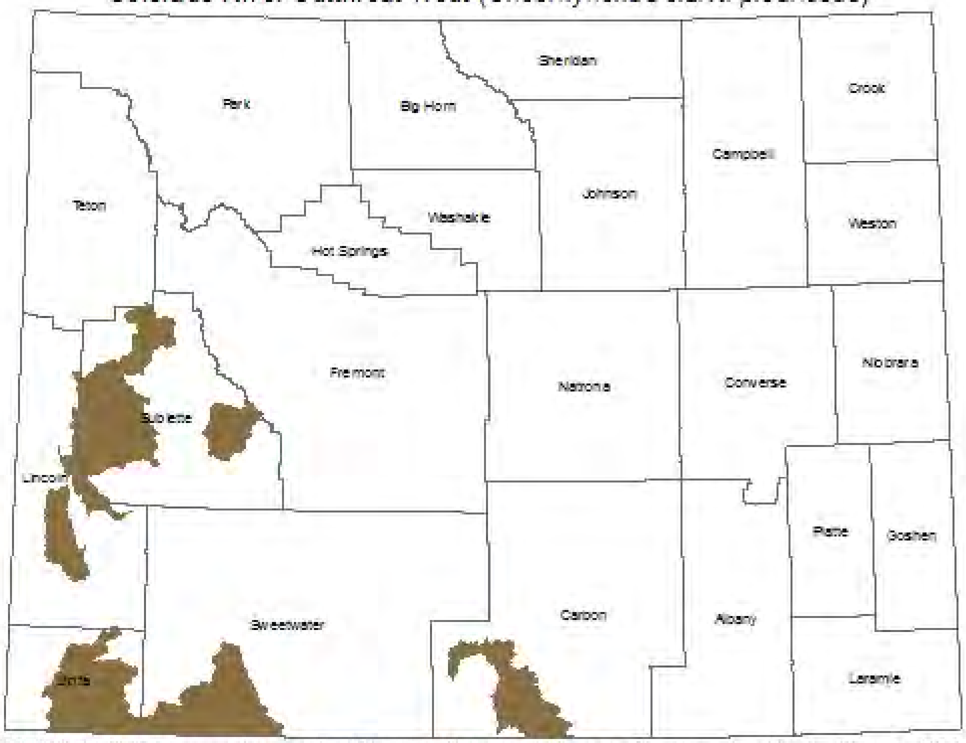
Colorado River Cutthroat Trout (*Oncorhynchus clarkii pleuriticus*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Common Shiner - Luxilus cornutus

Abundance: Common

Status: NSS4 (Bc) NatureServe: G5 S3S4

Population Status: Vulnerable due to limited distribution within Wyoming. Comparison of distribution surveys suggests a declining distribution.

Limiting Factor: Habitat: moderate. Habitat is vulnerable and increases in habitat loss are likely.

Comment: NSS Ranks are reviewed and revised with each SWAP revision. No changes were made for this species in this revision.

Introduction

Common shiner distribution extends across the eastern U.S. and Canada. In the U.S. they stretch from North Dakota eastward to Maine, south to Virginia, west to Wyoming. Populations in northern Colorado and Wyoming make up the southwestern edge of their distribution. In Wyoming, they are native to the North and South Platte drainages.

Common shiners most commonly feed in the open water, consuming aquatic and terrestrial insects and some fish (Pflieger 1997). Spawning usually occurs in slow riffles with gravel substrate when water temperature rises above 65 °F (Baxter and Stone 1995; Weitzel 2002). Males can excavate nests, but will commonly use the nests of creek chub or hornyhead chub. Males will aggressively defend the nest, thus providing benefit to any species of egg found in the nesting area. In Wyoming they were commonly found in association with creek chub and hornyhead chub (Moan et al. 2010).

Habitat

Common shiners are considered habitat generalists, but are said to prefer cool, clear streams with gravel substrates, little vegetation, and flowing water. They reside near pool – riffle complexes and become more dependent on pools as water levels decrease. In Wyoming they were found in a variety of habitats, usually at sites with clear water and gravel substrates present (Moan et al. 2010).

Problems

- Unfavorable land use and inefficient water management, particularly when combined with drought, can reduce the preferred habitat of common shiner through reduced flows, increased siltation, and increased aquatic vegetation.
- Altered flow regimes, habitat fragmentation, and impacts to aquatic and riparian habitat associated with agricultural practices.

Conservation Actions

- Continue efforts to educate landowners and the public about the importance of native fish and their habitats.
- Continue efforts to maintain flows and connectivity.

Monitoring / Research

Continue to identify and record observations while conducting fisheries management sampling.

Recent Developments

Detailed fish and habitat surveys were conducted in tributaries to the North Platte River between 2005 and 2009 to establish a baseline for future trend analysis in the North Platte drainage (Gerrity 2009, Moan et al. 2010). In 2005 and 2007, the Casper Region Fish Management Crew conducted non-game fish surveys in the lower sections of the mainstem North Platte River (WGFD 2005, WGFD 2007). Common shiners are currently found throughout most of their historic distribution in the drainage.

The Laramie Region Fish Management Crew sampled Lodegpole Creek upstream of Wyoming State Highway 213 in 2011 and 2012 for approximately nine miles. In 2011, common shiner were found at 12 of the 16 sampling sites (WGFD 2011). In 2012, surveys were conducted upstream of the 2011 surveys and were found at X of X sites (WGFD 2012). Common shiner were considered locally rare to common within this segment.

The Laramie Fish Management Crew conducted surveys on the lower Laramie River below Grayrocks Reservoir in 2012 and 2013. Nine common shiner were collected in 2012 and were considered locally rare at these sites (WGFD 2012). In 2013, the lower Laramie River was sampled within the Fort Laramie NHS boundary and three common shiners were collected (WGFD 2013).

From June 29, 2012 to August 5, 2012 the Arapaho Fire burned over 100,000 acres (153 square miles) in Albany, Platte and Converse counties. Streams impacted in the Laramie Region were the North Laramie River, Bear Creek, Friend Creek and Arapaho Creek. In addition to the direct effects of the fire, the chief concern for aquatics was the potential flooding and debris flows after storm events. Large debris flows and ash affected about 46 miles of the North Laramie River. Common Shiner were found in post-fire sampling in 2013 below the North Laramie Diversion, but not found in 2014 in the North Laramie River. Their recovery in the North Laramie River is as important as hornyhead chub and common shiner have important interspecies interactions that benefit both species.

Intensive surveys were completed on Horse Creek, Lodgepole Creek, and Laramie River in 2015 (Compton and Hogberg: In Draft). Common shiner were found at 29 of 40 sites on Horse Creek, 22 of 22 sites on Lodgepole Creek, and 19 of 29 sites on the Laramie River. 2014 and 2015 were wet years in southeast Wyoming and stream discharge over this period was average or above average. It is likely that river conditions were favorable for common shiner during this period, as common shiner were one of the most abundant species sampled and all life stages were observed.

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Common Shiner (*Luxilus cornutus*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

Finescale Dace - Phoxinus neogaeus

Abundance: Extremely rare

Status: NSS2 (Ba) NatureServe: G5 S2

Population Status: Imperiled because of greatly restricted distribution. Found in Niobrara River and some locations in the Belle Fourche watershed. Wyoming populations are isolated from the species' core range in North America.

Limiting Factor: Habitat: severe due to limited habitat in Wyoming.

Comment: NSS Ranks are reviewed and revised with each SWAP revision. No changes were made for this species in this revision.

Introduction

Finescale dace distribution extends throughout Canada and from Minnesota to Maine in the United States. Disjunct populations also exist in areas of South Dakota, Nebraska, and Wyoming. In Wyoming they are found in the Redwater and Niobrara River drainages. Recent surveys found finescale dace throughout the mainstem Niobrara River and in Hemler Reservoir in the Redwater drainage (McGree et al. 2010; Moan et al. 2010). Throughout their distribution, finescale dace freely hybridize with northern redbelly dace. The population in the Niobrara River headwaters of Wyoming is believed to be the only genetically pure population at the southern extent of their distribution (Isaak et al. 2003).

Finescale dace reach maturity by age two and generally spawn in April or May depending on water temperature. Spawning occurs over silt substrate, usually in depressions under logs or other cover. No nesting occurs and no parental care is given. Female fecundity can range from 400 to 3,000 eggs depending on body size (Isaak et al. 2003).

Finescale dace have flexible feeding habits, eating a variety of zooplankton, aquatic insects, and plant material (Litvak and Hansell 1990). In Wyoming, finescale dace were found with brassy minnow, creek chub, fathead minnow, Iowa darter, longnose dace, pearl dace, plains topminnow, central stoneroller, and white sucker (Bear and Barrineau 2007; Moan et al. 2010).

Habitat

In streams, finescale dace are said to prefer slow or stagnant water with abundant vegetation or other cover. They are intolerant of water temperatures greater than 77 °F and are frequently found in the absence of large predators (Isaak et al. 2003). In Wyoming, they were found at sites with clear, slow moving or stagnant water with dense aquatic vegetation, predominantly silt substrate, and water depths greater than 1.0 ft. (Moan et al. 2010).

Problems

- Restricted population, making them susceptible to extirpation from disease and habitat alterations.
- Introduced nonnative predators.
- Hemler reservoir population was found to contain the parasite Clinostomum complanatum commonly referred to as “yellow grub disease.” This parasite can rob the fish of nutrients and increase stress levels resulting in decreased fitness (Mitchum 1995).
- Dewatering of reservoirs and loss of beavor ponds have greatly reduced suitable finescale dace habitat in the Black Hills National Forest.

Conservation Actions

- Investigate the re-establishment of finescale dace into waters they were historically found (e.g. Montana Lake).
- Investigate finescale dace behavior and habitat utilization within Wyoming.
- Continue to exclude stocking of non-native fish in the mainstem Niobrara River.
- Encourage beaver activity to rebuild ponds that provided suitable finescale dace habitat in the Black Hills National Forest.

Monitoring / Research

Evaluate the need and design for a monitoring plan. Existing data suggest annual or biannual, single event presence/absence sampling of finescale dace populations at the Nebraska border to facilitate the assessment of population trends.

Coordinate with Nebraska Game and Parks Commission and National Parks Service to monitor and assess impacts from northern pike and other invasive fish.

Recent Developments

Two prairie stream surveys (2004 and 2008) were conducted on the Niobrara River to develop a baseline understanding of its fish assemblage (Bear and Barrineau 2007, Moan et al. 2010). Finescale dace were found at similar sampling locations during each survey and were found at new locations throughout the mainstem Niobrara River.

Surveys conducted in the Niobrara River drainage during 2015 detected finescale dace at multiple locations including McMaster Reservoir and marshy areas with little flow near the state line. They currently coexist with non-native northern pike near the state line; however, it is unknown how long the pike have been present there or what long-term effect they will have on SGCN fishes in the Lower Niobrara River.

Surveys conducted in the Belle Fourche drainage in 2015 failed to detect finescale dace in several areas they had previously been present (Bill Bradshaw, WGFD, unpublished data). They were still present in Hemler Reservoir and a beaver pond upstream, but were not found in Montana Lake - a historical stronghold for the species that had been completely dewatered in recent years. Additionally, several beaver ponds in the Black Hills National Forest near Hemler Reservoir that had previously contained finescale dace were no longer present during the 2015 survey.

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Finescale Dace (*Chrosomus neogaeus*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Flannelmouth Sucker - Catostomus latipinnis

Abundance: Rare

Status: NSS1 (Aa) NatureServe: G3G4 S3

Population Status: Greatly restricted in numbers and distribution and extirpation is possible.

Limiting Factor: Genetics: species declining in genetic purity due to introgression with nonnative sucker species.

Comment: NSS Ranks are reviewed and revised with each SWAP revision. No changes were made for this species in this revision.

Introduction

Flannelmouth sucker, along with roundtail chub Gila robusta, and bluehead sucker C. discobolus are all relatively large-bodied species of imperiled Colorado River fish. The three are collectively called "the three species" and their conservation is a cooperative effort which spans state lines (Colorado River Fish and Wildlife Council 2004). Although flannelmouth sucker were once widespread throughout the Colorado River basin, they currently occupy approximately 45% of their historic range (Bezzerides and Bestgen 2002). Reasons for declines include dam construction and operation as well as predation, competition and hybridization with non-native fishes. The primary cause of declines in Wyoming is the risk of genetic introgression with widely distributed non-native suckers (Bezzerides and Bestgen 2002; McDonald et al. 2008; Mandeville 2015). Although genetically pure individuals still exist throughout the Green River drainage in Wyoming, upper Bitter Creek has the states' only remaining population of flannelmouth sucker that is isolated from non-native, hybridizing sucker species (Gelwicks et al. 2009). Recent evidence of reduced abundances, truncated age structure, and habitat limitations within this population raise concerns about its future viability (Senecal 2010). Flannelmouth sucker are omnivorous. Juveniles of this species feed on aquatic invertebrates and organic detritus while adults consume terrestrial seeds, plant debris, algae, and phytoplankton in addition (Muth and Snyder 1995; Childs et al. 1998). Spawning occurs in May and June in the Upper Colorado River Basin whereby adhesive, demersal eggs are deposited over sand and gravel bars in shallow water (McAda and Wydoski 1985). Flannelmouth sucker movement into and out of tributary streams has been observed. However, sedentary patterns are also apparent (Cavalli 1999; Beatty 2005; Compton 2007; Sweet 2007).

Habitat

Although preferring large rivers with deep riffles and runs, flannelmouth sucker can also be found in smaller streams and sometimes in lakes (Baxter and Stone 1995). Juveniles select for slower current velocity habitats, such as backwaters, eddies, side channels, and shallow riffles (Bezzerides and Bestgen 2002). Flannelmouth sucker tend to occupy habitats lower in the drainage and exhibit more overlap with white suckers Catostomus commersoni than do bluehead suckers Catostomus discobolus (Sweet 2007).

Problems

- Competition with and predation by nonnative species (i.e., Catostomus sp., creek chub Semotilus atromaculatus, redside shiner Richardsonius balteatus, burbot Lota lota, brown trout Salmo trutta, and lake trout Salvelinus namaycush) further limit bluehead and flannelmouth sucker populations.
- Hybridization between native bluehead and flannelmouth sucker and non-native white sucker Catostomus commersoni, longnose sucker Catostomus catostomus, and Utah sucker Catostomus ardens is occurring. Some combinations are fertile and will lead to introgression.
- The effects of water development and reservoir construction exacerbated by drought have cut off this species' migratory corridors, degraded its habitat, and encouraged the spread of nonnatives.

Conservation Actions

- Continue as a signatory to the "Rangewide Conservation Agreement for Roundtail Chub, Bluehead Sucker and Flannelmouth Sucker" (Colorado River Fish and Wildlife Council 2004).
- Develop methods for holding and spawning in captivity.
- Mechanically remove nonnative species where appropriate.
- Chemically treat Big Sandy River, Little Sandy and Muddy Creeks to remove nonnative species and reduce the risk of hybridization.
- Construct a barrier upstream of Big Sandy reservoir to prevent recolonization of treated stream reaches by nonnative fish.
- Continue to partner with other agencies and conservation organizations (e.g., BLM, Little Snake River Conservation District, and Trout Unlimited) to address conservation needs for this species.
- Increase the availability of hard substrates and pool habitat in upper Bitter Creek according to recommendations by Senecal (2010)

Monitoring / Research

Continue regular monitoring of drainages containing the three species to track population trends, hybridization rates, and the abundance and ranges of nonnative species.

Conduct monitoring before and after chemical treatments and transplants to determine the success of removal efforts.

Conduct a project to determine juvenile abundance and habitat use.

Recent Developments

A survey from 2002-2006 of the three species throughout the Green River drainage in Wyoming has been completed and summarized in an Administrative Report (Gelwicks et al. 2009). Surveys indicate that the most imminent threat to the persistence of flannelmouth suckers in the Green River drainage is genetic introgression with white suckers.

Genetics analyses reveal that Wyoming populations of the three species contain unique haplotypes not found in downstream populations (Douglas and Douglas 2008), that hybridization with white suckers enables further backcrossing among native and nonnative sucker species (Douglas and Douglas 2008; McDonald et al. 2008), and that the level of hybridization varies among drainages (Mandeville 2015).

Six studies were completed describing three species populations, habitat, and/or movement in Big Sandy River, and Little Sandy and Muddy Creeks (Bower 2005; Beatty 2005; Compton 2007; Sweet 2007; Banks 2009).

Nonlethal methods for precisely aging native and nonnative sucker species and their hybrids were developed (Quist et al. 2007) and used to age bluehead and flannelmouth suckers in Big Sandy River, and Little Sandy and Muddy Creeks (Sweet et al. 2009).

Methods for salvage, transport, holding, and repatriation of native species were investigated (Compton 2013).

Chemical treatments to remove nonnative species in Sculpin Creek and Long Draw (Big Sandy drainage) and Muddy Creek have begun.

A barrier is being constructed on the Big Sandy River to prevent recolonization of treated stream reaches by nonnative fish. Barrier design was influenced by research on the jumping capabilities of burbot and white suckers (Gardunio 2014). Barrier location was influenced by research on the larval drift of Catostomids in the Big Sandy River (Zelasko et. al. 2011).

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Flannelmouth Sucker (*Catostomus latipinnis*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Flathead Chub - Hybopsis gracilis

Abundance: Rare

Status: NSS4 (Bc) NatureServe: G5 S5

Population Status: Some populations are vulnerable where they occur in low abundance and habitats have been severely altered. Other populations are stable and secure.

Limiting Factor: Habitat: Impoundments in major drainages have reduced population size and distribution through reduced turbidity, altered temperature regimes, and flow regulation.

Comment: NSS Ranks are reviewed and revised with each SWAP revision. No changes were made for this species in this revision.

Introduction

Flathead chub are native to turbid rivers of the Great Plains from the Northwest Territories in Canada south to Oklahoma and New Mexico (Baxter and Stone 1995). However, their abundance within the Missouri River basin has declined as a result of water development, dam construction, and flow regime changes (Pflieger 1997). Although omnivorous, their diet consists primarily of adult terrestrial insects (Olund and Cross 1961). Streamlined bodies, large fins and sensory organs including barbels enable flathead chubs to efficiently feed in the swift currents of turbid rivers (Moore 1950). Spawning occurs from July through September, coinciding with receding water levels, maximum temperatures, low turbidities, and stable sand substrates (Olund and Cross 1961).

Habitat

Flathead chub occupy the main channels of sandy, turbid streams (Olund and Cross 1961). These fish select for small substrates, deep water, and woody debris (Bear 2009). Their habitat requirements most closely resemble those of sandshiners Notropis stramineus and adult members of the genus Hybognathus (Senecal 2009).

Problems

- The species' Wyoming distribution is declining in heavily altered drainages where turbidity and flow have been significantly reduced.

Conservation Actions

- Continue efforts to reduce land and water uses which exacerbate stream channel drying.

Monitoring/Research

Continue to identify and record observations while conducting fisheries management sampling.

Recent Developments

Flathead chub populations are stable and common throughout the Bighorn Basin (Bear 2009).

While generally stable throughout Southeastern Wyoming (Bear and Barrineau 2007; Moan et al. 2010) and much of Northeastern Wyoming (Barrineau et al. 2007; Peterson et al. 2009; McGree et al. 2010), populations of flathead chub may be in decline in the Cheyenne River drainage (McGree et al. 2010).

Completed construction of the Kendrick Diversion dam bypass channel on Clear Creek, a tributary to the Powder River, to allow fish passage for spawning migrations. A project to determine which species are utilizing the bypass channel was intiated in 2011. Flathead chub have been documented using the bypass channel every year from 2011 - 2015.

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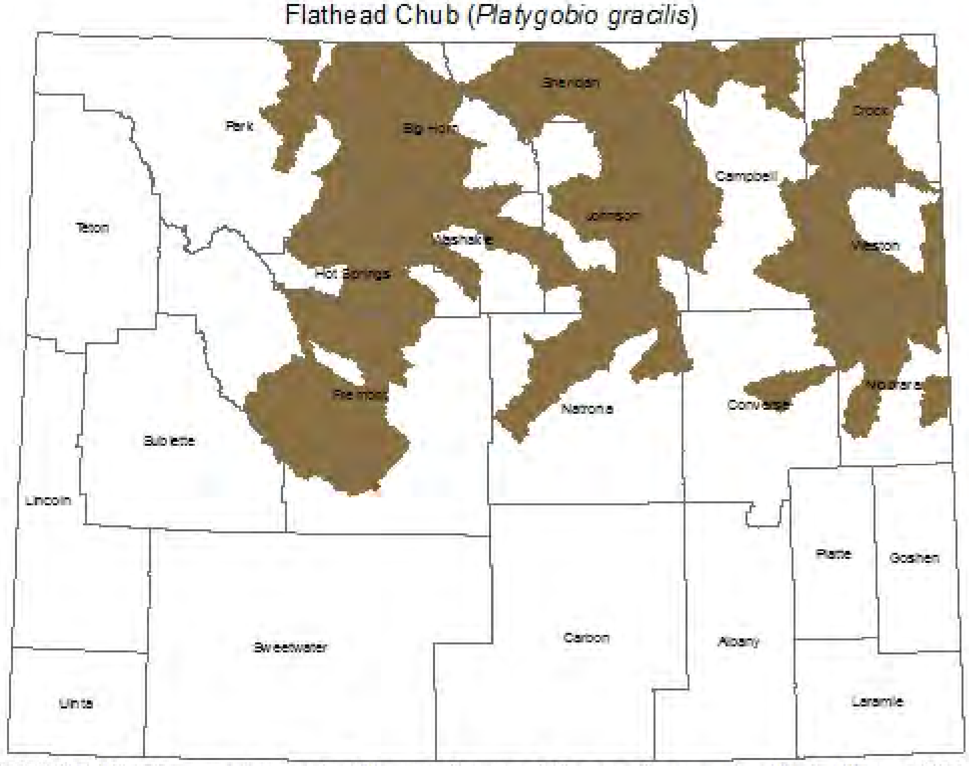
Flathead Chub (*Platygobio gracilis*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Goldeye - *Hiodon alosoides*

Abundance: Rare

Status: NSS3 (Bb) NatureServe: G5 S2

Population Status: Extirpated from the North Platte River. Remaining populations are in the Powder and Little Missouri River drainages. Young-of-year have never been found in Wyoming. Migratory patterns are unknown.

Limiting Factor: Habitat: impoundments are most likely responsible for the extirpation of this species from major drainages. Impoundments block migrations, fragment populations, alter temperature and flow regimes, and disrupt life cycles. Habitat is limited, but loss is not increasing significantly.

Comment: NSS Ranks are reviewed and revised with each SWAP revision. No changes were made for this species in this revision.

Introduction

The goldeye's native range spans from the Hudson Bay drainage through the Missouri and Mississippi (Scott and Crossman 1973). Goldeye were once found in Wyoming's North Platte, Big Horn, Little Missouri, Little Powder and Powder rivers, but have only been sampled from the latter two in recent years (Peterson et al. 2009; McGree et al. 2010; Barrineau et al. 2010). Goldeye are active, crepuscular feeders. While aquatic and terrestrial invertebrates make up the majority of their diet, they have also been known to feed on small fish, mammals, and amphibians (Baxter and Simon 1970; Pflieger 1997). The goldeye's large eye enables it to locate food items in highly turbid environments. Although never observed, spawning is thought to take place in the water column in early spring (late April to early June; Hill 1966). Semi-buoyant eggs and larvae are transported downstream to suitable nursery and rearing habitat (Battle and Sprules 1960; Pflieger 1997). Seasonal movement of goldeye during their spring spawning period has been documented in Montana's Teton River where marked fish moved as many as 68 miles in 13 days (Hill 1966). Similar seasonality is apparent in the Powder River. The Powder River population is likely composed of immigrating adults as juveniles have never been observed (Baxter and Simon 1970).

Habitat

Goldeye prefer large rivers and their associated backwaters and marshes (Baxter and Simon 1970). These fishes are also commonly associated with deep pools (Weitzel 2002). Goldeye were not sampled from riffles, backwaters, or shoals during 2005 and 2006 sampling of the mainstem of the Powder River (Peterson et al. 2009). Connectivity among habitat types and river systems is important for this species to be able to complete spawning and rearing life history stages (Hill 1966). Many adult goldeye have been sampled below Kendrick Dam in Clear Creek during evaluations of the Kendrick Bypass Channel.

Problems

- Lack of connectivity resulting from low flows or other physical barriers (natural and man made) may significantly limit access to upstream habitats.
- Infrastructure that creates physical barriers or changes water quality by making water cooler and less turbid can negatively affect the distribution, abundance, recruitment, growth, and survival of the species.

Conservation Actions

Monitoring/Research

• Conduct regular sampling of the Above Crazy Woman site (P7) for monitoring presence/absence of goldeye and associated species, such as sturgeon chub.

• Monitor use of the Kendrick Diversion dam bypass channel on Clear Creek, a tributary to the Powder River, by large-bodied, migratory fishes.

Recent Developments

Goldeye may be declining in the Little Powder River basin which has been listed as a conservation priority (McGree et al. 2010).

Reports from other WGFD surveys: (1) prairie stream surveys (Barrineau et al. 2007; Bear and Barrineau 2007; Barrineau et al., 2010); and (2) Powder River surveys conducted in conjunction with the Aquatic Task Group (Peterson et al. 2009) suggest that goldeye are stable throughout their remaining Wyoming range.

Completed construction of the Kendrick Diversion dam bypass channel on Clear Creek, a tributary to the Powder River, to allow fish passage for spawning migrations. A project to determine which species are utilizing the bypass channel found goldeye are able to use the bypass channel and now occupy Clear Creek above Kendrick Dam.

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Goldeye (*Hiodon alosoides*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Hornyhead Chub - Nocomis biguttatus

Abundance: Extremely rare

Status: NSS1 (Aa) NatureServe: G5 S1

Population Status: Imperiled because of greatly restricted distribution. Found only in Laramie and North Laramie Rivers and is at periphery of range in Wyoming.

Limiting Factor: Habitat: severe due to limited habitat in Wyoming.

Comment: Changed to NSS1 from NSS2 in 2017 due to population loss in North Laramie River drainage following 2012 wildfire. NSS Ranks are reviewed and revised with each SWAP revision.

Introduction

Core hornyhead chub distribution creates a loose triangle stretching from extreme eastern North Dakota to western New York, southwesterly to northern Arkansas, then northwesterly back to North Dakota. Isolated populations are either currently or were historically present in Nebraska, Colorado and Wyoming. In Wyoming, they are found in a small section of the lower Laramie River and North Laramie River as they pass through the Laramie Mountains.

Hornyhead chub are a visual feeder, actively feeding during the daylight. Younger fish consume aquatic larvae, while adults consume more aquatic insects and fish. Sexual maturity is reached at 2 or 3 years and spawning generally occurs from April to June (Lachneri 1952). Males build spawning nests with gravel and will cover the eggs with gravel after spawning occurs. Females can carry both mature and immature eggs, with the amount of mature eggs ranging from 460 to 995.

In 2010, hornyhead chub occupied about 24 mi of stream habitat in the lower Laramie (16 mi) and North Laramie (8 mi) rivers (Bestgen 2013). This was effectively reduced to 0 miles in the North Laramie River by the Arapaho Fire and debris flows that followed. Hornyhead chub were reintroduced to approximately 1 mile of the river in 2014-15.

Hornyhead chub have been found in association with 16 native fish species and 5 introduced species. Hornyhead chub are found most commonly with creek chub, common shiner, stonecat and introduced brook trout. Exotic carp, green sunfish, rainbow trout and brown trout also inhabit some sites containing hornyhead chub (Bear and Barrineau 2007, Moan et al. 2010).

Habitat

Hornyhead chub are typically found in clear streams, with riffle habitat and gravel substrate. In the Lower Laramie River drainage, they were collected at sites above 4,750 ft in elevation and most sites had a slope greater than 1.1%. Riffle habitat was present at each site. Boulder and cobble made up 42% to 66% of substrates found, minimal aquatic vegetation was encountered, and average thalweg depths were greater than 1.5 ft (Moan et al. 2010).

Occupied reaches in the Laramie and North Laramie were mainly upstream of diversions, where streams had relatively stable summer baseflow, cool, clear water that was relatively deep, sand and gravel substrate with little silt, cover, and few non-native piscivores, especially in the Laramie River. In addition, occupied reaches of stream had stable banks relatively free of disturbance from road crossings or grazing animals. Downstream of diversions, flows were lower and less reliable, warmer, shallower, stream banks were less stable, silt common, and few hornyhead chubs were present (Bestgen 2013).

Problems

- Siltation and other habitat alterations associated with wildfire.
- Restricted population, making them susceptible to extirpation from disease and habitat alterations.
- Introduced non-native piscivores.

Conservation Actions

- Investigate entrainment of hornyhead chub in the North Laramie Canal.
- Continue to work with private landowners and other agencies to reduce entrainment issues.
- Work with private landowner, irrigators, and WGFD Fish Passage Program Coordinator on North Laramie Canal Diversion to discuss nongame passage issues. Work with State Land Board to develop a grazing approach on the Tunnel Road State Land parcel to promote stable banks and healthy riparian area
- Evaluate the potential for restoring populations within suitable portions of historic range that are currently uninhabited or where competing species can be removed.
- Prevent stocking with non-native species that are likely to negatively influence populations.
- Protect and manage riparian areas for native riparian vegetation, that will filter runoff, maintain a higher water table, provide late season stream recharge, and stabilize stream banks. Use riparian fencing, grazing management, fire management, and invasive species control to promote native vegetation.
- Surveys of extant populations are needed to provide baseline data, develop monitoring protocols, and establish monitoring locations to assess distribution and population trends.
- File for instream flow water rights to protect habitat of conservation populations.

Monitoring / Research

Develop a monitoring plan to monitor extant populations of hornyhead chub within the Laramie and North Laramie rivers. Investigate entrainment of hornyhead chub in the North Laramie Canal. Work with private landowner, irrigators, and WGFD Fish Passage Program Coordinator on North Laramie Canal Diversion to discuss nongame passage issues. Work with State Land Board to develop a grazing approach on the Tunnel Road State Land parcel to promote stable banks and healthy riparian area, this project could serve as a model for others. Provide support to ongoing hornyhead chub project looking a potential refugia sites within and outside of native range in Wyoming and salmonid predation on hornyhead chub in the Laramie River.

Recent Developments

From 2004 through 2009, detailed fish and habitat surveys were conducted to establish a baseline for future trend analysis and guide conservation efforts on the Lower Laramie River (Bear and Barrineau 2007; Moan et al. 2010).

A project was completed by Colorado State University and WGFD to refine our understanding of HHC abundance, movement, and habitat utilization within Wyoming in 2009-2010 (Bestgen 2013) .

In June of 2012, the Arapaho Fire burned over 100,000 acres in Albany, Platte and Converse counties. One drainage impacted was the North Laramie River in Albany and Platte County. Large debris flows, high water, and ash flow affected roughly 46 miles of the river. HHC previously occupied around 8 miles of the North Laramie River in the area affected by the fire.

North Laramie River sampling post-fire:

In 2013, sampling stations above the known upstream distribution and within known distribution of HHC were sampled in and no HHC were found. Other nongame native fish were collected, most directly below the North Laramie Canal Diversion and in low numbers. In 2014 10,400 feet of the North Laramie River was sampled and no HHC were captured or observed. In October, 209 HHC were transplanted from the Laramie River at Tunnel Road to the North Laramie River. An additional 203 HHC were transplanted in August of 2015.

Laramie River sampling 2013 through 2015:

In 2013, the Laramie River was sampled upstream from the Tunnel Road crossing to the gauging station below Tunnel Diversion. The purpose was to confirm the presence of HHC at this site. HHC likely expanded into this section of the Laramie River in 2010, when high flows allowed HHC to ascend a low-flow barrier (Bestgen 2013). A total of 33 HHC were captured. Most were small with a mean length of 3.9 inches, indicating successful reproduction since 2010.
In 2014 two sampling events occurred at the Tunnel Road section of the Laramie River in 2014. The first event was to determine the abundance of HHC prior to a possible transplant to the North Laramie River. 81 HHC were captured despite poor capture efficiency. A second event in October captured 209 HHC for transplant. Additional sampling in 2015 was conducted to again assess abundance and capture 203 HHC for transplant.

A UW Coop research project was initiated in 2015. The project objectives are to exam potential refugia sites within and outside of native range in Wyoming. In addition, the project will attempt to assess impacts of salmonid predation on HHC within the Laramie River.

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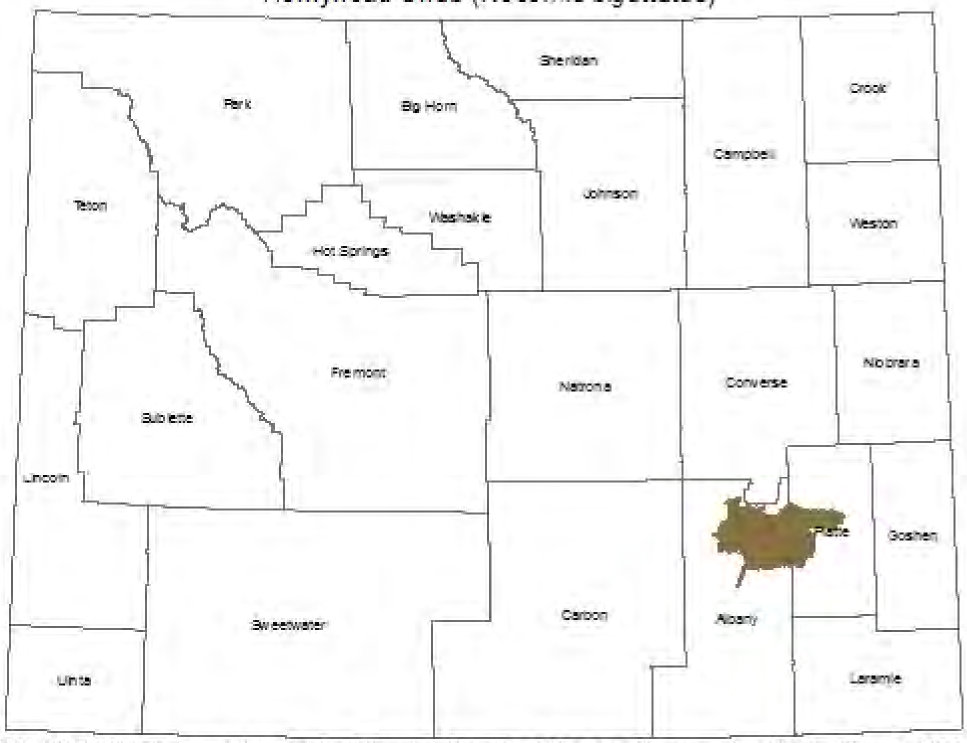
Hornyhead Chub (*Nocomis biguttatus*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Iowa Darter - Etheostoma exile

Abundance: Rare

Status: NSS3 (Bb) NatureServe: G5 S3S4

Population Status: Vulnerable due to decreasing abundance and distribution. Appear to be decreasing in distribution over the last decade. Extirpated from many locations in the southern part of its range.

Limiting Factor: Habitat: severe due to increasing turbidity, pollution, and drainage of wetlands, which limit preffered habitat. Also non-native species introductions.

Comment: NSS Ranks are reviewed and revised with each SWAP revision. No changes were made for this species in this revision.

Introduction

Iowa darter are native to the north central region of the United States and central Canada. Their U.S. distribution stretches from the northern Rocky Mountain states, across the upper Midwest, to New York state. They have been introduced in Utah and New Mexico. Wyoming makes up the western edge of their distribution.

In Wyoming, they have been found in the Niobrara, North Platte, and South Platte River drainages.
Iowa darters actively feed along stream bottoms during both day and night, mostly consuming small aquatic insects (Baxter and Stone 1995). Spawning occurs in late April to July, under the cover of submerged objects or undercut banks. Males move into shallow waters and establish a territory where the females will deposit a few eggs per spawning event. The male will defend the territory but will not provide parental care (Weitzel 2002).

Habitat

Iowa darter prefer cool, slow moving vegetated waters with little to no turbidity and sand or gravel substrates, but will use a variety of available habitats. In Wyoming, they were found at sites with slow moving water, with light to heavy vegetation and cobble to silt substrates. Greatest numbers were collected at sites with few or no predators (Moan et al. 2010).

Problems

- Reduced numbers found in association with piscivores (brown trout and creek chub) in the Lower Laramie River.
- Limited numbers and restricted populations, making them susceptible to extirpation from disease and habitat alterations.

Conservation Actions

- Determine limiting factors for Lodgepole Creek fish populations.

Monitoring / Research

Initiate routine monitoring in the Lodgepole Creek, Laramie River, and North Platte River drainages to determine trends in Iowa darter abundance and detect changes in the overall composition of fish communities.

Continue to identify and record observations while conducting fisheries management sampling.

Recent Developments

Detailed fish and habitat surveys were conducted in tributaries to the North Platte River in 2004-2005 (Bear and Barrineau 2007) and 2008-2009 (Moan et al. 2010) to establish a baseline for future trend analysis in the North Platte drainage. During the 2004-2005 surveys, Iowa darters were found in Antelope Creek (Chugwater Creek drainage) and in the Niobrara and Laramie rivers. The species was found at sites in the Niobrara and Laramie rivers in 2010, but was not found in the Chugwater Creek draingage. Patton (1997) and Barrineau (2006, unpublished data) found that Iowa darters were relatively common in the Lodgepole Creek watershed. However, the species was not found during the 2008-2009 surveys in the watershed (Moan et al. 2010), indicating a potential decline in distribution in the South Platte River basin in Wyoming.

The Casper Fisheries Management Crew conducted native fish surveys in the lower mainstem North Platte River in 2005 and 2007. Iowa darters were found at two locations between Guernsey and Torrington, Wyoming in 2007 (WGFD 2008). Iowa darters were also sampled in Big Muddy Pond near Glenrock, Wyoming in 2005 (WGFD 2006).

The Laramie Fisheries Management Crew conducted surveys at 2 sites on Antelope Creek in Platte County in 2010. Antelope Creek was sampled just downstream from the Bordeaux Road Exit, Interstate 25 and near I-25 Exit 68. Iowa darter were numerous at both sites.

The Laramie Fisheries Management Crew conducted extensive surveys in Lodgepole Creek upstream of WY HWY 213 in 2011 and 2012. Over a mile of Lodgepole Creek was sampled in 2011 upstream from HWY 213 and Iowa darter were found at 14 of the 16 sampling sites. A total of 131 Iowa darter were collected in the >1 mile of Lodgepole Creek surveyed in 2011, this was far less than the numbers of orangethroat darter collected at the same sites in 2011, 1,981. Surveys in 2012 occured upstream of the 2011 surveys and 7 Iowa darter were collected. Iowa darter appear to be rare in Lodgepole Creek from HWY 213 upstream about 9 miles. Results from 2011 and 2012 can be found in the corresponding Fish Division Annual Reports.

The Laramie Fisheries Management Crew documented Iowa darter in Saratoga Lake for the first time in 2012 and captured them again in 2013. In addition, Iowa darter were captured for the first time in 2013 since 2010 in Alsop Lake. Alsop Lake had a complete winterkill in 2010. Iowa darter were also captured in Mortenson Lake in 2013 during surveys conducted with the Aquatic Assessemnt Crew. One Iowa Darter was captured during surveys on the Laramie River on the Tunnel Road in 2014.

The Casper Fisheries Management Crew found IDT in low abundance during surveys of North Platte River side channels, backwaters, and streambank margins during 2012-2013. These native fish surveys were conducted at various sites from Casper downstream to the Nebraska state line (WGFD 2014).

Multiple surveys on Lodgepole Creek and the Laramie River were conducted by the Aquatic Assessment and Laramie Fish Management crews in 2014-2015 as part of the Eastern Wyoming Intermittent Streams project. Iowa darter were found in low abundance on both streams. Results are on file and will be detailed in a forthcoming administrative report.

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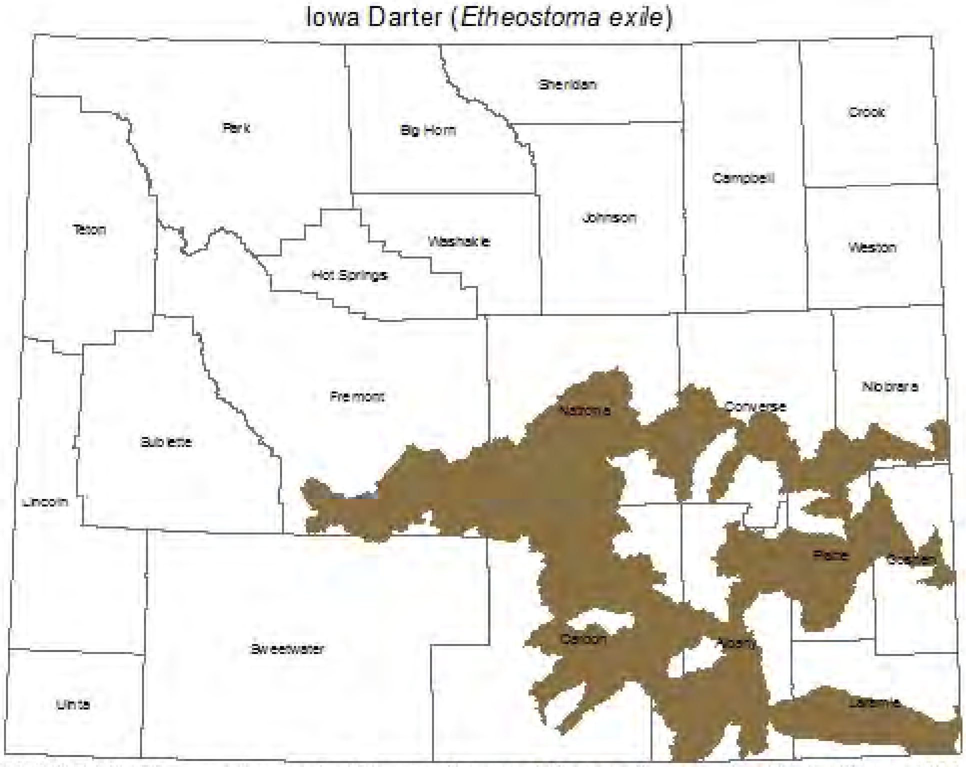
Iowa Darter (*Etheostoma exile*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Kendall Warm Springs Dace - Rhinichthys osculus

Abundance: Common within an extremely limited range

Status: NSS1 (Aa) NatureServe: G5T1 S1

Population Status: Greatly restricted in distribution and extirpation is possible. A decline in relative abundance has been documented during routine sampling.

Limiting Factor: Habitat: KWS are found in one small thermal spring fed stream. Habitat is extremely limited and any loss of habitat or change in habitat conditions may result in extinction of the species. Changes in habitat condition (i.e., width/depth ratio, stream vegetation), changes in thermal regime, water table, water chemistry, and potential non-native species introductions are all threats to this species.

Comment:

Introduction

This is a diminutive subspecies of the speckled dace, typically achieving a length of less than 2 inches. It resides solely in a warm spring tributary to the Green River within the Bridger-Teton National Forest. Kendall Warm Springs dace are found well distributed throughout all but the upper portion of the 984-foot long thermal spring creek. This stream is located about 30 miles north of Pinedale, WY. The habitat ends at a waterfall near the mouth of the Green River. A typical section of this creek is considered swift fluvial habitat enclosed by boggy areas containing clumps of aquatic plants. The small, still pocket pools in the bog areas are important nurseries for Kendall Warm Springs dace fry. Adult dace typically stay in quiet pockets in the main water flow. (Binns 1978) This dace has been seen to spawn year-round, but the majority of young have been observed from late June through September. At time of spawning it sports spawning tubercles while the body and fins turn a bright purple. The Kendall Warm Springs Dace recovery plan was revised in September 2015 by the USFWS in collaboration with multiple partners (U.S. Fish and Wildlife Service. 2015. Recovery Plan for the Kendall Warm Springs Dace (Rhinichthys osculus thermalis). Revision: Original Approved July 12, 1982. U.S. Fish and Wildlife Service, Cheyenne, Wyoming).

Habitat

Kendall Warm Springs dace are found well distributed throughout all but the upper portion of the spring creek (Binns 1978). The temperature of Kendall Warm Springs has a near constant temperature of 85 degrees F. Habitat consists of moderate to fast riffles, several man-made pools less than 3 feet deep and shallower boggy areas. Substrate for the dace ranges from gravel to small rock. Adults are seen in the main current and pools while juveniles are seen in vegetated lateral habitats (Binns 1978).

Problems

- The species' habitat is extremely limited and vulnerable to any natural or anthropogenic perturbations
- Lack of ungulate hoof action to keep the stream wide and shallow has resulted in narrowing and deepening of the channel.

Conservation Actions

- A better understanding of the habitat and flow requirements of this species is needed to assess the impacts of water and land use activities.
- Implement 2015 Recovery Plan
- Implement a grazing regime that would be beneficial to the species.
- A better understanding of juvenile habitat requirements is needed.

Monitoring / Research

US Forest Service personnel conduct population monitoring for the USFWS. Include detailed habitat monitoring, water chemistry, and water temperature to the monitoring activities for this species

Recent Developments

In 2007, the USFWS completed a five-year review of the Kendall Warm Springs dace (USFWS 2007) and determined that no change in ESA status was warranted.
In 2015, the USFWS completed a revision of the 1982 Recovery Plan.
USFS continues to monitor KWS populations.

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Kendall Warm Springs Dace (*Rhinichthys osculus thermalis*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: April 2010. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Northern leatherside chub - Lepidomeda copei

Abundance: Rare

Status: NSS3 (Bb) NatureServe: G3 S1

Population Status: Distribution is reduced from historical distribution and current populations are isolated. Population size is variable with populations in some locales declining or vunerable, while others appear stable. Greatly restricted in numbers and distribution and extirpation is possible in some portions of its native range. Populations extremely limited, but trends unknown.

Limiting Factor: Habitat: Significant loss of habitat and population connectivity due to water development and diversion. Other habitat requirements and limiting factors are largely unknown. Although habitat has been historically degraded and the carrying capacity of most streams has been compromised across the range of northern leatherside, habitat conditions are not likely to deteriorate into the future. Populations in the upper Bear River drainage were determined to be genetically pure in 2007 (Amadio 2009), and populations in the Bear River, Green River, and Snake River drainages appear to have been historically connected (Blakney 2012). Competition and predation from native and non-native fish may also adversely affect populations in some locales.

Comment: Changed from NSSU to NSS3 in 2017 due to results of rangewide inventory and population assesments. NSS Ranks are reviewed and revised with each SWAP revision.

Introduction

Northern leatherside chub is one of two taxa formerly known as leatherside chub (Gila copei and Snyderichthys copei) that was recently split into two species: Northern (Lepidomeda copei) and Southern (L. aliciae) based upon genetic, morphological, and ecological differences (Johnson et al. 2004). This small mid-elevation fish is endemic to streams within the northeastern portions of the Bonneville Basin and select drainages of the upper Snake River (Johnson and Jordan 2000). Within their natural range, populations of both leatherside chub species have declined relative to historical observations and now appear to be extirpated in some systems (Wilson 1996, Wilson and Belk 1996, Wilson and Belk 2001, Johnson et al. 2004, Belk and Johnson 2007). In response to the taxanomic split and declining populations, the states of Idaho, Nevada, Utah and Wyoming along with the U.S. Forest Service, Bureau of Land Management, Bureau of Reclamation, National Park Service, Fish and Wildlife Service, Trout Unlimited and The Nature Conservancy, signed a Rangewide Conservation Agreement and Strategy for Northern Leatherside (Lepidomeda copei) to jointly conserve, protect and restore populations within historic range (UDWR 2009). Northern leatherside are native to the Bear and Snake River drainages in Wyoming (Baxter and Stone 1995). The species is widely distributed across the Bear River drainage, and is found in Pacific Creek, Triangle X Spring, the Gros Ventre River, and the Salt River watershed (Idaho portion) in the Snake River drainage (Quist et al. 2004, Schultz and Cavalli 2012, WGFD 2015). Northern leatherside also occur in isolated tributaries of the upper Green River drainages, and Blakney (2012) found mitochondrial evidence suggesting that those populations may be endemic. Populations of northern leatherside in Wyoming represent the core of the species' range. The Bear River system supports two northern leatherside populations in Wyoming thought to be once continuous but now isolated by Woodruff Dam. Additional water development and habitat degradation has further fragmented remaining populations above and below this barrier. Populations in the upper portion of the watershed (upstream of Woodruff Dam) are thought to be isolated, but stable and genetically pure (Amadio et al. 2009, Zafft et al. 2009). Above and below Woodruff Dam, populations of northern leatherside are relatively robust and multiple populations of high conservation value exist. The population of northern leatherside in Pacific Creek is also of high conservation value. The maximum life span of northern leatherside chub is at least eight years and adults can grow to 6 inches (Johnson et al. 1995). Its diet consists of mainly aquatic invertebrates. Growth rate is rapid in early years but tends to slow at the onset of sexual maturity. Reproduction can begin at age 2 or at lengths greater than 2 inches (Johnson et al. 1995, Belk et al. 2005). Spawning typically occurs over gravel and cobble substrates (Billman et al. 2008) during spring high water periods, and spawning may occasionally occur in intermittent stream reaches (Schultz 2012). Some populations in Wyoming are thought to have a prolonged spawning period from April through August (Baxter and Stone 1995).

Habitat

Northern leatherside in Wyoming normally inhabit deep pools in medium-sized streams with cool water temperatures, but are also frequently found in streams with mostly riffle habitat. Water velocity, temperature and depth are all thought to be key habitat components, and northern leatherside chub often occupy habitats with some form of cover (vegetation, woody debris, lateral banks). In the Snake River drainage, northern leatherside occupy lateral habitats almost exclusively, usually with some type of cover (Schultz and Cavalli 2012). Across its native range, northern leatherside requires flowing water and generally does not persist in lakes or reservoirs (UDWR 2009). Its habitat preferences are thought to be similar to those of southern leatherside (Belk and Johnson 2007). Like southern leatherside, northern leatherside are found in stream reaches with abundant deep pools (Quist et al. 2004) and in systems that contain a high degree of depth variability (Wesner and Belk 2011, Schultz and Cavalli 2012). It is also positively associated with other native fishes (Schultz and Cavalli 2012). Spawning occurs over cobble and gravel substrate (Billman et al. 2008) during spring, and the availability of coarse substrate is an important habitat component (Wesner and Belk 2011). Northern leatherside will also use seasonally-available habitats, probably for spawning (Schultz 2012). Stream systems occupied by leatherside chub have a broad range of physical conditions including high variability of elevation, gradient, stream flow, temperature, and water quality (Wilson 1996, Wilson and Belk 2001). They may also persist in systems composed mostly of isolated pools (Belk and Johnson 2007). The elevation range for northern leatherside is approximately 4200 to 9000 feet. The summer temperature range has been reported from 50 to 75F, but they are thought to favor water temperatures between 60 and 68F (Sigler and Sigler 1987, Sigler and Sigler 1996). Microhabitat variables associated with leatherside chub include low water velocities (<1.5 ft/sec), intermediate water depths (1-3 ft), and low percent composition of sand-silt or gravel substrates (Wilson 1996, Wilson and Belk 2001). Northern leatherside tend to be found with other native fishes in the Bear River drainage (Wesner and Belk 2011, Schultz and Cavalli 2012). In most systems, adults and juveniles tend to utilize the main channel of streams more often than off channel habitats, but in the presence of nonnative predators like brook and brown trout, they often shift habitat use to off channel habitats (Walser et al. 1999; Olsen and Belk 2001). Recent evidence suggests that northern leatherside may be highly mobile and utilize a variety of habitats to complete its life history (Schultz 2012), and connectivity to other populations is likely influential to its occurrence (Wesner and Belk 2007).

Problems

- Population fragmentation resulting in the loss of extant populations and individuals within existing populations, limited opportunity for genetic exchange, and limited access to preferred habitats. These problems can ultimately threaten population viability and increase vulnerability to environmental or demographic stochasticity.
- Habitat degradation from water development (diversions and dams) that has reduced or halted instream flows, fragmented populations and habitat, created movement barriers and caused fish entrainment.
- Manipulation of natural flood regimes that cause general habitat degradation or loss of spawning habitats.
- Habitat degradation from stream channelization and other anthropogenic alterations including road and train track development.
- Past and current livestock grazing practices have altered riparian and in-stream habitat, water quality and sediment transport regimes. Ramifications of this practice includes loss of instream cover and channel complexity, increased water temperature, bank erosion and loss of preferred substrate.

Conservation Actions

- Methods and strategies for conservation are detailed in the Rangewide Conservation Agreement and Strategy for Northern Leatherside.
- Continue efforts to maintain flows and connectivity.
- A better understanding of the basic biology, life history and habitat requirements is needed.
- Collaborate with UDWR and Trout Unlimited to assess and mitigate impacts of water development to the northern leatherside chub population in Yellow Creek.
- Evaluate the potential to mechanically or chemically remove nonnative fishes from some streams occupied by northern leatherside chub.
- Continue to educate landowners and the public about the importance of maintaining habitat for native fish
- Implement a grazing regime that would be beneficial to the species.
- Prevent stocking of public or private waters with non-native species that may impact conservation populations.
- Continue ongoing watershed habitat programs aimed at overall ecosystem function and fish passage.
- Actively coordinate with and assist federal land managers in developing and implementing management plans.

Monitoring / Research

Continue population monitoring at recently established abundance survey sites in LaChapelle Creek, Yellow Creek, Dry Fork, Muddy Creek, and Twin Creek.

Continue to monitor distribution of northern leatherside in Pacific Creek, Triangle X Spring, Gros Ventre River drainage, and similar habitats within the Upper Snake River drainage.

Examine the response of northern leatherside to habitat restoration or degradation

Monitor the success of any translocations of northern leatherside to currently unoccupied habitat

Assess the thermal tolerance and thermal preference of northern leatherside

Recent Developments

In 2009 the states of Idaho, Nevada, Utah and Wyoming along with the U.S. Forest Service, Bureau of Land Management, Bureau of Reclamation, National Park Service, Fish and Wildlife Service, Trout Unlimited and The Nature Conservancy, signed a Rangewide Conservation Agreement and Strategy for Northern Leatherside (Lepidomeda copei) to jointly conserve, protect and restore northern leatherside chub populations within their historic range (UDWR 2009).

A northern leatherside chub State Wildlife Grant project was completed (Schultz and Cavalli 2012) to a) document the current distribution of northern leatherside in the Bear and Snake River drainages of Wyoming, b) assess baseline abundance for major populations in Wyoming, c) identify species of fish sympatric with northern leatherside in Wyoming, d) identify habitat associations of northern leatherside, e) examine its seasonal habitat use patterns, and f) collect tissue samples from major northern leatherside populations in Wyoming for genetic analyses.

Surveys of extant populations were completed to provide baseline data, develop monitoring protocols, establish monitoring locations, and identify specific threats and management priorities for northern leatherside in Wyoming.

A landscape-scale genetic analyses was conducted in 2010-2011 (Blakney 2012) to assess genetic diversity across the range of northern leatherside. This work found mitochondrial evidence suggesting that populations in the Green River basin are endemic.

Genetic characteristics of four northern leatherside chub populations in the upper Bear River drainage was assessed in 2007 and all populations were determined to be genetically pure (Amadio et al. 2009).

Northern leatherside chub monitoring stations were established throughout the Bear River drainage in 2010-2011, and its distribution in the Upper Snake River was delineated in 2011. Northern leatherside were identified in the Gros Ventre River for the first time in 2014.

Northern leatherside chub abundance estimates were calculated for LaChapelle and Yellow Creek populations in 2006 and 2011, and Mill Creek (tributary to Muddy, Smiths Fork), Muddy Creek, Twin Creek, and Dry Fork in 2010-2011.

Along with Trout Unlimited, WGFD recently implemented fish passage and screening improvements in the Twin Creek and Smiths Fork drainages. A barrier assessment in Yellow Creek was initiated by Trout unlimited in 2011.

Priority conservation areas for northern leatherside were identified in the Snake and Bear River drainages in 2011.

A petition to list northern leatherside as threatened or endangered under the Endangered Species Act was found to be not warrented (United States Fish and Wildlife Service 2011).

Schultz (2012) found spawning may occasionally occur in intermittent stream reaches

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Northern Leatherside Chub (*Lepidomeda copei*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Northern Pearl Dace - Margariscus margarita

Abundance: Extremely rare

Status: NSS2 (Ab) NatureServe: G5 S1

Population Status: Imperiled because of greatly restricted distribution. Found only in Niobrara River drainage at very few locations.

Limiting Factor: Habitat: severe due to limited habitat in Wyoming.

Comment: NSS Ranks are reviewed and revised with each SWAP revision. No changes were made for this species in this revision.

Introduction

The species was referred to as northern pearl minnow by Simon (1951) and northern pearl dace by Baxter and Simon (1970). Pearl dace are found across the northern United States and Canada with populations in the U.S. sporadically distributed along the Canadian border from Montana to Maine. Their distribution extends south to Nebraska (Cunningham 2006). The population in Wyoming is considered a glacial relict population and is found in the Niobrara River and Van Tassell Creek in the Niobrara River drainage (Moan et al. 2010).

Pearl dace are sight-feeding foragers, actively feeding on aquatic macroinvertebrates and zooplankton. They spawn when water temperatures are around 61 °F to 64 °F, generally mid April to mid May. Females spawn multiple times per year over cobble or gravel substrates. Males defend egg deposit sites, but no parental care is given.

In Wyoming pearl dace are found with brassy minnow, creek chub, fathead minnow, finescale dace, plains topminnow, central stonerollers and white suckers. When present, pearl dace commonly dominate species composition making up more than 70% of species collected (Bear and Barrineau 2007; Moan et al. 2010).

Habitat

Pearl dace prefer slow moving, spring-fed streams with well-vegetated banks (Cunningham 2006). They are frequently found in cool clear headwater drainages, with deep pools and sand or gravel substrates. Pearl dace are most commonly found in the absence of large predatory fish (Cunningham 2006). In Wyoming pearl dace were collected at sites with clear, slow moving or stagnant water with depths greater than 1.5 feet, dense aquatic vegetation, and predominantly silt substrate (Moan et al. 2010).

Problems

- Introduced nonnative predators.
- Restricted population, making them susceptible to extirpation from disease and habitat alterations.

Conservation Actions

- Investigate threats posed by Northern Pike present in the stream, and explore options for their suppression.
- Investigate pearl dace behavior and habitat utilization within Wyoming.
- Continue to exclude stocking of non-native fish in the mainstem Niobrara River.

Monitoring / Research

Conduct annual or biannual, single event presence/absence sampling of pearl dace populations at the Nebraska border to facilitate the assessment of population trends. Co-occurring SGCN, including Finescale dace and Plains topminnow can be monitored concurrently.

Coordinate with Nebraska Game and Parks Commission and National Parks Service to monitor invasive species influence, especially northern pike, from Nebraska.

Recent Developments

WGFD surveys were conducted on the Niobrara River in 2004 (Bear and Barrineau 2007) and 2008 (Moan et al. 2010) to develop a baseline understanding of the fish assemblage. Pearl dace have been found at similar sampling locations during each survey.

Pearl dace were found in large numbers during Niobrara River fish surveys in 2015 (Nick Hogberg, WGFD, unpublished data). They were particularly abundant in the marshy sections of the river near the state line.

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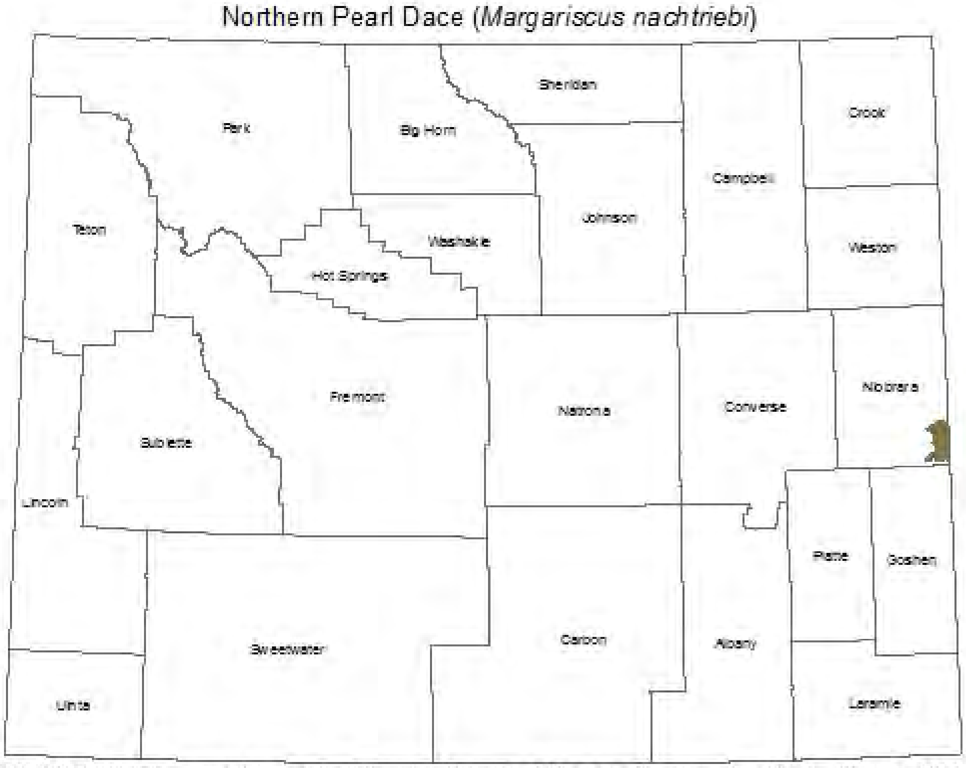
Northern Pearl Dace (*Margariscus nachtriebi*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Northern plains Killifish - Fundulus kansae

Abundance: Common

Status: NSS3 (Bb) NatureServe: G5 S5

Population Status: Stable. Distribution and abundance appears stable over last decade.

Limiting Factor: Habitat: severe due to limited availability of shallow, sandy habitats.

Comment: Changed from NSS4 to NSS3 in 2017 due to recent surveys indicating that the distribution of this species is more restricted than previously believed within native range.

Introduction

The northern plains killifish is native to the Great Plains region of central North America, where it ranges from southeast Montana, South Dakota, and Missouri south to Texas (Rahel and Thel 2004). Populations have been introduced in Colorado, Utah, Arizona, New Mexico, Montana, Wyoming, Texas, and South Dakota (Rahel and Thel 2004). In Wyoming, northern plains killifish are indigenous to the North Platte and South Platte drainages, but are also found outside their range in the Big Horn and Cheyenne river drainages (Baxter and Stone 1995), possibly introduced by bait fisherman (Baxter and Simon 1970). Baxter and Simon (1970) reported no findings of northern plains killifish within the Powder River basin during 1964 sampling. Patton (1997) was the first to record the presence of this species in the Powder River system. Given this, they are likely not native to the Powder River drainage. Northern plains killifish are typically carnivorous, consuming a variety of insects and other aquatic invertebrates, and occasionally eat plant material and diatoms (Minckley and Klaassen 1969; Pflieger 1997; Rahel and Thel 2004). They feed at the surface, in the water column, and from the bottom substrate (Baxter and Stone 1995). Spawning takes place from May to August and may be stimulated by temperature and flow cues (Pflieger 1997; Rahel and Thel 2004). Males do not establish territories but they are aggressive and competitive when in pursuit of females (Pflieger 1997). One male and one female contribute to spawning, and eggs are buried in the sand (Baxter and Stone 1995; Pflieger 1997). Little is known about the movement and activity patterns of the northern plains killifish (Rahel and Thel 2004). In Wyoming, this species was formerly referred to as plains killifish, F. zebrinus, but has been recognized as a separate species (Kreiser 2001; Kreiser et al. 2001; Nelson et al. 2004).

Habitat

Northern plains killifish prefer shallow streams with sand or gravel substrate (Baxter and Stone 1995) but are generalists and can be found in a wide variety of habitats (Pflieger 1997; Senecal 2009). They can survive in rapid or sluggish current or pools (Minckley and Klaassen 1969), but prefer slower waters and are often found in backwater and shoal areas (Senecal 2009). They are often found in alkaline streams with high salinity (Baxter and Stone 1995; Pflieger 1997), are tolerant of intermittency, and can survive in isolated pools (Baxter and Stone 1995).

Problems

- Abundance and distribution has declined compared to previous surveys.
- Lack of connectivity resulting from low flows or other physical barriers (natural and man made) may significantly limit access to upstream habitats.
- Altered flow regimes, habitat fragmentation, and impacts to aquatic and riparian habitat associated with agricultural practices.

Conservation Actions

- Continue efforts to educate landowners and the public about the importance of native fish and their habitats.
- Continue efforts to maintain flows and connectivity.

Monitoring/Research

Continue to identify and record observations while conducting fisheries management sampling.

Recent Developments

Prairie stream surveys were completed in 2004-2005 (Barrineau et al. 2007; Bear and Barrineau 2007) and 2008-2009 (McGree et al. 2010; Moan et al. 2010) to assess the distribution of this species in eastern Wyoming and to determine potential conservation actions. Additionally, recent studies have documented the expansion of northern plains killifish in the Powder River from comprising less than 1% of the total fish assemblage in 1995 (Patton 1997), to 2-4% in 2009 (Peterson et al. 2009; Senecal 2009).

Intensive surveys were completed on Horse Creek, Lodgepole Creek, and Laramie River in 2015 (Compton and Hogberg: In Draft). Northern plains killifsh were found at 12 of 40 sites on Horse Creek, 6 of 22 sites on Lodgepole Creek, and 0 of 29 sites on the Laramie River.

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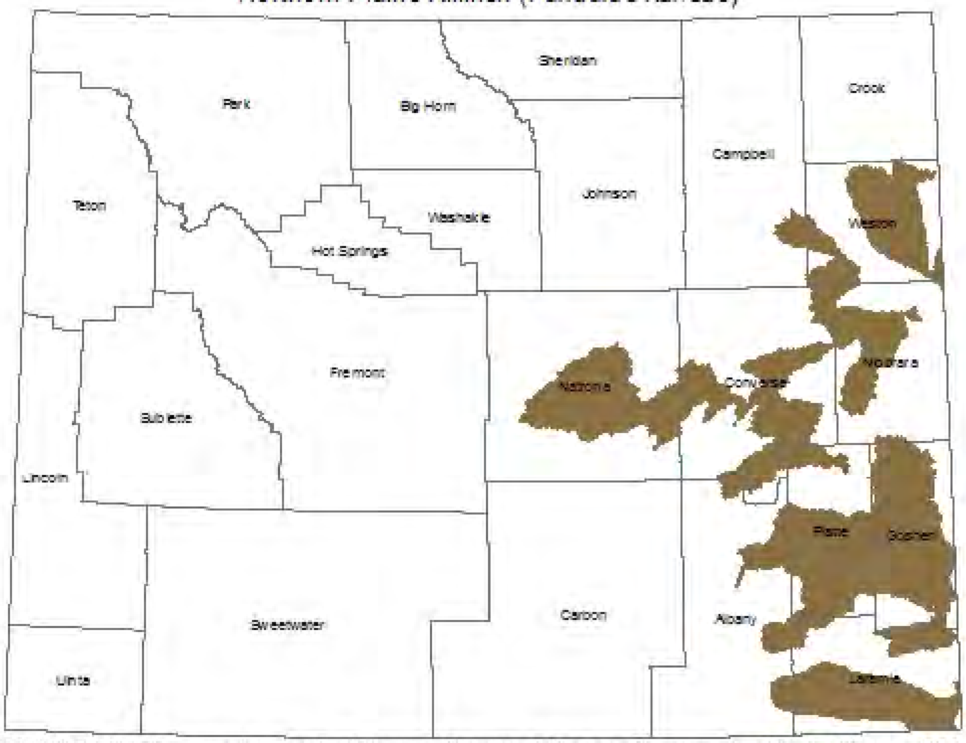
Northern Plains Killifish (*Fundulus kansae*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Orangethroat Darter - Etheostoma spectabile

Abundance: Unknown

Status: NSS3 (Bb) NatureServe: G5 S1

Population Status: Greatly restricted distribution. Found in lower Lodegpole Creek in South Platte River drainage and North Platte River (Goshen County). The species also occurs in the lower North Platte River and in the Laramie River below Grayrocks Reservoir. Species can be difficult to tell from Iowa darter.

Limiting Factor: Habitat: severe due to very limited habitat range in Wyoming.

Comment: NSS status changed from NSSU to NSS3 (Bb) in 2017 based on recent survey work. NSS Ranks are reviewed and revised with each SWAP revision.

Introduction

Orangethroat darter distribution extends from central Texas to southern Wisconsin and Michigan. Wyoming is at the western extreme of their distribution. Historically, orangethroat darters in Wyoming were only found in Lodgepole Creek, in the South Platte River drainage. Recent surveys have discovered new populations in the lower sections of the North Platte River and in the Lower Laramie River (Moan et al. 2010).

Orangethroat darters primarily reside on stream bottoms, actively feeding on aquatic macroinvertebrates. They generally spawn over fine gravel in early spring depending on water temperature. Females bury themselves in the gravel during spawning, depositing eggs into the gravel. No parental care is given (Pflieger 1997). Maturity is generally reached during their second spring after hatching and few live for more than four years.

During the 2008-2009 WGFD surveys, orangethroat darter were found in association with 14 other species, but were most commonly found with longnose sucker, central stoneroller, Johnny darter, and exotic smallmouth bass and common carp. Exotic green sunfish were also found at one site in the Laramie River drainage that was occupied by orangethroat darter (Moan et al. 2010).

Habitat

Orangethroat darters prefer clear to moderately turbid water with gravel substrates. They are said to subsist in slow riffles or pools with enough flow to keep substrates free of silt. In the Lower Laramie River, they were collected at sites dominated by gravel substrates, with riffle habitat present, and some aquatic vegetation. The 2008 surveys were the first time orangethroat darter had been documented in the Laramie River (Moan et al. 2011). Based on WGFD surveys conducted in 2012 and 2013, orangethroat darter were present, when suitable habitat was present, in the Laramie River below Grayrocks Reservoir. Only one orangethroat darter was collected during 2009 Lodgepole Creek surveys and it was thought that their preferred habitat was limited (Moan et al. 2011). In contrast, data collected in 2011, 2012, and 2015 by WGFD showed that orangethroat darter are actually thriving in approximately nine miles of Lodgepole Creek, where preferred habitat is still available.

Problems

- Altered flow regimes, habitat fragmentation, and impacts to aquatic and riparian habitat associated with agricultural practices.
- Competition with introduced non-native fish may adversely effect populations in some areas within native range.
- Lack of connectivity resulting from low flows or other physical barriers (natural and man made) may significantly limit access to upstream habitats.
- Restricted population, making them susceptible to extirpation from disease and habitat alterations.

Conservation Actions

- Continue efforts to maintain flows and connectivity.
- Continue to educate landowners and the public about the importance of maintaining habitat for native fish
- Surveys of extant populations are needed to provide baseline data, develop monitoring protocols, and establish monitoring locations to assess distribution and population trends.

Monitoring / Research

Design a plan to monitor known populations in the North Platte and Lower Laramie river systems. In addition, develop a plan to monitoring sites on Lodgepole Creek. Work with private landowners to maintain and or enhance orangethroat darter habitat or distribution by decreasing habitat fragmentation and incorporating best land management practices.

Continue to identify and record observations while conducting fisheries management sampling.

Recent Developments

The 2008 WGFD surveys were the first time orangethroat darter had been documented in the Laramie River below Grayrocks Reservoir (Moan et al. 2011) and 2012 and 2013 surveys further confirmed their presence. Orangethroat darter are said to prefer sluggish riffles or pools with gravel or rocky substrates (Pflieger 1997), habitat that was present in the sample sites in 2012 and 2013 and throughout the Lower Laramie River drainage (Moan et al. 2011). Additional sampling by WGFD in 2008 in the North Platte River found orangethroat darter occupying backwaters of the mainstem North Platte River near Torrington, WY.

Surveys conducted in 2011 and 2012 by WGFD addressed the 2010 SWAP and verified results from Lodgepole Creek surveys conducted in 2009 where only one orangethroat darter was collected (Moan et al. 2011). Many assertions about the status of orangethroat darter in Lodgepole Creek were made in the 2010 SWAP after surveys conducted by Moan et al. (2011) in 2009 reported there had been a drastic decline in orangethroat darter from 1993 to 2009 due to scarcity of habitat. Site selection and sampling methodology may have played a role in 2009 survey results. Data collected in 2011, 2012, and 2015 have refined our understanding of the abundance and distribution of orangethroat darter in Lodgepole Creek. Future sampling for orangethroat darter should take into account site selection and sampling methodology for monitoring purposes. Data collected in 2011, 2012, and 2015 have confirmed that orangethroat darter are actually thriving in approximately nine miles of Lodgepole Creek, where preferred habitat is still available.

WGFD 2015 surveys of lower Horse Creek turned up one ODT. This would represent the first observance of ODT in the Horse Creek Drainage.

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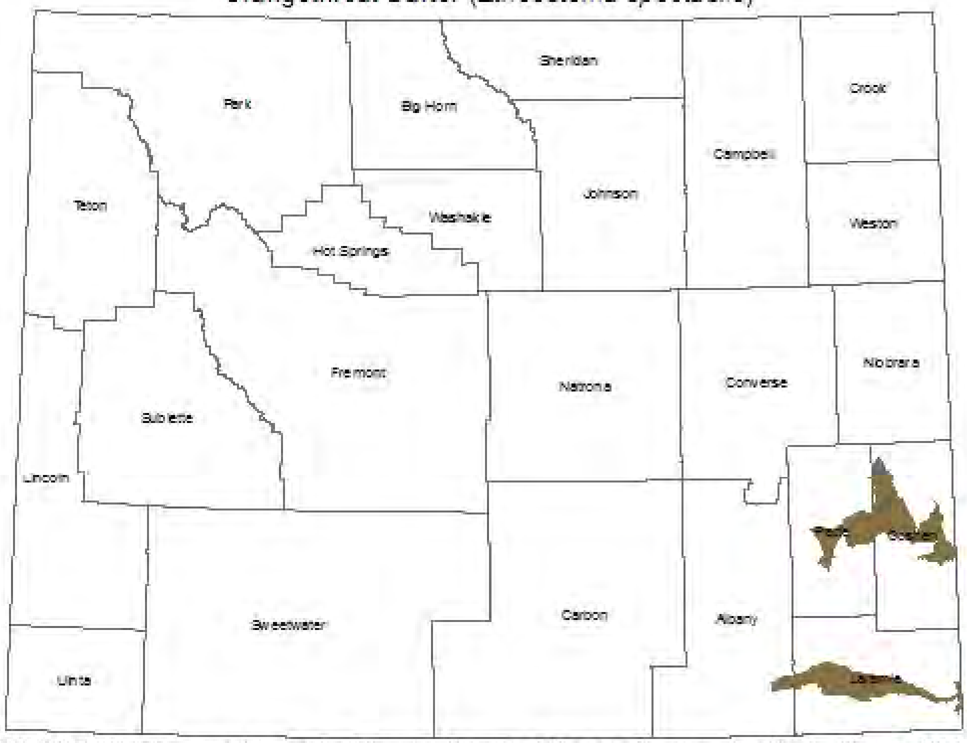
Orangethroat Darter (*Etheostoma spectabile*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Plains Minnow - Hybognathus placitus

Abundance: Rare

Status: NSS3 (Bb) NatureServe: G4 S3

Population Status: Some populations appear vulnerable where they occur in low abundance and are restricted from historical distribution. This species has been extirpated from the North Platte River basin and may also be gone from the Bighorn River basin. Other populations appear stable.

Limiting Factor: Habitat: impoundments in major river drainages reduced population size and distribution presumably through loss of stream connectivity, reduced turbidity, altered temperature regimes, and flow regulation.

Comment: NSS Ranks are reviewed and revised with each SWAP revision. No changes were made for this species in this revision.

Introduction

Historically, the distribution of the plains minnow was similar to the range of the western silvery minnow (Hybognathus argyritis), found in the Missouri River and middle Mississippi River drainages, but was more widespread in western tributaries of the Missouri river (Pflieger 1997). They are considered native to the Mississippi, Red, Arkansas, and Missouri River drainages and are found primarily from Montana and Wyoming east to Iowa (Weitzel 2002). In Wyoming, plains minnow have been reported in the Belle Fourche, Big Horn, Cheyenne, Little Missouri, and Powder river drainages (northeastern and northwestern Missouri aquatic habitats; Baxter and Stone 1995; Patton 1997; McGree et al. 2010). They are rare in some drainages, for example, McGree et al. (2010) caught two above Keyhole Reservoir, Patton (1997) found one above and one below Keyhole Reservoir, and Pindel (1997) reported one from near Devils Tower. Dooenbos also (1998) captured low numbers in South Dakota near the state line. No Hybognathus sp. were found in the Bighorn River basin during widespread surveys in 2005 (WGFD 2006, Wilhite 2007) and 2006-2007 (Bear 2009). The species has not been documented in the Bighorn River since surveys reported by Patton (1997) and may have been extirpated. Plains minnow have not been sampled in the North Platte River drainage for many years (Patton 1997; Bear and Barrineau 2007; Moan et al. 2010) and are presumed extirpated. Plains minnow are commonly associated with the western silvery minnow throughout their range, and although the two species look similar, plains minnow have a narrow and peg-like basioccipital process with a back margin that is nearly straight (Pflieger 1997). To ensure proper identification of field-collected Hybognathus specimens, subsets are positively identified to species by Colorado State University's Larval Fish Laboratory. Limited information exists about this species, but its diet is thought to include algae and other organic matter and spawning likely involves an extended breeding season and semibuoyant eggs that hatch in the current (Pflieger 1997; Platania and Altenbach 1998). Throughout its entire range, this species has undergone a large decline in abundance and distribution in recent decades (Pflieger 1997). In Wyoming, it is currently believed to be in decline (McGree et al. 2010). A better understanding of the habitat, life-history, and flow requirements of this species is needed to assess the impacts of water and land use activities.

Habitat

Plains minnow are often associated with large, turbid, prairie streams and rivers, slow water and side pool habitat (Baxter and Stone 1995). They are typically found in streams with sand or silt bottoms and some current (Pflieger 1997). The plains minnow is tolerant of high water temperature, high salinity and low oxygen (Ostrand and Wilde 2001), making them well adapted for survival in intermittent pools.

Problems

- Habitat degradation due to impoundments in major river drainages is likely contributing to declines in distribution and population size.
- Reductions in turbidity reduce the competitive advantage of this species, encouraging displacement by sight-feeding species that are predators or can more efficiently exploit resources.
- Nonnative species are present and may be expanding within drainages occupied by this species.
- Altered flow regimes, habitat fragmentation, and impacts to aquatic and riparian habitat associated with agricultural practices.

Conservation Actions

- Continue efforts to educate landowners and the public about the importance of native fish and their habitats, including the development of a prairie stream conservation brochure.

Monitoring / Research

Establish a routine monitoring program at select sites reported in Barrineau et al. (2007), Peterson et al. (2009), and McGree et al. (2010) to track the distribution and relative abundance of this species. If observed in the Bighorn River basin, voucher specimens should be collected.

Continue to identify and record observations while conducting fisheries management sampling.

Recent Developments

Prairie stream surveys were completed in 2004-2005 (Barrineau et al. 2007; Bear and Barrineau 2007) and 2008-2009 (McGree et al. 2010; Moan et al. 2010) to assess the distribution of this species in eastern Wyoming. Detailed spatially and temporally stratified surveys were also conducted from 2004 to 2006 at multiple sites on the mainstem Powder River in Wyoming and Montana (Peterson et al. 2009) and Crazy Woman Ceek in Wyoming (WGFD 2005, WGFD 2006, WGFD 2007).

Detailed fish and habitat surveys were also conducted at sites throughout the Bighorn River basin in 2006 and 2007 (Bear 2009). No plains minnow were found.

Completed construction of the Kendrick Diversion dam bypass channel on Clear Creek in 2010, a tributary to the Powder River, to allow fish passage for spawning migrations. A project to determine which species are utilizing the bypass channel was begun in 2011 and documented that Plains Minnow ascended the bypass channel and entered Clear Creek above Kendrick Dam (Bradshaw 2006).

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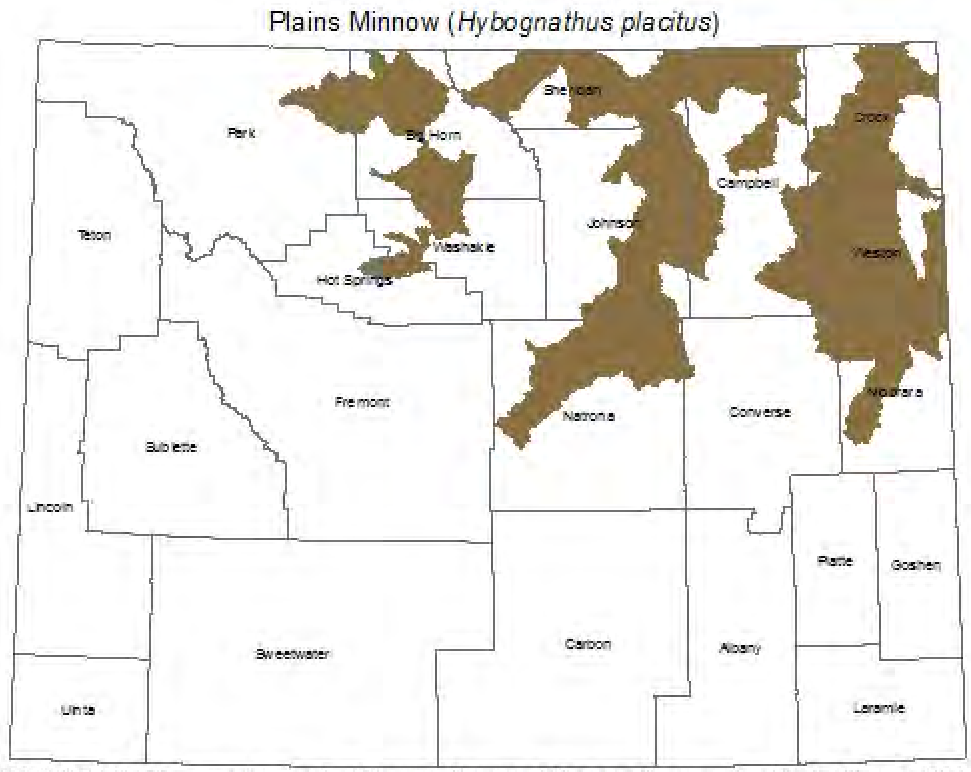

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Plains Topminnow - Fundulus sciadicus

Abundance: Rare

Status: NSS3 (Bb) NatureServe: G4 S3

Population Status: Vulnerable due to limited distribution in native range. Distribution may be declining in native range (North Platte and South Platte drainages).

Limiting Factor: Habitat: severe due to limited availability of preferred shallow, backwater habitats.

Comment: NSS Ranks are reviewed and revised with each SWAP revision. No changes were made for this species in this revision.

Introduction

The distribution of the plains topminnow ranges from South Dakota to Oklahoma and from eastern Wyoming to western Iowa in the streams within the Great Plains region (Baxter and Stone 1995; Rahel and Thel 2004). In Wyoming, they are found in the North Platte, South Platte, Niobrara, and Cheyenne river drainages, but are considered introduced to the Cheyenne drainage (Baxter and Stone 1995; Rahel and Thel 2004). Little is known about the feeding habits of plains topminnow, but insects are probably an important component of their diet (Pflieger 1997). Spawning occurs in late spring and early summer, and eggs are deposited on aquatic plants or algae (Pflieger 1997). They may reproduce in the same areas of aquatic vegetation that they occupy throughout the year (Rahel and Thel 2004). Little is known about the life history of plains topminnow.

Habitat

The plains topminnow prefers shallow, slow water in clear streams with heavy vegetation (Rahel and Thel 2004) and sand or gravel substrate (Baxter and Stone 1995). They have also been collected in vegetation-filled sloughs and backwaters (Baxter and Stone 1995).

Problems

- Introductions of western mosquitofish (Gambusia affinis) have been implicated in the current restricted distribution of plains topminnow in Nebraska and may be affecting populations in Wyoming (Rahel and Thel 2004).
- The plains topminnow occupies habitats that are impacted by natural and anthropogenic dewatering.
- Altered flow regimes, habitat fragmentation, and impacts to aquatic and riparian habitat associated with agricultural practices.

Conservation Actions

- Continue efforts to maintain flows and connectivity.
- Continue efforts to educate landowners and the public about the importance of native fish and their habitats.

Monitoring/Research

Continue to identify and record observations while conducting fisheries management sampling.

Recent Developments

Prairie stream surveys were completed in 2004-2005 (Barrineau et al. 2007; Bear and Barrineau 2007) and 2008-2009 (McGree et al. 2010; Moan et al. 2010) to assess the distribution of this species in eastern Wyoming and to determine potential conservation actions.

The Laramie Region Fish Mangement Crew conducted surveys in 2012 at two sites (Interstate 25 Exit 70 Bordeaux Road Crossing and at Interstate 25 Exit 68) on Antelope Creek in Platte County. Twenty-four plains topminnow were captured at the Bordeaux site and but were not collected at the Exit 68 site. Plains topminnow were considered locally common and good habitat conditions were observed.

The Laramie Region Fish Management Crew sampled Lodegpole Creek upstream of Wyoming State Highway 213 in 2011 and 2012 for approximately nine miles. In 2011, plains topminnow were found at 9 of 16 sampling sites (Wyoming Game and Fish Department 2011). In 2012, surveys were conducted upstream of the 2011 surveys and were found at 7 of 9 sites (Wyoming Game and Fish Department 2012). Plains topminnow were considered locally rare within this segment, but when good habitat was observed, plains topminnow were found.

Intensive surveys were completed on Horse Creek, Lodgepole Creek, Laramie River, and Niobrara River in 2015 (Compton and Hogberg: In Draft). Plains topminnow were found at 9 of 40 sites on Horse Creek, 11 of 22 sites on Lodgepole Creek, 9 of 29 sites on the Laramie River, and at 3 of 8 sites on the Niobrara River. Like 2011 and 2012 surveys, when favorable habitat was observed, plains topminnow were found.

Western mosquitofish were collected at three sites on Horse Creek in 2015. This is the first time they have been docuemented in the North Platte drainage of Wyoming.

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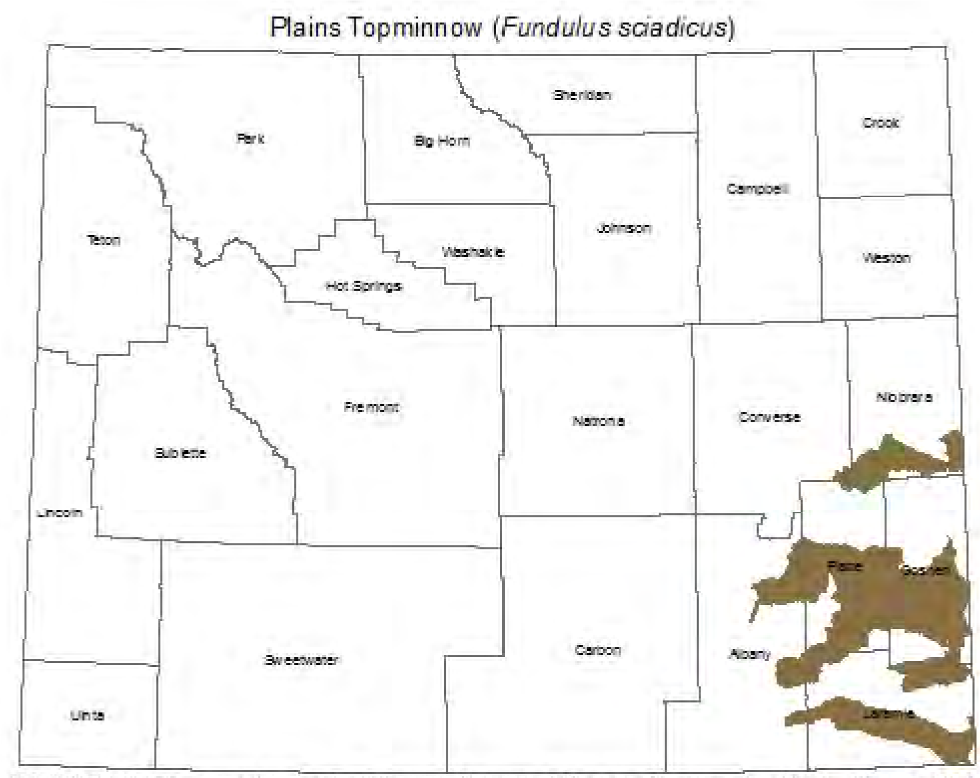

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Roundtail Chub - Gila robusta

Abundance: Rare

Status: NSS1 (Aa) NatureServe: G3 S3

Population Status: Greatly restricted in numbers and distribution and extirpation is possible.

Limiting Factor: The biggest limiting factor for roundtail chub is invasive species. This threat has significant impacts through competition and predation. The threat of invasive species is growing with introductions of new species and the expansion of existing species. This is particularly true of predatory fish. Population of roundtails in Wyoming are imperiled due to limited distribution and declines in numbers.

Comment: NSS Ranks are reviewed and revised with each SWAP revision. No changes were made for this species in this revision.

Introduction

Roundtail chub, along with flannelmouth sucker Catostomus latipinnis, and bluehead sucker C. discobolus are all relatively large-bodied species native to the Colorado River drainage. These three imperiled fish are collectively called "the three species" and their conservation has been a cooperative effort spanning state lines (Utah Department of Natural Resources 2006, updated in 2011). Once common throughout the drainage, roundtail chub currently occupy approximately 45% of their historic range in the Colorado River Basin (Baxter and Stone 1995; Bezzerides and Bestgen 2002). They still occur in relatively low numbers throughout the Green River drainage of Wyoming, with lentic populations in the Finger Lakes of the New Fork Drainage (Baxter and Stone 1995; Gelwicks et al. 2009). Roundtail chubs are omnivorous. Larvae feed on diatoms and filamentous algae (Neve 1967). Juveniles feed on aquatic insects, crustaceans, and algae. (Bestgen 1985). Adults consume these food items as well as terrestrial gastropods, insects, and reptiles (Rinne 1992). Laske et al. (2011) showed that lentic populations consumed terrestrial and aquatic insects, vegetation, and fish. Spawning takes place in the spring and early summer during the falling limb of the snowmelt runoff hydrograph (Brouder 2001, Laske et al. 2011). During this time, the adhesive, demersal eggs are deposited over gravel in deep pools and runs (Neve 1967). Movements have been observed to coincide with the spawning season (Bestgen et al. 1987; Beatty 2005; Compton 2007).

Habitat

Roundtail chub are most commonly found in pool-riffle habitats of Colorado River Basin rivers and streams (Bezzerides and Bestgen 2002). Adults are associated with low current velocities, deep pools, undercut banks, woody debris, and boulders (Bestgen 1985; Bestgen and Propst 1989). Populations are also found in several lakes in the Upper Green River drainage in Wyoming (Laske 2010)

Problems

h The effects of water development and reservoir construction exacerbated by drought have cut off this species' migratory corridors, degraded its habitat, and encouraged the spread of nonnatives.

h Habitat degradation (e.g., dewatering, loss of connectivity) and introduced species pose the most serious threats to this species' persistence.

Conservation Actions

- Continue as a signatory to the "Rangewide Conservation Agreement for Roundtail Chub, Bluehead Sucker and Flannelmouth Sucker" (Colorado River Fish and Wildlife Council 2004).
- Continue efforts to maintain flows and connectivity.
- Develop methods for holding and spawning in captivity.
- Continue to educate landowners and the public about the importance of maintaining habitat for native fish
- Evaluate the potential for restoring populations within suitable portions of historic range that are currently uninhabited or where competing species can be removed.
- Continue efforts to remove competing and hybridizing nonnative species to secure, enhance and restore populations.
- Continue to partner with other agencies and conservation organizations (e.g., BLM, Little Snake River Conservation District, and Trout Unlimited) to address conservation needs for this species.
- Use transplants as a means of establishing new lentic populations that are free from predatory threats.
- Chemically treat Muddy Creek to remove nonnative species.

Monitoring / Research

Continue regular monitoring of drainages containing the three species to track population trends and the abundance and ranges of nonnative species.

Conduct monitoring before and after chemical treatments and transplants to determine the success of removal/transplant efforts.

Continue to identify and record observations while conducting fisheries management sampling.

Recent Developments

The Wyoming Game and Fish Department is a signatory to the "Rangewide Conservation Agreement and Strategy for Roundtail Chub Gila robusta, Bluehead Sucker Catostomus discobolus, and Flannelmouth Sucker Catostomus latipinnis" (Utah Department of Natural Resources 2006). Most other wildlife and land management agencies within the native range of roundtail chub have also signed this agreement.

A survey from 2002-2006 of the three species throughout the Green River drainage in Wyoming has been completed and summarized in a report (Gelwicks et al. 2009). Surveys indicate that the most imminent threat to the persistence of roundtail chubs is habitat degradation, mainly due to water development.

Genetics analyses reveal that Wyoming populations contain unique haplotypes not found in downstream populations (Douglas and Douglas 2008).

Three graduate studies were completed describing roundtail chub populations, habitat, and/or movement in Muddy Creek (Bower 2005; Beatty 2005; Compton 2007).

Long-term (Cavalli 2006) and short-term (Senecal et al. 2010) management plans for Wyoming's three species have been completed.

The first transplants to establish roundtail chub populations in lakes where lake trout and brown trout are absent was conducted (WGFD 2010). Transplanted fish have survived, but no evidence of reproduction has been documented (Wyoming Game and Fish Department 2015).

A University of Wyoming graduate, Sara Laske, completed a MS thesis describing habitat use and diets of roundtail chub, brown trout, and lake trout in Halfmoon and Little Halfmoon lakes (Laske 2010).

A Colorado State University graduate study was done to determine the jumping and swimming abilities of burbot and white sucker in order to design effective barriers to prevent their spread in the Green River drainage of Wyoming (Gardunio 2014).

Work to restore native species including roundtail chub, through the removal of nonnatives, in the Muddy Creek drainage continues.

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Roundtail Chub (*Gila robusta*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Sauger - Sander canadensis

Abundance: Common within a limited range

Status: NSS3 (Bb) NatureServe: G5 N5B,N5N

Population Status: Population distribution is reduced from historical. Population size is variable with populations in some locales declining (Wind River) while others are stable or increasing (Bighorn River in recent years).

Limiting Factor: Habitat: significant loss of habitat and population connectivity due to water development and diversion. Genetic purity of some Wyoming stocks may be at risk due to coexistence with non-native walleye. Competition with introduced non-native fish and angler exploitation may adversely affect populations in some locales.

Comment: NSS Ranks are reviewed and revised with each SWAP revision. No changes were made for this species in this revision.

Introduction

Sauger populations have declined across a large part of the Missouri River drainage (McMahon and Gardner 2001; Caruful 1963; Nelson and Walburg 1977; Hesse 1994). In Wyoming, saugers are native in the North Platte, Powder, Tongue, and Bighorn-Wind rivers (Baxter and Stone 1995). Sauger distribution in Wyoming has decreased including extirpation from the North Platte River. The Powder River provides seasonal sauger habitat for fish migrating from the Yellowstone River to spawn (Hubert 1993). A small population of unknown purity exists in the Tongue River. The Bighorn and Wind Rivers each contain populations that were once continuous with one another and those downstream; however, the construction of Boysen and Yellowtail Dams isolated the two. The Bighorn River population was considered to be genetically pure until hybridization with walleye was documented in 2014. The Wind River population is among the last genetically pure sauger populations in the Missouri River drainage (Billington et al. 2006; Bingham et al. 2011). The Bighorn and Wind river populations are currently considered the only viable populations within Wyoming and have high conservation value. Genetic analyses indicate that Bighorn and Wind river sauger are genetically unique from other sauger populations in Montana, and Wind River sauger and Big Horn River sauger are different from one another (Bingham et al. 2011). Sauger from Bighorn and Wind river populations have some of the slowest growth rates throughout the range of the species (Gerrity and Smith 2013). The Wind River population also contains the longest-lived fish (up to age-18) and occupies the highest elevation of any population throughout the species' range (Amadio et al. 2005; Wyoming Game and Fish Department 2016). Spawning occurs in the spring, generally May in Wyoming, and is typically associated with migration of adults to a spawning location (Welker et al. 2001; Kuhn 2005; WGFD 2012 - 2015). Spawning migration distances of up to 235 miles have been observed where barriers to movement do not exist (Collete et al. 1977). Spawning migrations can occur in upstream and downstream directions (Collete et al. 1977; Pegg et al. 1997; Kuhn 2005; Jaeger et al. 2005; Bellgraph et al. 2008).

Habitat

Sauger have evolved and thrive in free-flowing, turbid river systems and their preferred habitat is deep, low-velocity pools and runs in large, turbid rivers (Hesse 1994; Welker et al. 2002; Amadio et al. 2005, 2006; Kuhn 2005). Sauger also live in reservoirs or systems that contain a combination of large river and reservoir habitat. In rivers the key component of sauger habitat is velocity and depth. In summer and spring they select low velocity areas with fine substrates. Pool habitats are preferred by sauger especially in winter where they tend to select low velocity pools greater than 6 feet deep (Welker et al. 2002; Jaeger et al. 2005; Kuhn 2005). Sauger prefer lower light conditions and may seek turbid areas for cover. Four major spawning aggregations, three in the Little Wind River and one in the Popo Agie River population have been documented in the Wind River population (Kuhn 2005; WGFD 2012 – 2015). Tagged saugers from all four rivers within the Wind River population have been documented spawning at these four aggregations. Spawning occurs over gravel and cobble in 52-59°F water in the Bighorn River and over sand substrate in the Wind River drainage (Roberts et al. 2003; WGFD 2012, 2016). Reservoirs fragment native sauger habitat but also provide abundant deep, low velocity, prey rich habitat that sauger prefer. Additionally, Boysen Reservoir (particularly Poison Creek Bay) and the Wind River upstream from the reservoir provide nursery habitat for juvenile saugers (Lionberger 2006).

Problems

- Infrastructure that creates physical barriers or changes water quality by making water cooler and less turbid can negatively affect the distribution, abundance, recruitment, growth, and survival of the species.
- Lack of connectivity resulting from low flows or other physical barriers (natural and man made) may significantly limit access to upstream habitats.
- Genetic purity of Wyoming sauger stocks may be at risk due to coexistence with non-native walleye.
- Predation by introduced picivores (especially in reservoirs) may limit recruitment.
- Stocking of walleye in Big Horn Lake by the State of Montana poses a risk to the genetic purity of the Bighorn River population.
- Flow alteration from cumulative irrigation withdrawls has altered the physical habitat in the Wind River below Diversion Dam, negatively impacting sauger habitat by reducing side-channel habitat, reducing woody debris recruitment, and altering sediment regimes.
- Habitat degradation (e.g., dewatering, loss of connectivity) and introduced species pose the most serious threats to this species' persistence.
- Habitat degradation due to impoundments in major river drainages is likely contributing to declines in distribution and population size.
- Entrainment of sauger in water diversion structures may impact populations (Jaeger et al. 2005)

Conservation Actions

- A collaborative process is needed to develop a management plan for saugers in the Wind River watershed.
- Continue efforts to reduce land and water uses which exacerbate stream channel drying.
- Conduct wild egg takes and stock progeny as needed to supplement natural reproduction
- Continue to collaborate with Shoshone and Arapaho tribes and the USFWS to gain better understanding of factors influencing native fish populations within the Wind River drainage.
- A better understanding of juvenile habitat requirements is needed.
- Management actions that favor the production of walleye or other exotic piscivores would be contrary to the best interests of native sauger populations.
- A better understanding of the habitat and flow requirements of this species is needed to assess the impacts of water and land use activities.
- A more robust evaluation of the extent of walleye/sauger hybridization need to be conducted in the Bighorn River/Big Horn Lake system
- Entrainment in canals needs evaluation

Monitoring / Research

Continue established trend monitoring programs for Bighorn, Little Wind and Popo Agie rivers, as well as Boysen Reservoir and Big Horn Lake.

Create new monitoring programs and research habitat types used and available for juvenile saugers in the Bighorn and Wind river populations

Research the types of habitat used by juveniles and their availbility in Big Horn Lake, Boysen Reservoir, and the Wind RIver upstream from Boysen Reservoir.

Use stable isotopes and genetics to determine if saugers stocked during the 2013 - 2017 Wind River drainage spawning operations are surviving and reproducing.

Continue tagging saugers within the Bighorn and Wind river populations to obtain mortality estimates and learn more about migration tendencies

Work with Colorado State University to determine the effects of water temperature on the early life history of sauger

Monitor larval sauger in the Bighorn River in an effort to identify factors driving recruitment variability

Conduct study of sauger population in the Tongue River above Tongue River Reservoir to determine genetic purity and population viability

Recent Developments

Since the initiation of sauger research in the Wind River watershed by graduate students at the University of Wyoming, several major questions have been answered concerning sauger ecology. Sauger distributions and habitat associations (Amadio 2003; Amadio etal. 2005 and 2006), seasonal movements and spawning locations (Kuhn 2005), and nursery areas and movement of saugers in the Wind River watershed (Lionberger 2006) have been identified.

An annual monitoring program has been established within the core area of the Wind River drainage sauger population.

In 2006 the statewide creel limit for sauger was reduced from six fish to two fish.

The WGFD contracted with Montana Fish, Wildlife and Parks to conduct microsatellite genetic analysis of sauger from Boysen Reservoir and the Wind River upstream. Analyses determined that Bighorn and Wind river sauger are genetically unique from other sauger populations in Montana, and Wind River sauger and Big Horn River sauger are different from one another. Analyses also determined that genetic diversity (i.e., heterozygosity and allelic richness) are adequate in both populations.

Completed construction of the Kendrick Diversion dam bypass channel on Clear Creek, a tributary to the Powder River, to allow fish passage for spawning migrations. A project to determine which species are utilizing the bypass channel will be intiated in 2011.

An age and growth study revealed that Wind River drainage sauger are the slowest growing and longest lived throughout the range of the species (Gerrity and Smith 2013)

Wild egg takes were conducted and the resulting progeny were stocked in the Wind river population tos supplement low natural recruitment from 2013 - 2017.

Research at the University of Wyoming determined that endocrine disrupting compounds were not the cause of low natural reproduction in the Wind River population (Johnson 2014).

Montana terminated diploid walleye stocking in Big Horn Lake in 2008 to reduce the hybridization potential between walleye and sauger in the Bighorn River. To maintain angling opportunity, sauger from wild egg takes in the Bighorn River were stocked from 2011 – 2014, and triploid walleye stocking began in 2015

Sauger hybridization with walleye in the Bighorn population was documented for the first time in 2014.

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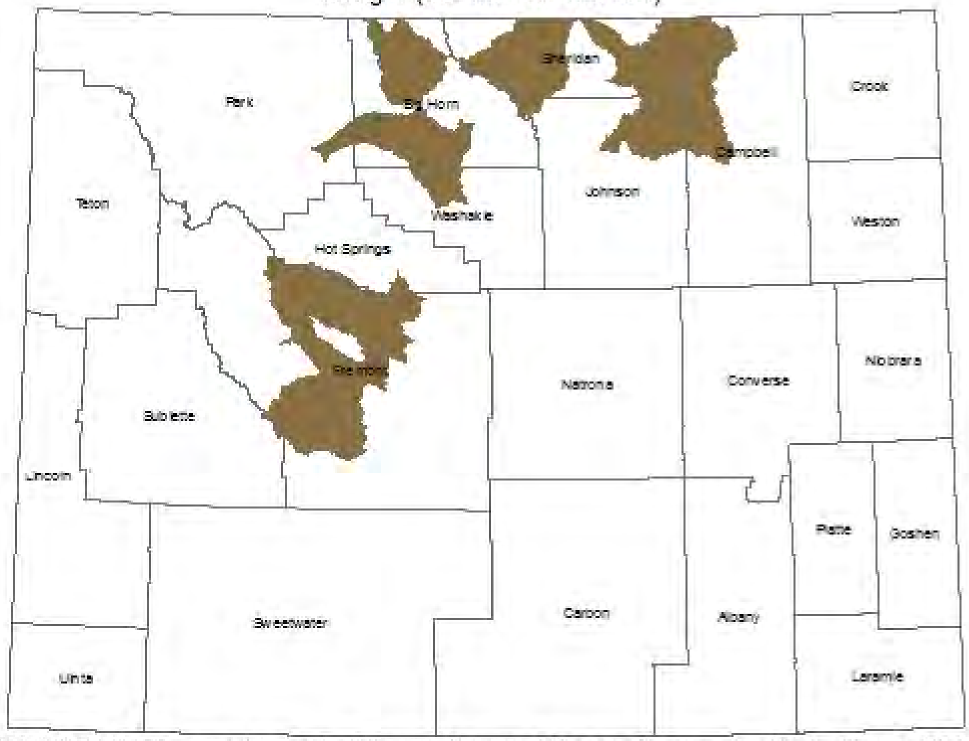
Sauger (*Sander canadensis*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Shovelnose Sturgeon - Scaphirhynchus platorynchus

Abundance: Rare

Status: NSS3 (Bb) NatureServe: G4 S1

Population Status: Extirpated from the North Platte River and Bighorn River drainages. Native populations restricted to the Powder River. Re-introduced to the Bighorn River.

Limiting Factor: Habitat: Physical barriers caused by the construction of major dams and irrigation diversions on main stem rivers are most likely responsible for the extirpation of this species from major drainages in Wyoming. Impoundments block access to spawning habitats, fragment populations, alter temperature and flow regimes, and alter physical and chemical queues that are critical to maintaining the timing of life cycles.

Comment: NSS Ranks are reviewed and revised with each SWAP revision. No changes were made for this species in this revision.

Introduction

Although relatively widespread in the Missouri River drainage, this fish is rare in Wyoming. Prior to 1900, shovelnose sturgeon were found in the large rivers of Wyoming's North Platte, Powder and Bighorn River basins (Evermann and Cox 1896). Recent sampling efforts document their presence in the latter two (WGFD 2006; WGFD 2009). This species was initially reintroduced to the Bighorn River and its tributaries in 1996, and regular stocking continues (WGFD Fish Stock database). The diet consists primarily of bottom-dwelling invertebrates as well as some minnows, fish eggs, and vegetation (Baxter and Simon 1970). Shovelnose sturgeon are typically sampled from the mainstem of the Powder River and its major tributaries between the Montana border and Interstate 90 only from mid-May through late June, during what is presumed to be their spawning migration (WGFD 1991; 1998; 2006). Shovelnose sturgeon are regularly sampled in the mainstem of the Bighorn River from the confluence of the Nowood River downstream to Big Horn Lake (WGFD 2015, 2016). While spawning has never been observed, multiple instances of ripe males and females have been documented in the Powder River and Crazy Woman Creek (Smith and Hubert 1989) and in the Bighorn River (WGFD 2016). Shovelnose sturgeon may live up to 40 years (Brown 1971).

Habitat

Shovelnose sturgeon prefer habitat at or near the bottom of large, unregulated, turbid rivers with relatively warm water that is essentially free of chemical contaminants. Flowing water over sand or fine gravel substrates is preferred. Given its migratory tendencies, unregulated flows and the absence of fish barriers that allow unrestricted access to very long segments of rivers are critical to the completion of the sturgeon's lifecycle (Baxter and Stone 1970; Pflieger 1997).

Problems

- Infrastructure that creates physical barriers or changes water quality by making water cooler and less turbid can negatively affect the distribution, abundance, recruitment, growth, and survival of the species.
- Lack of connectivity resulting from low flows or other physical barriers (natural and man made) may significantly limit access to upstream habitats.
- There are no published reports that indicate fish passage features can be built into dams to allow shovelnose sturgeon to move up and downstream past the dam due to the fish's inability to move very high off the river bottom or jump.

Conservation Actions

- Use radio telemetry to identify spawning sites and seasonal habitat use of shovelnose sturgeon in the Bighorn and Nowood rivers. Determine if natural recruitment is occurring in the Bighorn River system by modeling embryo development rates and drift distances. Validate model results with larval drift surveys.
- Revaluate annual stocking of fry and fingerling shovelnose sturgeon in the Bighorn River based upon the presence or absence of natural recruitment in the system. If successful recruitment is documented, discontinue regular stocking efforts.

Monitoring/Research

Monitor use of the Kendrick Diversion dam bypass channel on Clear Creek, a tributary to the Powder River, by large-bodied, migratory fishes.

Continue periodic monitoring of the shovelnose sturgeon population that spawns in the lower reaches of Crazy Woman Creek and the Powder River below the confluence of this tributary.

Continue and expand upon surveys to determine recruitment, growth, and survival of stocked shovelnose sturgeon in the lower Bighorn River mainstem and tributaries.

Use radio telemetry to determine seasonal distribution and habitat use in the Bighorn River system. Use these data to develop an annual monitoring protocol.

Continue and expand upon larval drift sampling to document presence or absence of natural recruitment.

Recent Developments

A radio telemetry project was initiated in 2015 to identify spawning sites and determine seasonal habitat use of adult shovelnose sturgeon in the Bighorn River system. The goal of this project is to determine if there is an adequate length of fluvial habitat between the spawning sites and the reservoir to allow for natural recruitment to occur (see Braaten et al. 2008 and Guy et al. 2015). Data needed to model embryo drift and larval settlement of shovelnose sturgeon in the Bighorn River (water temperature and river velocities) began in 2015 and will be expanded upon in 2016 and 2017.

Completed construction of the Kendrick Diversion dam bypass channel on Clear Creek, a tributary to the Powder River, to allow fish passage for spawning migrations. A project to determine which species are utilizing the bypass channel was initiated in 2011. No shovelnose sturgeon were documented using the Kendrick bypass channel during annual surveys in 2011 - 2014 (WGFD 2015).

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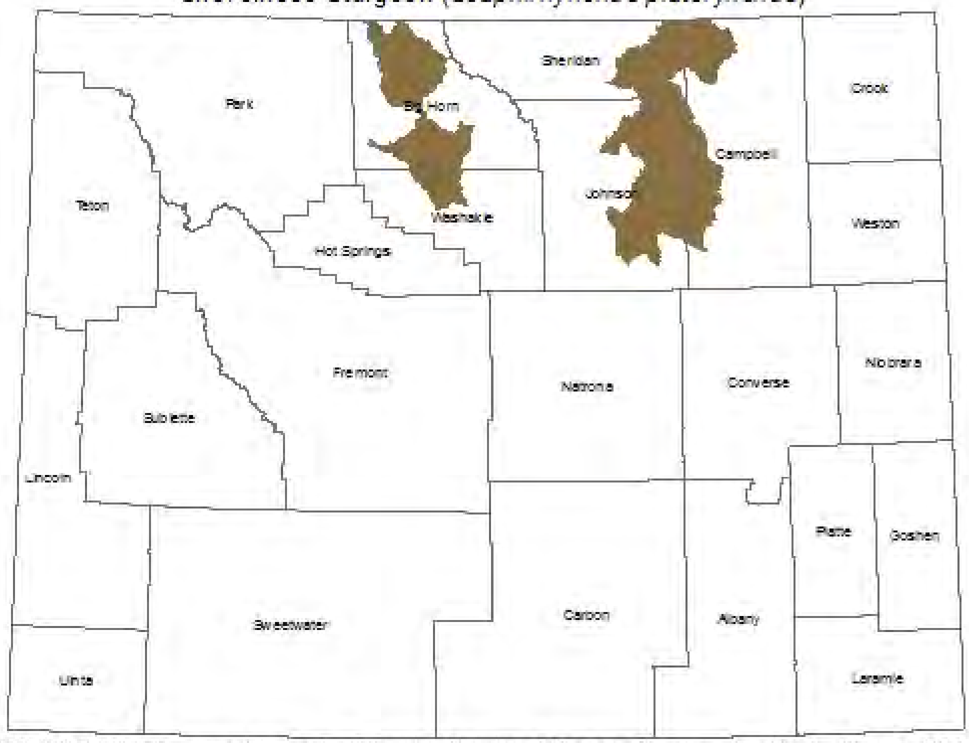
Shovelnose Sturgeon (*Scaphirhynchus platorynchus*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Snake River Cutthroat Trout - Oncorhynchus clarkii

Abundance: Common within a limited range

Status: NSS3 (Bb) NatureServe: G4T1T2Q S1

Population Status: Populations are vulerable and widely distributed throughout its limited historic range within the Snake River drainage of Wyoming.

Limiting Factor: Habitat: Limiting factors are severe, but are not increasing significantly. Habitats in the Snake River have been impacted by flow regulation, channel stabilization, and floodplain modifications. Other large river habitats are impacted by agriculture and suburban development.

Comment: Change from NSS4 (Cb) to NSS3 (Bb) in 2017. Rationale for change is an attempt to provide a consistent classification for conservation efforts towards Snake River and Yellowstone cutthroat trout.

Introduction

Snake River Cutthroat Trout are native to the upper Snake River above Palisades Reservoir (Baxter and Stone 1995). They have been introduced into other drainages as a sport fish. Snake River Cutthroat Trout are typically distinguished from other Cutthroat Trout in Wyoming by their profuse and very fine spotting (Baxter and Stone 1995, Behnke 1992). Their diet consists of insects and other fish (Kiefling 1978). Spawning generally begins in late March and continues until early July.

See the Snake/Salt River Basin aquatic basin chapter in the current SWAP for more information relative to this fish.

Habitat

Snake River Cutthroat Trout are found in larger rivers but also occur in reservoirs, lakes, and small streams (Baxter and Stone 1995, Kiefling 1978). They prefer areas with good overhead or instream cover (Kiefling 1978). Snake River Cutthroat Trout typically use smaller tributary streams or spring creeks for spawning (Hayden 1967, Kiefling 1978).

Problems

- Habitat alterations are believed to be responsible for declines of Snake River cutthroat trout. Habitat alterations include manipulation of the hydrograph due to Jackson Lake Dam, altering available habitats in summer and winter, loss of connectivity due to the construction of Jackson Lake Dam, dewatered reaches caused by irrigation diversions, and impassable irrigation diversions, construction of an extensive levee system along the Snake River that has altered aquatic habitat between the levees and prevented flushing flows to adjoining spring creek systems, and land use practices in certain watersheds may increase bank erosion and siltation.
- Competition and hybridization with nonnative trout are impacting some populations.
- Altered flow regimes, habitat fragmentation, and impacts to aquatic and riparian habitat associated with agricultural practices.

Conservation Actions

- Continue efforts to maintain flows and connectivity.
- Continue to educate landowners and the public about the importance of maintaining habitat for native fish
- Continue efforts to restore populations within native ranges where opportunities to remove competing or hybridizing species exist

Monitoring/Research

Population estimates are conducted annually on the Snake, Gros Ventre, Hoback, and Salt rivers. Populations will continue to be monitored during routine sampling of other waters.

Recent Developments

In 1998, YSC were petitioned for listing as a threatened species under the Endangered Species Act. The petition was rejected in February 2001, but in December 2004, U.S. District Court for the District of Colorado ruled that the U.S. Fish and Wildlife Service (FWS) illegally rejected the petition. The FWS conducted a 12-month status review of the species and found listing unwarranted. After the FWS decision was announced, proponents for listing filed an Intent to Appeal Brief within 60 days of the decision but have completed no further actions since.

A second iteration of the range-wide assessment was completed in 2006 (May et al. 2007), delineating distribution, abundance, barrier locations, genetic purity, and natural and anthropogenic factors potentially impacting Cutthroat Trout populations and distribution.

New rangewide Conservation Agreement and Conservation Strategy were completed (YCT Range-wide Conservation Team 2009).

In 2010, an irrigation dam was removed from Spread Creek, connecting over 70 miles of additional habitat.

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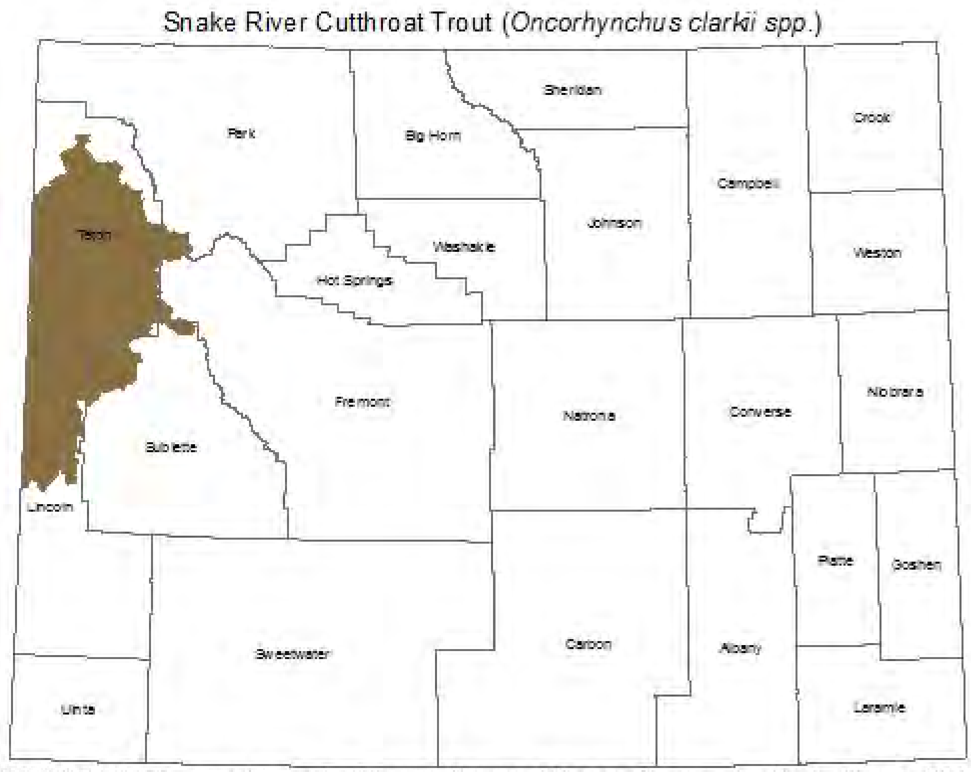

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Sturgeon Chub - Hybopsis gelida

Abundance: Extremely rare

Status: NSS2 (Ab) NatureServe: G3 S1

Population Status: Extirpated from the North Platte River drainage. The species exists in relatively low numbers in the Powder River drainage and is nearly extinct in the Bighorn River drainage.

Limiting Factor: Habitat: Habitat is limited for this species in Wyoming.

Comment: Changed from NSS1(Aa) to NSS2 (Ab) in 2017 due to a resurgence in the Powder River population following high water in 2011. Limiting factor in the Powder appears to be discharge and may not as extreme as previously believed. NSS Ranks are reviewed and revised with each SWAP revision.

Introduction

The historic range of the sturgeon chub extended throughout the Missouri and Lower Mississippi River drainages from Montana to Louisiana (Cross et al. 1986). In Wyoming this species once occupied the Bighorn, North Platte, and Powder River basins (Baxter and Stone 1995). Currently, sturgeon chub are primarily restricted to the Yellowstone and Powder rivers of Montana and Wyoming. Sturgeon chub are well-adapted to unregulated, mainstem turbid river systems. Sensory organs such as taste buds on their fins and barbels, enable sturgeon chub to locate aquatic insects (Stewart 1981). Although the details are unknown, sturgeon chub likely spawn over gravels, and once emerged, the larvae are free-floating (Werdon 1993).

Habitat

Sturgeon chub are obligates of free flowing, turbid, rivers. They are largely mainstem dwellers and are rarely found in tributary streams (Weitzel 2002). Sturgeon chub are usually associated with hard substrates and relatively shallow, high current velocity habitats (Baxter and Simon 1970; Lee et al. 1980; Stewart 1981). However, Lee et al. (1980) and Weitzel (2002) note sturgeon chub occurrences over sandy substrate, and Senecal (2009) sampled them from relatively deep and slow pool and run habitat with predominantly sandy substrates.

Problems

- Habitat degradation (e.g., dewatering, loss of connectivity) and introduced species pose the most serious threats to this species' persistence.
- Habitat degradation due to impoundments in major river drainages is likely contributing to declines in distribution and population size.

Conservation Actions

- Continue efforts to educate landowners and the public about the importance of native fish and their habitats.
- Continue efforts to prevent the colonization and spread of nonnative fishes throughout the Powder River basin through the maintenance of natural flow processes.

Monitoring/Research

Conduct regular sampling at established Powder River sites to monitor presence/absence of sturgeon chub and associated species, such as goldeye.

Continue to identify and record observations while conducting fisheries management sampling.

Recent Developments

Sampling from 2004-2007 indicated that sturgeon chub are present in the Powder River at extremely low densities. This species comprised less than 1% of the total fish assemblage (Peterson et al. 2009; Senecal 2009). Following the historically high water year in 2011, Game and Fish has found sturgeon chub in most of the established Powder River sites including as far upstream as near Kaycee. It now appears if there is high water, we will see more sturgeon chub in Wyoming.

Completed construction of the Kendrick Diversion dam bypass channel on Clear Creek, a tributary to the Powder River, to allow fish passage for spawning migrations. A project to determine which species are utilizing the bypass channel will be intiated in 2011.

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Sturgeon Chub (*Macrhybopsis gelida*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Suckermouth Minnow - *Phenacobius mirabilis*

Abundance: Extremely rare

Status: NSS2 (Ab) NatureServe: G5 S2

Population Status: Imperiled because of greatly restricted distribution. Found only in Horse Creek drainage.

Limiting Factor: Habitat: severe due to very limited habitat in Wyoming.

Comment: NSS Ranks are reviewed and revised with each SWAP revision. No changes were made for this species in this revision.

Introduction

Suckermouth minnow are distributed throughout the Mississippi River Basin from Ohio to Wyoming, with isolated populations also present in the Gulf Coast drainage. In Wyoming they are historically present in the North Platte River drainage and two tributaries, Horse Creek and the Lower Laramie River. Recent surveys found populations in Horse Creek (Patton, 1997; Bear and Barrineau 2007; Moan et al. 2010) and one suckermouth minnow each in the Lower Laramie River and North Platte River (White et al. 2002).

Suckermouth minnow remain near the bottom of streams, digging in the substrate with their snout and lips for food. Their diet generally consists of aquatic insects (Pflieger 1997). Suckermouth minnow have been found to spawn from April to August, in temperatures ranging from 57 °F to 77 °F (Bestgen and Compton 2007). Spawning activity occurs over gravel or cobble substrates, where eggs can be deposited in the interstitial spaces for protection. Females may hold 200 – 500 eggs, but deposit few eggs (1 to 5) per spawning event (Bestgen and Compton 2007).

In Wyoming, they are associated with brassy minnow, bigmouth shiner, creek chub, common carp, common shiner, emerald shiner, fathead minnow, northern plains killifish, plains topminnow, red shiner, sand shiner, and white sucker (Moan et al. 2010).

Habitat

Suckermouth minnow are usually found in the riffles of warm streams, with gravel or sand substrates. They are said to avoid intermittent streams and streams that are continuously cooled by springs (Pflieger 1997). In Wyoming, suckermouth minnow were found in areas with fine gravel, limited aquatic vegetation, mean thalweg depths greater than 0.75 ft, and water temperatures ranging from 46 °F to 81 °F in October and June, respectively (Moan et al. 2010).

Problems

- Limited numbers and restricted populations, making them susceptible to extirpation from disease and habitat alterations.

Conservation Actions

- Review literature and other published documents to gain an understanding of the historical suckermouth minnow distribution in the Lower Laramie and the potential of re-establishing a population.
- Investigate suckermouth minnow behavior and habitat utilization within Wyoming. This could include an investigation of the impacts of diversion flows in Horse Creek on suckermouth minnow preferred habitat
- Continue efforts to educate landowners and the public about the importance of native fish and their habitats, including the development of a prairie stream conservation brochure.

Monitoring/Research

Conduct routine monitoring at sites that have been occupied by suckermouth minnow in the past. Monitoring sites should include the Fort Laramie National Park and replicate sites from White (2002) where suckermouth minnow were collected.

Recent Developments

Detailed fish and habitat surveys were conducted in tributaries to the North Platte River between 2005 and 2009 to establish a baseline for future trend analysis in the North Platte River drainage (Bear and Barrineau 2007; Moan 2010). Greater numbers of suckermouth minnows were found in 2009 sampling than in 2005. Additional surveys in 2015 found juvenile and adult suckermouth minnow at multiple locations in lower Horse Creek, but non were found in the lower Laramie River (Nick Hogberg and Bobby Compton, WGFD, unpublished data).

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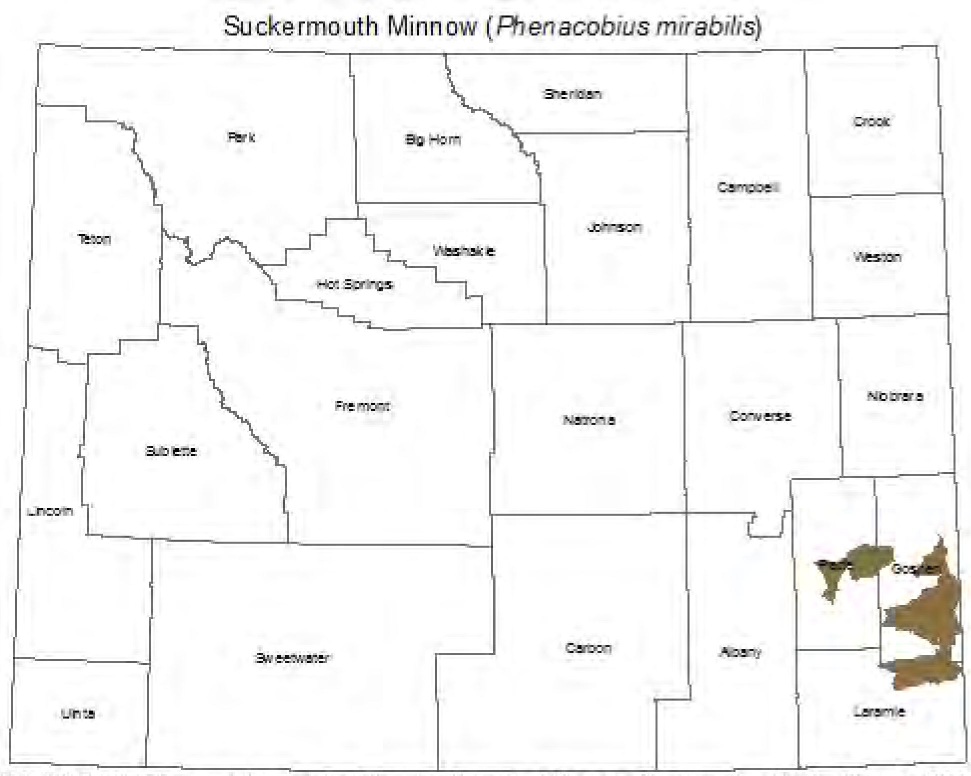

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Western Silvery Minnow - Hybognathus argyritis

Abundance: Rare

Status: NSS2 (Ab) NatureServe: G4 SX

Population Status: This species has been extirpated from major drainages and occurs in very low abundance in a few others. Populations appear to have declined significantly, but reasons for declines are not known.

Limiting Factor: Habitat: impoundments are most likely responsible for the extirpation of this species from major drainages. Impoundments block migrations, fragment populations, alter temperature and flow regimes, and disrupt life-cycles.

Comment: NSS Ranks are reviewed and revised with each SWAP revision. No changes were made for this species in this revision.

Introduction

The historical distribution of the Western Silvery Minnow primarily encompassed the Missouri and middle Mississippi rivers and the lower reaches of tributaries to the Missouri River (Pflieger 1997). Within Wyoming, they are present in the Powder and Little Missouri River drainages (Baxter and Stone 1995; McGree et al. 2010) of the northwestern and northeastern Missouri aquatic habitats. They may be present in the Belle Fourche River drainage but have not been sampled in recent surveys (Patton 1997; McGree et al. 2010), nor were they collected near the state line in South Dakota by Doorenbos (1998). However, Pindel (1997) reported 12 captured in 1994 and one in 1997, and long before Keyhole Reservoir was constructed, Bjorn (1938) reported "silvery minnow, numerous" near Devils Tower. None of these latter two authors noted any attempt to confirm species identifications however (i.e. not Plains Minnow). They are believed to be extirpated in the Big Horn drainage. Western Silvery Minnow are commonly associated with Plains Minnow (Hybognathus placitus) throughout their range, and although the two species look similar, Western Silver Minnow have a broad and blade-like basioccipital process with a back margin that is straight or only slightly concave (Pflieger 1997). To ensure proper identification of field-collected Hybognathus specimens, subsets are positively identified to species by Colorado State University's Larval Fish Laboratory. The diet, movement, breeding behavior, and life-history characteristics of this species are poorly known and often are presumed to be similar to other Hybognathus species. Throughout its entire range, this species has undergone a large decline in abundance and distribution in recent decades (Pflieger 1997). In Wyoming, it currently is believed to be in decline (McGree et al. 2010). A better understanding of the habitat, life-history, and flow requirements of this species is needed to assess the impacts of water and land use activities.

Habitat

This species typically is found in medium to large, prairie rivers in habitats with sluggish flows. They are found in areas with fine substrate and silted bottoms: shallow backwaters, slow pools, or lower reaches of river tributaries (Pflieger 1997). This minnow species is adapted to turbid rivers, historically associated with the flathead chub (Platygobio gracilis), goldeye (Hiodon alosoides), plains minnow, sturgeon chub (Macrhybopsis gelida) and shovelnose sturgeon (Scaphirhynchus platorynchus). Detailed habitat requirements are not presently known (Quist et al. 2004).

Problems

- Habitat degradation due to impoundments in major river drainages is likely contributing to declines in distribution and population size.
- Nonnative species are present and may be expanding within drainages occupied by this species.
- Altered flow regimes, habitat fragmentation, and impacts to aquatic and riparian habitat associated with agricultural practices.

Conservation Actions

- Continue efforts to educate landowners and the public about the importance of native fish and their habitats.
- Continue efforts to maintain flows and connectivity.
- Continue efforts to prevent the colonization and spread of nonnative fishes throughout the Powder River basin through the maintenance of natural flow processes.

Monitoring / Research

Revisit sites in the range of this species sampled by Barrineau et al. (2007), Peterson et al. (2009) and McGree et al. (2010) to continue monitoring presence/absence and distribution.

Continue to identify and record observations while conducting fisheries management sampling.

Recent Developments

No plains minnow were found during detailed fish and habitat surveys at sites throughout the Bighorn River basin in 2006 and 2007 (Bear 2009). The species is believed extirpated from the basin.

Prairie stream surveys were completed in 2004-2005 (Barrineau et al. 2007) and 2008-2009 (McGree et al. 2010) to assess the distribution of this species in northeast Wyoming. Detailed spatially and temporally stratified surveys were also conducted from 2004 to 2006 at multiple sites on the mainstem Powder River in Wyoming and Montana (Peterson et al. 2009) and Crazy Woman Ceek in Wyoming (WGFD 2005, WGFD 2006, WGFD 2007). Results of these studies suggest a decline in the distribution of this species.

Completed construction of the Kendrick Diversion dam bypass channel on Clear Creek in 2010, a tributary to the Powder River, to allow fish passage for spawning migrations. A project to determine which species are utilizing the bypass channel was intiated in 2011 (Bradshaw 2015), and Western Silvery Minnow were subsequently documented above Kendrick Dam.

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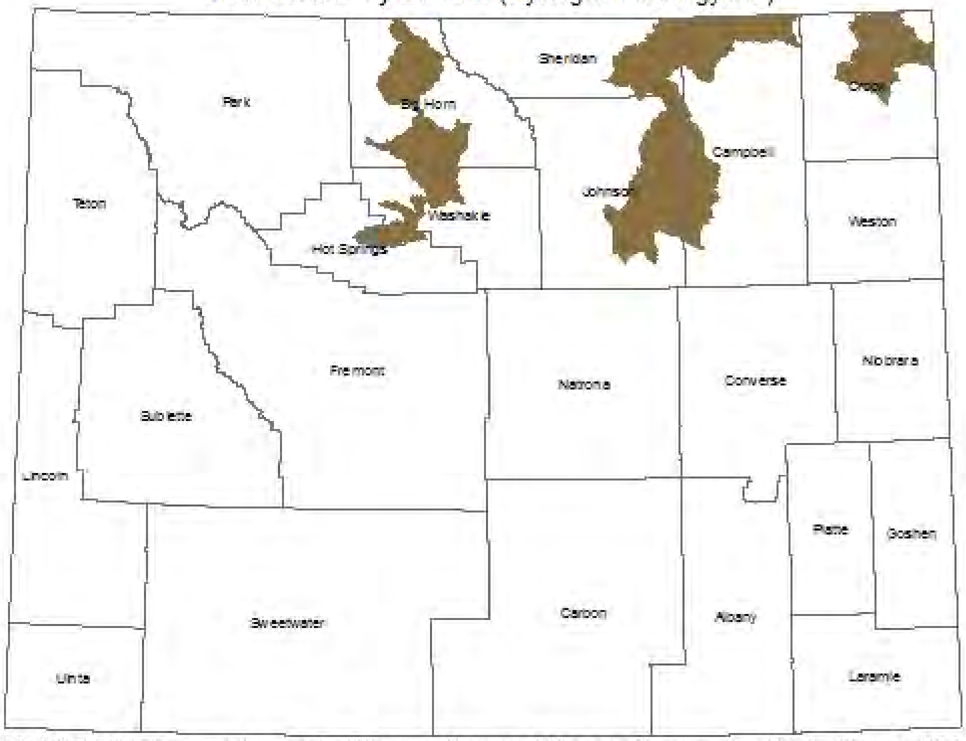
Western Silvery Minnow (*Hybognathus argyritis*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Yellowstone Cutthroat Trout - Oncorhynchus clarkii bouvieri

Abundance: Rare

Status: NSS3 (Bb) NatureServe: G4T4 S2

Population Status: Restricted in numbers and distribution, but extirpation is not imminent.

Limiting Factor: Other: hybridization with introduced non-native species has caused significant declines in genetic purity. Other limiting factors include competition with non-native salmonids, habitat loss and degradation. Habitat availability is limited by land management activities such as grazing, irrigation diversions, roads, energy development, and municipal water diversions.

Comment: Changed from NSS2 (Ba) to NSS3 (Bb) in 2017. Rationale for change was to create a consistent classification for Snake River and Yellowstone cutthroat by considering the current status of both collectively.

Introduction

Yellowstone cutthroat are game fish native to coldwater habitats in the Snake, Yellowstone, Bighorn-Wind and Tongue River drainages of Wyoming. Yellowstone cutthroat distribution throughout their range and in Wyoming have declined substantially (May et al. 2007). Yellowstone cutthroat trout are distinguished from other cutthroat trout by large black spots concentrated towards the caudal peduncle. The fish feed on zooplankton, freshwater shrimp, a wide variety of insects, mollusks and other fish. Some populations occupy lakes and are adfluvial, while most populations are strictly fluvial. Yellowstone cutthroat spawn in early summer (May to July), often migrating upstream to spawn in tributaries with clean gravel substrates. In late summer or early fall, eggs hatch and fry emerge.

A range wide strategy for Yellowstone cutthroat conservation has been developed and recently updated (YCT Range-wide Conservation Team 2009). The objectives identified and incorporated into management in Wyoming are 1) identify and characterize all populations, 2) secure and enhance populations and 3) restore populations where possible. Extensive surveys of fish and habitat have been completed in most of the species' range in Wyoming. Most populations are believed to be well documented. Efforts to enhance Yellowstone cutthroat populations by expanding their distribution in occupied streams have been completed or are underway in the Bighorn, Clarks Fork and Tongue River drainages.

See the Yellowston River Basin aquatic basin chapter in the current SWAP for more information relative to this fish.

Habitat

Yellowstone cutthroat are native to the coldwater habitats in the Yellowstone River drainage downstream to the Tongue River. Yellowstone cutthroat (large spotted form) are also found in Pacific Creek and other upper Snake River tributaries. See Snake River cutthroat trout species account for more details. They have been widely stocked outside of their native range. Yellowstone cutthroat inhabit coldwater lakes, rivers and streams but require flowing water environments for spawning.

Problems

- Nonnative salmonids introduced into waters with Yellowstone cutthroat almost always eliminate cutthroat populations over time through hybridization, predation and/or competition.
- Previous introduction of nonnative fish has diminished the genetic integrity of many Wyoming populations. In some cases there continues to be hybridization.
- Lack of connectivity resulting from low flows or other physical barriers (natural and man made) may significantly limit access to upstream habitats.
- Available habitat that is not affected by anthropogenic influences are located in headwater streams with limited connectivity and some are located within wilderness areas. Restoration or introductions can be problematic in these areas. Construction of exclusionary barriers to limit non-native salmonid introgression or competition can also be a problem given the soil types and erosive nature of the Absaroka volcanics that dominate the range of Yellowstone Cutthroat trout.

Conservation Actions

- Develop and implement a public outreach effort specifically addressing Yellowstone Cutthroat Trout conservation in Wyoming.
- Continue to build and maintain rangewide database so that information can readily be shared between and among jurisdictions.
- Complete genetic analyses on known or potential populations to detect hybridization. A reference collection of fish or DNA from the entire five-state area should be developed and maintained in conjunction with the genetic monitoring program.
- Construct In-channel barriers, where feasible, to prevent the invasion of nonnative fish.
- Continue efforts to remove competing and hybridizing nonnative species to secure, enhance and restore populations.
- Continue to remove anthropogenic barriers limiting gene flow and the expression of fluvial life history strategies.
- File for instream flow water rights to protect habitat of conservation populations.
- Continue regulations to restrict harvest of vulnerable populations.
- Prevent stocking of public or private waters with non-native species that may impact conservation populations.
- Protect and manage riparian areas for native riparian vegetation, that will filter runoff, maintain a higher water table, provide late season stream recharge, and stabilize stream banks. Use riparian fencing, grazing management, fire management, and invasive species control to promote native vegetation.
- Identify and characterize all populations within their native range in Wyoming.
- Develop refugia for pure populations in lakes or streams to act as backup for hatchery brood sources.

Monitoring / Research

Monitoring is ongoing. Populations are periodically sampled to determine change in status, population size and assess identified and new risk factors to formulate or revise management strategies.

Recent Developments

In 1998, YSC were petitioned for listing as a threatened species under the Endangered Species Act. The petition was rejected in February 2001, but in December 2004, U.S. District Court for the District of Colorado ruled that the U.S. Fish and Wildlife Service (FWS) illegally rejected the petition. The FWS conducted a 12-month status review of the species and found listing unwarranted. After the FWS decision was announced, proponents for listing filed an Intent to Appeal Brief within 60 days of the decision but have completed no further actions since.

A second iteration of the range-wide status assessment was completed in 2006 (May et al. 2007), delineating distribution, abundance, barrier locations, genetic purity, and natural and anthropogenic factors potentially impacting Yellowstone cutthroat trout populations and distribution.

Nonnative trout were removed from 3.5 miles of lower Dry Medicine Lodge Creek to enhance the upstream Yellowstone cutthroat population in 2006-07. Nonnative trout were removed from 8 miles of Buckskin Ed Creek for enhancement of the downstream Yellowstone cutthroat populations in 2008-09. Nonnative trout were removed from 1.5 miles of Elkhorn Creek and 1.2 miles of Red Gulch Creek in 2008. Nonnative trout were removed from about 15 miles of the Little Tongue River and 3 main tributaries in 2009. Preparations were made for the 2010 removal of nonnative trout from the South Little Tongue River.

Projects are underway to restore Yellowstone cutthroat to 10 miles of Dead Indian Creek, 13 miles of Soldier Creek, 17.5 miles of the Little Tongue River, and 5.0 miles of the South Little Tongue River.

New rangewide Conservation Agreement and Conservation Strategy were completed (YCT Range-wide Conservation Team 2014).

A report on the status of the species in the Little Bighorn River, Tongue River and Goose Creek drainages in Wyoming was completed (Bradshaw et al. 2008). A new rangewide status assessment was also completed (May et al. 2007).

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Yellowstone Cutthroat Trout (*Oncorhynchus clarkii bouvieri*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Abert's Squirrel
Sciurus aberti

REGULATORY STATUS
USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS4 (Bc), Tier III
WYNDD: G5, S1
    Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS
Abert's Squirrel (*Sciurus aberti*), also known as Tassel-eared Squirrel, has no additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY
Taxonomy:
Six subspecies of Abert's Squirrel are recognized. Of those, only one occurs in Wyoming – *S. a. ferreus* [1].

Description:
Abert's Squirrel is a large-bodied tree squirrel; adults weigh 550–750 g [2], with adult males slightly smaller than adult females. The species can easily be distinguished from other tree squirrels by a gray dorsum, often with a reddish medial band, white venter, and thick gray tail tipped with white [1]. Melanistic individuals may be locally common, especially in the northern part of the range [3], and may be the dominant color phase in Wyoming (S. Buskirk, pers. comm.; G. Beauvais, pers. comm.). Abert's Squirrel is further identified from other large-bodied tree squirrels by its conspicuous ear tufts, or tassels, that can reach ≤ 40 mm during the winter months [4].

Distribution & Range:
The current North American range of Abert's Squirrel is likely a result of Pleistocene isolation, subsequent post-Pleistocene dispersal, and intentional introductions by humans [5, 6]. Currently, Abert's Squirrel extends from southeastern Wyoming to south-central Arizona and New Mexico. Isolated populations exist in southeastern Utah and throughout the Sierra Madre in Mexico. Wyoming represents the northern limit of Abert's Squirrel range [1], where the species is limited to the extreme southeastern part of the state near Harriman [7]. The Wyoming population segment is assumed to derive from naturally-established animals, and not from human mediated translocations [2, 7].

Habitat:
Abert's Squirrel is most often classified as an obligate of Ponderosa Pine (*Pinus ponderosa*) forests, which provide both food and shelter [4, 8]. However, the species may also be found in mixed-conifer forests, especially when established via intentional introductions by humans [9]. Mosaic and heterogeneous forests seem to be preferred [1], especially those with large, tall trees and closed and interconnected canopies, which are particularly important for constructing leaf nests, or dreys [1, 7, 10]. Cavity nests are also used, although much less frequently, and are often located in large Aspen (*Populus tremuloides*) trees [11].

Phenology:
Abert's Squirrel is diurnal and active year-round [4]. Male Abert's Squirrels are capable of reproduction from approximately mid-March through the end of August [4], although most breeding activity occurs during April and May [3]. During other times of the year, the testes are withdrawn into the abdomen [4]. Like many tree squirrels, females are in estrus for a single day per breeding cycle, during which time they mate with multiple males [1]. Litters of 3–4 young are born in June and July after a 46-day gestation [3, 4, 7]. Females produce a single litter per year, although second litters may be common in the southern part of the range [4]. Young disperse after 10 weeks and are capable of reproducing the following year [1].

Diet:
Abert's Squirrel is often considered a Ponderosa Pine-obligate, which can make up a substantial portion of the diet, and includes inner bark, phloem, seeds, buds, and flowers [4]. Clipped twigs are stripped of bark in order to access the phloem; discarded twigs may be used to evaluate presence and density of squirrels [1]. Individual trees are selected for herbivory depending on their unique chemical compounds [12, 13]. In Arizona, Abert's Squirrel has been shown to reduce Ponderosa Pine production by 21% [14]. However, they will also eat seeds from a variety of other species, including other pine species, fir (*Abies* spp.), Douglas Fir (*Pseudotsuga menziesii*), and oaks (*Quercus* spp.), as well as fungi, carrion, and bones [4, 9]. Abert's Squirrel does not cache seeds, although they are known to pilfer seeds from other tree squirrels that do cache [1, 4].

CONSERVATION CONCERNS

Abundance:
Continental: REGIONAL ENDEMIC
Wyoming: VERY RARE
Estimates of Abert's Squirrel abundance in Wyoming are not available. Given the limited range of the species in the state, total numbers are expected to be very low. In northern Colorado, near Boulder, densities of Abert's Squirrel varied between 82 individuals per square km in the winter and 114 individuals per square km in the fall after young became independent [3]. Population fluctuations are common [4].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Nothing is known regarding the population trends of Abert's Squirrel in Wyoming. In Colorado, populations began expanding in the early 20th century following the establishment of hunting regulations [2], and subsequent increases in records of occurrence suggest range expansions in the southern half of the state [15]. However, the northern distribution has remained relatively unchanged, and it is unlikely these increases also occurred in Wyoming.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Across most of its range Abert's Squirrel depends on Ponderosa Pine and other coniferous forests, which makes the species sensitive to changes in these forest types. However, a number of intrinsic factors may help buffer this specificity. The ability of populations to thrive in coniferous habitats where Ponderosa Pine is nearly absent may provide some resiliency. For example, Abert's Squirrels introduced into mixed conifer habitat maintained similar or slightly smaller home ranges than those in Ponderosa Pine forests, which may be the result of a broader food base [16]. Additionally, dispersing juveniles can move relatively large distances ($\leq$ 1.44 km) [3], which may allow individuals to expand populations to unoccupied environments. Abert's Squirrels also have the ability to establish and maintain populations with as few as 15 to 45 founders, and, as such, introduced populations tend to fare very well [6, 17]. Finally, the species appears able to persist in areas of moderate human presence and low-density housing development (S. Buskirk, pers. obs.; G. Beauvais, pers. obs.).

Extrinsic Stressors:
SLIGHTLY to MODERATELY STRESSED
Because Abert's Squirrel depends on coniferous forests, and Ponderosa Pine in particular, they are subject to the stressors that threaten this habitat. Forest management practices such as logging and thinning can negatively impact populations, even when they are designed to mimic historic fire patterns [18, 19]. Catastrophic, stand-replacing fires likely represent substantial habitat loss. The recent Mountain Pine Beetle epidemic has impacted coniferous forests throughout the state, including those within the range of the Abert's Squirrel. The species may also be exposed to habitat modifications from wind power development, which is predicted to increase within its Wyoming range [20]. Abert's Squirrel is known to frequent bird feeders and other infrastructure in low density housing developments, indicating that such development may not be a significant threat to the species (S. Buskirk, pers. obs.; G. Beauvais, pers. obs.).

KEY ACTIVITIES IN WYOMING

Little work has been done to-date on Abert's Squirrel in Wyoming. Formal surveys are planned for 2016 and 2017 to evaluate presence of Abert's Squirrel throughout its predicted range in the state.

ECOLOGICAL INFORMATION NEEDS

In Wyoming, Ponderosa Pine forests are far vaster than the range of Abert's Squirrel [5]. Consequently, a better understanding of the physical and ecological factors that limit Abert's Squirrel at this northern range limit is needed. Although the strict dependence on Ponderosa Pine forests may be overstated, Abert's Squirrel still depends upon dense coniferous forests for food and shelter. The impacts of bark beetle outbreaks, climate change, wind power development, and forestry practices still need to be evaluated in Wyoming. Finally, quantifying the relative contributions of dispersal and in-state reproduction to persistence would assist managers in prioritizing resources and projects aimed at maintaining Abert's Squirrels in Wyoming.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Little is known about Abert's Squirrel in Wyoming. Consequently, management priorities for the species in the short-term will focus on addressing these data deficiencies. Of particular importance are data on presence, distribution, population status, and the impact of potential threats, including the current condition of Ponderosa Pine habitat, which will ultimately be used to develop management and conservation recommendations.

CONTRIBUTORS

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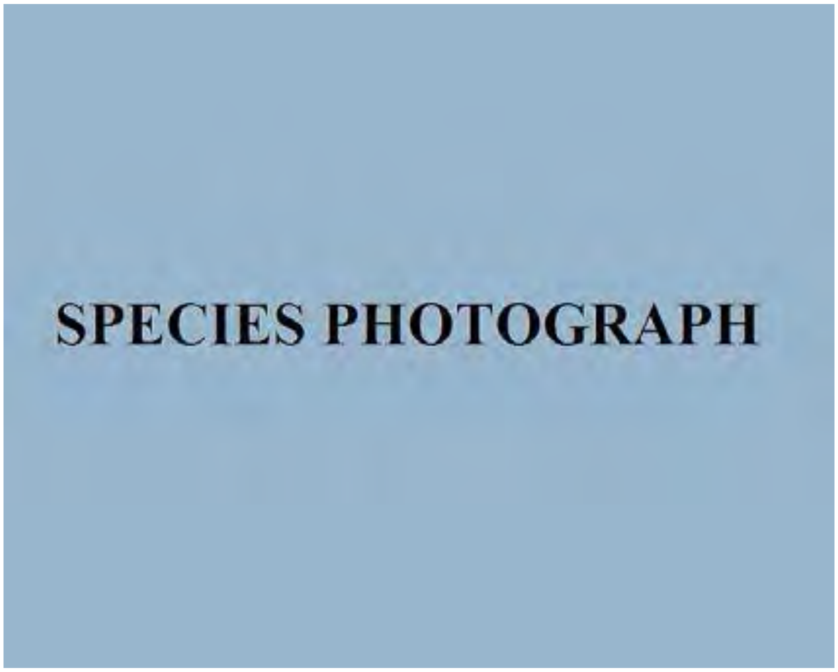

Figure 1: Photo not available.

Figure 2: North American range of *Sciurus aberti*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

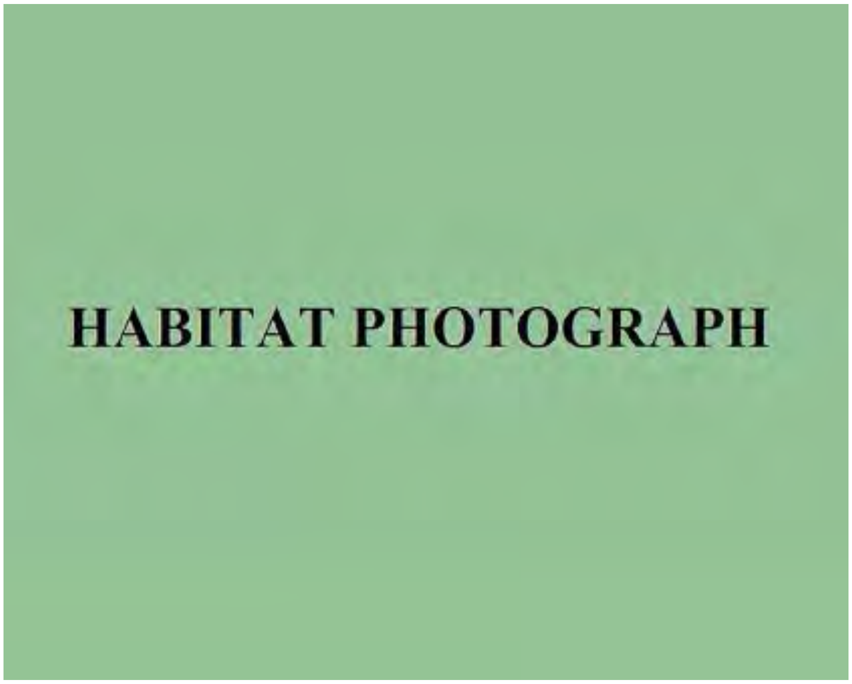

Figure 3: Photo not available.

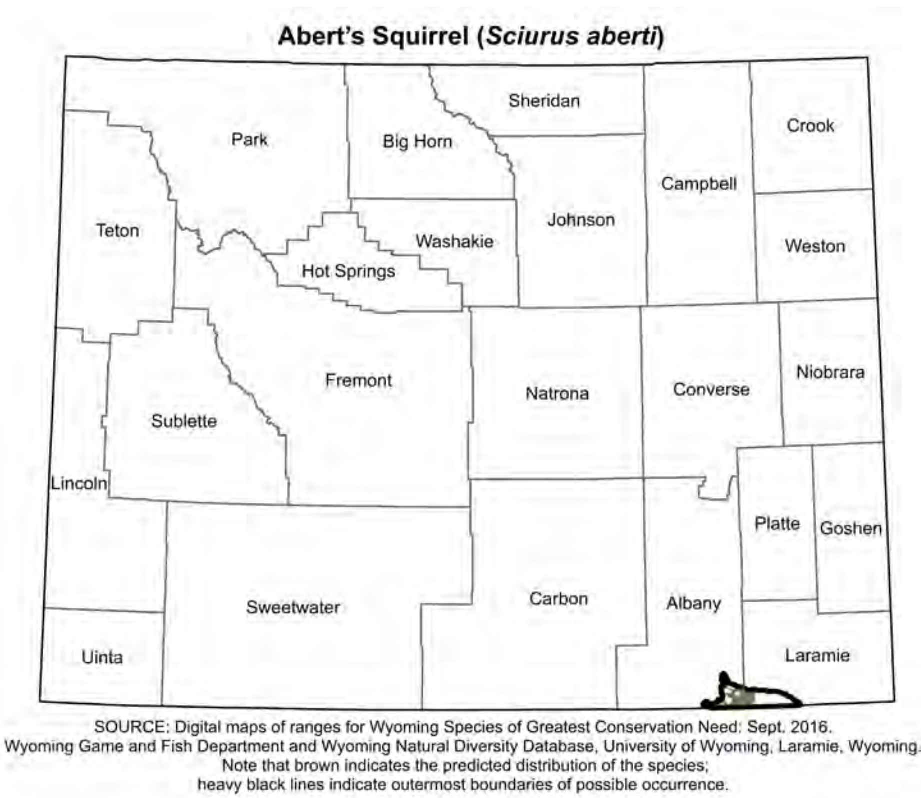

Figure 4: Range and predicted distribution of *Sciurus aberti* in Wyoming.

American Pika
Ochotona princeps

Regulatory Status
USFWS: Listing Not Warranted
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Animal

Conservation Ranks
USFWS: No special status
WGFD: NSS2 (Ba), Tier II
WYNDD: G5, S2
Wyoming Contribution: HIGH
IUCN: Least Concern

Status and Rank Comments
American Pika (*Ochotona princeps*) was petitioned for listing under the Federal Endangered Species Act in 2007. In 2010 the U.S. Fish and Wildlife Service (USFWS) determined listing was not warranted, largely due to a paucity of range-wide information on the species and on how it might respond to climate change [1]. The species was again petitioned for listing in April of 2016, and the USFWS again determined that listing was not warranted (via a "not substantial" 90-day decision) in September 2016 [2]. American Pika is one of six species protected by Wyoming Statute §23-1-101. The Wyoming Natural Diversity Database recognizes the population in the Bighorn Mountains as deserving an independent conservation rank (S1; Very High Wyoming Contribution) due to its geographic isolation.

Natural History

Taxonomy:
Recent research on the molecular phylogenetics of *O. princeps* lead to a revision of the number of subspecies from 36 to 5 [3]. These 5 subspecies are now widely accepted and include the Northern Rocky Mountain Pika (*O. p. princeps*) that occurs in Wyoming. Each subspecies is associated with a mountain system in the Intermountain West and has probably undergone intermixing during periodic cycles of glaciation [4, 5].

Description:
American Pika is one of the most conspicuous and identifiable alpine species in the Rocky Mountains and can easily be distinguished in the field. Also known as "rock rabbits," pikas are most closely related to hares and resemble a tiny, short-eared rabbit. Adult size is consistent between sexes. Body mass is 150–175 g, and total length is 170–204 mm [6]. American Pika is very vocal, and individuals will give an alarm call to warn neighbors of nearby predators. To an untrained observer, pikas can be confused with marmots (*Marmota* spp.) that occupy similar habitat, but pikas are considerably smaller, and their nasal "eep, eep" vocalization is distinct

from the high-pitched whistle of a marmot. Unlike rabbits and hares, pikas have several distinct vocalizations, including a short alarm call and a longer song. Pikas in Wyoming exhibit a short call dialect that is notably different in duration and frequency from populations that extend south of the Colorado River [7].

Distribution & Range:
American Pika occupies the intermountain west with an elevational extent from 0 to > 4,000 m above sea level [8]. In the Great Basin, the lower elevational extent of American Pika distribution is moving upslope as a response to climate warming [9-11], and populations in areas with limited habitat, lower elevation of talus slopes, and populations nearer to roads have been extirpated [12]. However, newly documented pika populations suggest that populations may continue to persist in locations that are representative of the edges of climatic tolerances [13]. Mountain ranges along the western border of Wyoming are considered part of core pika habitat in the Central Rocky Mountain Range. The Bighorn Mountains host an insular patch of suitable habitat that supports abundant pika populations. The Snowy Range is at the very southern end of *O. p. princeps* range.

Habitat:
American Pika is considered a habitat specialist, requiring rocky habitats that provide thermal refugia interspersed with mesic meadows or patches of abundant forage. Patchily-distributed alpine talus fields are typical habitat for American Pika throughout its range. Anthropogenic substrate (e.g., mine tailings) and other natural formations (e.g., lava beds) are also habitat [14], as are downed logs and woody debris [15]. In Wyoming, pikas have been documented as low as 1,762 m [15], but most often they inhabit subalpine and alpine talus fields > 2,500 m. In order to maintain a balance between keeping cool during summer months and remaining active during winter months, habitat requirements and limitations vary throughout the geographic range depending on climate context [16]. At all latitudes, however, American Pika requires space within the rocky substrate to thermoregulate. At southern latitudes, refugia from heat may be particularly important. Individual pikas maintain territories of about 500 square meters [17, 18], but territories vary in size and shape depending on resource availability and pika density. Pikas actively defend territories from conspecifics to protect food caches.

Phenology:
Juveniles typically disperse ≤ 3 km, and populations separated by > 5 km are considered distinct [19]. Post dispersal, juveniles establish new territories. While they may relocate if an adjacent, higher quality territory becomes available, individuals will remain in the same talus patch for the duration of their lives [20]. Unlike most alpine mammals, American Pika neither migrates nor hibernates during winter, but remains active, usually under the snow, feeding on food caches known as “haypiles” harvested and assembled during the summer months. Females can have up to 2 litters per year but usually wean a single successful litter with an average of 3 offspring [14]. Timing and synchronicity of breeding and weaning varies annually and between individuals [21]. Females breed in early spring when snow cover is still present and again about 2 weeks after the first litter is born. Juveniles of a closely related species, Collared Pika (*O. collaris*), disperse about a month after parturition when emergence from the snow is feasible [22].

Diet:
American Pika is a generalist herbivore that feeds on a variety of vegetation. Pikas generally forage ≤ 100 m of their territories [23]. Because they build conspicuous haypiles during August and September, diet is identifiable. The content of winter caches generally resembles the surrounding plant community, although individuals often select plants that are high in nitrogen [24]. In

Wyoming, diet primarily consists of grasses, forbs, shrubs, and occasionally conifer twigs, moss, and lichen. Pikas are known to preferentially collect plant species with secondary compounds that have preservation qualities [25].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPPREAD BUT PATCHY
Wyoming: UNCOMMON
There are no abundance estimates for American Pika in Wyoming, although it is considered uncommon due to its restricted distribution. Pikas are known to occur in densities of < 10 individuals per ha [26]. In Wyoming, pikas are regularly found in patches of apparently suitable habitat and even in marginal habitat starting at about 2,000 m; they are found most reliably and consistently between 2,700–3,600 m. Pikas are locally abundant in places with ample forage and talus interstices.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
There are no published studies of American Pika population trends in Wyoming. One historical site in the Snowy Range was resurveyed in 2008, suggesting that pikas may have been extirpated from this site [27], although a subsequent 2009/2010 survey found some evidence of recent activity [28]. Pikas are still widely documented throughout the western and southern mountain ranges in the state as well as the Bighorn Mountains [29]. In western Wyoming pikas occurred at 58% of 146 surveyed locations [30]. At low elevation sites in the Great Basin, there have been population losses of 28% since the beginning of the 20th century [12] that are primarily linked to climatic extremes, including rising summer temperatures, exposure to cold during winter, and decrease in forb cover [9, 10]. A reevaluation of historical sites in the Southern Rocky Mountains found declines that were much less severe, with 6% of formerly occupied sites being extirpated [27]. The few extirpated sites were best explained by lack of availability of water at the site; extirpated sites were consistently dry over the last several decades. In other regions, including the Sierra Nevada and Cascade Ranges, populations are apparently stable [8, 18, 31].

Intrinsic Vulnerability:
HIGH VULNERABILITY
American Pika is highly vulnerable to habitat modifications due to its high specificity to isolated alpine and subalpine talus habitats. It is also susceptible to natural, local extirpations through metapopulation dynamics [32]. However, physiological requirements may be the most limiting factor. Because they remain active during winter, pikas maintain high metabolic rates, and their body temperature is consistently close to their upper critical temperature, which makes them vulnerable to heat stress [33, 34]. Low tolerance to heat can limit their ability to collect hay during the growing season if temperatures are close to their limiting threshold. Exposure to high summer temperatures also limits juvenile dispersal [14, 35].

Extrinsic Stressors:
MODERATELY STRESSED
Habitat alteration and loss driven by climate change is likely the biggest threat to American Pika range-wide. Climatic conditions, however, likely limit pika populations in context-dependent ways across latitudes [16]. Because summer temperatures are mild in Wyoming's more cool and

mesic alpine landscapes, increasing summer temperatures may not be as threatening as compared to populations in lower latitudes, unless there is local adaptation that could render Wyoming pikas relatively more sensitive than southern pikas to even moderate climatic changes. In the Wind River and Big Horn Mountain ranges, an index of pika abundance (scat density) increased linearly with elevation to a threshold of 3,600 and 3,300 m, respectively, beyond which abundance decreased, suggesting a ceiling effect [36]. The mechanisms of how climate limits American Pika in Wyoming remain unclear, although adequate snowpack and favorable growing conditions for forage during the summer might be important [27, 37]. Additionally, microrefugia provided by talus interstices may allow persistence in sites even with periodic extreme temperatures, albeit to an unknown extent [30]. Continued climate change will likely limit American Pika distribution indirectly by altering food availability, timing of daily activity, predation risk, and disease [10, 37].

KEY ACTIVITIES IN WYOMING

Ongoing efforts to monitor American Pika persistence in Wyoming began in 2009 when the Teton Science Schools initiated a pika project in the Gros Ventre and Teton Mountain ranges in northwestern Wyoming. This effort expanded into the Greater Yellowstone Ecosystem (GYE) Pika Initiative in 2010 [15, 38]. These studies use a widely accepted protocol primarily developed to monitor American Pika persistence over several years of survey [18, 39]. In collaboration with other non-governmental organizations, Nature Mapping Jackson Hole has developed a citizen science monitoring effort aimed at documenting American Pika observations made by volunteers throughout the GYE [15, 40]. Additional projects have evaluated the persistence of American Pika in portions of Wyoming's Snowy Range [27, 28], delineated limiting features of climate and habitat on American Pika populations in the Wind River and Bighorn Mountain ranges [36, 37], and quantified the relative importance of microrefugia to pika occurrence in the Gros Ventre, Salt, Wyoming, and Snake River Mountain ranges [30].

ECOLOGICAL INFORMATION NEEDS

Clear predictions about the responses of American Pika to climatic changes have been hampered by a lack of understanding of several key components, including the extent of local adaptation, the degree to which phenotypic plasticity may proximately buffer individuals during stressful periods, and the limits and trade-offs associated with such plasticity. There is also still debate regarding the lower temperature limits of American Pika, and an understanding of the ecology of pika in winter is lacking. Information on juvenile dispersal is similarly scarce. To date, the vast majority of American Pika research has focused on occupancy relationships. The fitness (e.g., fecundity, juvenile survival, adult survival) consequences of habitat selection and climatic variation need to be evaluated to assess habitat quality and risk of extirpation. Targeted study of preferred forage plants will also be important given the natural history of pika, their reliance on haypiles for winter forage, and climatic changes that may shift plant distributions.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Martin B. Grenier and Nichole L. Bjornlie. Recent management activities for American Pika have focused on funding research projects to improve understanding of habitat associations and potential impacts of climate change in Wyoming [36, 37], and on-going projects will continue to investigate these management questions. Moving forward, periodic surveys will be necessary in order to monitor site persistence and population trends.

CONTRIBUTORS

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Wyoming Species Account

Figure 1: American Pika. (Photo courtesy of John Whiteman)

Figure 2: North American range of *Ochotona princeps*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Talus fields intermixed with patchy alpine meadow at 10,900 ft in the Bighorn Mountains, Wyoming. (Photo courtesy of Leah H. Yandow)

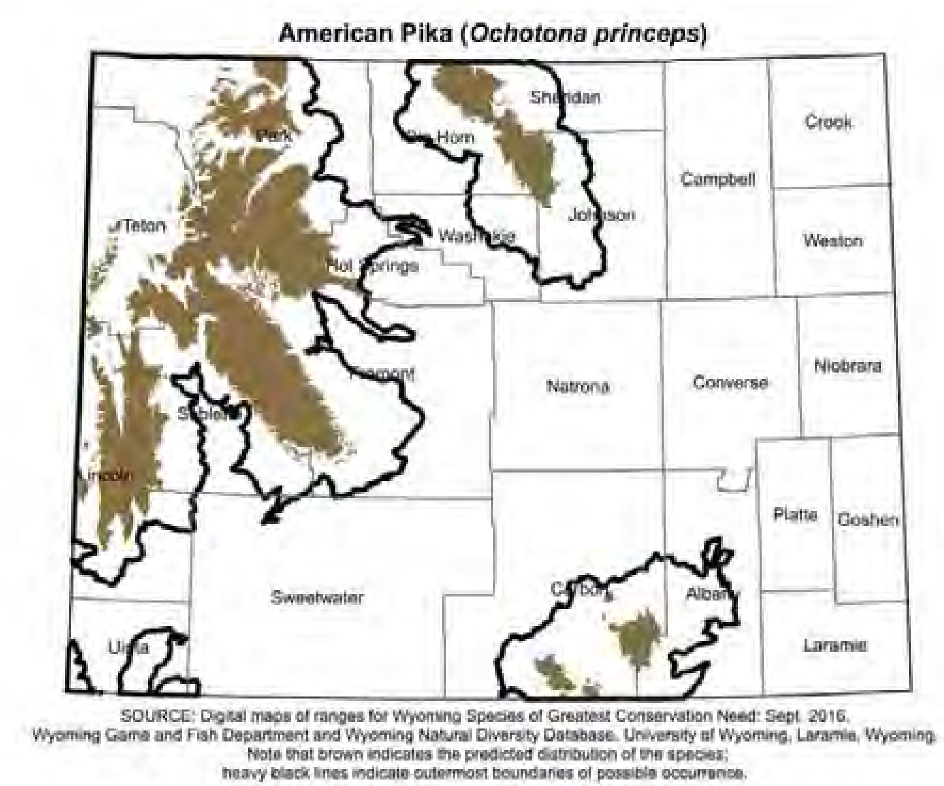

Figure 4: Range and predicted distribution of *Ochotona princeps* in Wyoming.


Figure 5: Pika haypile among rocks with old collected vegetation mixed with scat on the bottom, and fresh *G. rossii* clippings on the surface. This fresh sign is indicative of current occupied habitat. (Photo courtesy of Leah H. Yandow)

American Pygmy Shrew

Sorex hoyi

REGULATORY STATUS

USFWS: No special status
USFS R2: Sensitive
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS

USFWS: No special status
WGFD: NSSU (U), Tier III
WYNDD: G5, S1
    Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS

The full species American Pygmy Shrew (*Sorex hoyi*) has no additional regulatory status or conservation rank considerations beyond those listed above. However, the only Wyoming representative of American Pygmy Shrew is the isolated glacial relict subspecies Southern Rocky Mountain Pygmy Shrew (*S. h. montanus*; see Taxonomy, below), whose entire global range covers only a small portion of southern Wyoming and northern Colorado. At the subspecies level *S. h. montanus* is considered imperiled/vulnerable by NatureServe (Arlington, Virginia), and Wyoming supports a significant amount of its entire range.

NATURAL HISTORY

Taxonomy:

There are currently 5–6 recognized subspecies of American Pygmy Shrew. Only one subspecies is found in Wyoming, the Southern Rocky Mountain Pygmy Shrew. This subspecies appears to be a glacial relict that is completely separated from other subspecies. There is some uncertainty over subspecies taxonomy in *S. hoyi*, but most pertains to subspecies in more northern (i.e., outside of Wyoming) portions of the species range [1, 2].

Description:

American Pygmy Shrew is an extremely small mammal, and is very similar in appearance to other Wyoming shrew species. Adult total length is 60–110 mm, and adult mass is 3–8 g. Like other *Sorex* species, American Pygmy Shrew has a relatively long and flexible snout, bicolored tail, proportionally small eyes, uniformly brownish or grayish fur on the back, and silvery-whitish fur below. Identification to species requires a combination of body measurements, skull measurements, and, especially, dental characteristics [3], which typically requires the individual shrew to be sacrificed. Critically, the third and fifth upper unicuspids are much smaller in Pygmy Shrew than in other Wyoming *Sorex*. Figure 5 illustrates important differences in shrew dentition, and a technical key such as in Clark and Stromberg (1987) is an important aid in identifying Wyoming shrews to species [4].

Distribution & Range:
American Pygmy Shrew is distributed across the boreal zone of northern North America, with southern extensions along the Appalachian and Rocky Mountains. There are two disjunct populations: one in the southern Appalachian Mountains and one in the Southern Rocky Mountains. The latter, recognized as *S. h. montanus*, occupies the mountains of southern Wyoming and northern Colorado, and is isolated by several hundred miles from the main body of the species' range. In Wyoming, American Pygmy Shrew is restricted to forests in the Medicine Bow and Sierra Madre ranges [1, 3].

Habitat:
Across its range American Pygmy Shrew is associated with a broad array of habitat types, with an apparent preference for moist environments such as fens, bogs, and riparian zones. In Wyoming the species has generally been found in moist, mature stands of Engelmann Spruce (*Picea engelmannii*) and Subalpine Fir (*Abies lasiocarpa*) [1, 5, 6]. Recent work in Colorado found the species in Lodgepole Pine (*Pinus contorta*), Quaking Aspen (*Populus tremuloides*)-spruce, and spruce-fir woodlands [7]. At a landscape scale, the Southern Rocky Mountain subspecies appears to occupy boreal/ subalpine mosaics of dry upland forest mixed with wet forest and meadows. Within these landscapes the subspecies seems to be associated with streams and other wet areas [1]. In general, shrews are assumed to seek out certain microhabitats (e.g., specific litter depths, debris densities, or soil textures) that may not align well with traditional categories of wildlife habitat based on dominant overstory plants [1, 8].

Phenology:
American Pygmy Shrew is active year round. Limited research on the species in Wyoming suggests that breeding occurs primarily in July, and young are born in late July to mid-August. In other parts of the species' range, females raise one litter consisting of 3–7 young per year. Young likely disperse at 3–5 weeks of age [1].

Diet:
American Pygmy Shrew primarily consumes small invertebrates, including but not limited to insect larva, adult insects, and spiders [1]. Prey preferences and seasonal diet shifts are unknown.

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD BUT PATCHY
Wyoming: RARE
There are no population estimates of American Pygmy Shrew at continental, national, or state scales. Based on the species' restricted distribution in Wyoming and apparent low frequency of capture relative to other shrews, it is thought to be rare in Wyoming [1, 9]. Considered at the subspecies level, *S. h. montanus* is one of the most narrowly endemic mammals in the region, with Wyoming encompassing a significant portion of its continental range.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends of American Pygmy Shrew in Wyoming are unknown.

Intrinsic Vulnerability:
HIGH VULNERABILITY
Though little is known about American Pygmy Shrew, the general breeding biology of *Sorex* shrews, in addition to the species' apparently narrow range of habitat use, suggests high vulnerability. Many *Sorex* have a life expectancy of one year, and high-elevation forms such as *S. h. montanus* likely produce only one litter per year. Also, limited mobility restricts shrews' ability to re-colonize suitable habitats and expand populations. These characteristics may predispose *Sorex* populations to fragmentation and local extirpation if breeding is disrupted for even a single season. Furthermore, *S. h. montanus* appears somewhat specialized to moist habitats; its small size may place it at a competitive disadvantage with other *Sorex*; and it maintains relatively large home ranges (and thus lower population densities) than would be expected from its body size [1, 4].

Extrinsic Stressors:
MODERATELY STRESSED
So little is known about American Pygmy Shrew in Wyoming that any outline of extrinsic threats is somewhat speculative. Based on its relatively narrow habitat preferences (i.e., wet areas within mosaics of dry and moist coniferous forest), significant disturbances to such habitat are assumed to negatively affect *S. h. montanus*. Wildfire, tree disease and insect infestation, drought, and other natural disturbances may negatively affect habitat, as may anthropogenic actions such as clear-cut timber harvesting and unrestrained motorized recreation [1]. However, shrews may rely on certain microhabitats that remain relatively unaffected by some large-scale disturbances, allowing populations to persist in otherwise disturbed areas.

KEY ACTIVITIES IN WYOMING
American Pygmy Shrew is classified as a Species of Greatest Conservation Need by the Wyoming Game and Fish Department (WGFD). Currently, there is no research being conducted on American Pygmy Shrew in Wyoming. A 2010–2012 study documented one American Pygmy Shrew (assumed to be *S. h. montanus*) in the Medicine Bow Mountains of southern Wyoming [6]. Recent small mammal trapping efforts near Wyoming in northwestern Colorado failed to document the presence of American Pygmy Shrew [10]. Recent work in the Routt National Forest in north-central Colorado has helped expand knowledge of American Pygmy Shrew distribution and habitat preferences [7]. In 2014 the WGFD funded and conducted an evaluation of the potential to use guard hairs to identify shrews to species, thus allowing for identification without the need to sacrifice individuals. However, only Western Water Shrew (*S. navigator*) was identifiable by guard hair, which is also the only shrew in Wyoming that is identifiable in hand [11].

ECOLOGICAL INFORMATION NEEDS
Very little is known about American Pygmy Shrew in Wyoming. There is a paucity of confirmed observations, and, as a result, the species' distribution, habitat preferences, dietary needs, breeding phenology, and potential threats are poorly understood. A better estimate of actual distribution in the state may be the top priority information need at this time and could be efficiently generated as part of a larger field survey effort targeting multiple *Sorex* species simultaneously.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. American Pygmy Shrew is assigned an NSSU rank because survey data that would provide for an assessment of population status are lacking. Consequently, management priorities for the species in the short-term will focus on addressing these data deficiencies. Of particular importance are data on presence, distribution, population status and trends, habitat needs, and the impact of potential threats. Because shrews are rarely trapped as part of other small mammal projects, addressing these needs will require systematic surveys designed to target shrews (i.e., pitfall traps). However, these species would also benefit from the development of new capture and identification techniques that would not require sacrificing individuals. Results from these efforts will ultimately be used to update status and develop management and conservation recommendations.

CONTRIBUTORS

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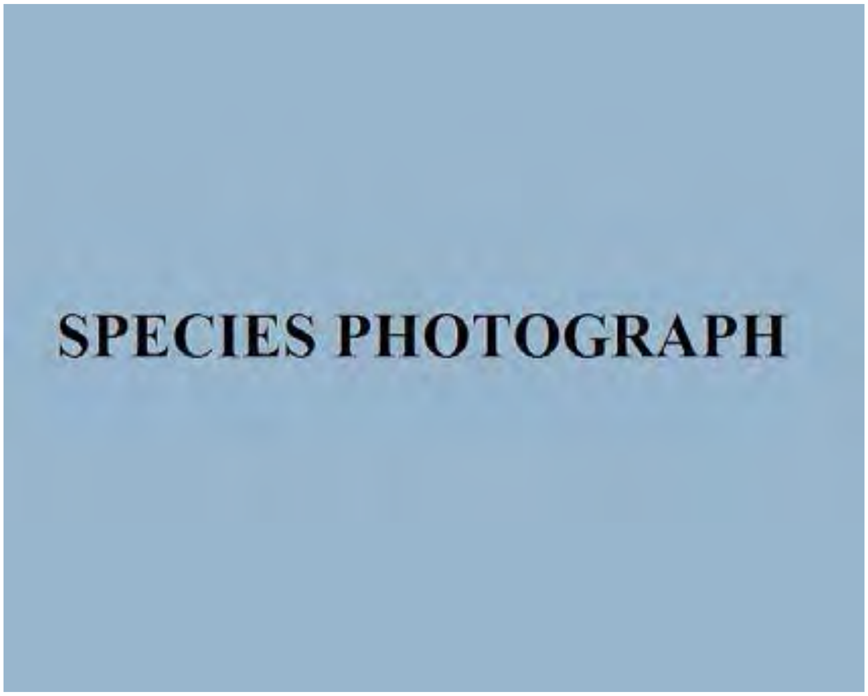

Figure 1: Photo not available.

Figure 2: North American range of *Sorex hoyi*. The isolated range of the species in Wyoming and Colorado is the *montanus* subspecies. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Potential habitat for American Pygmy Shrew. Subalpine forest near streams and wetlands, Medicine Bow National Forest, Snowy Range. (Photo courtesy of Michael T. Wickens)

Figure 4: Range and predicted distribution of *Sorex hoyi* in Wyoming.

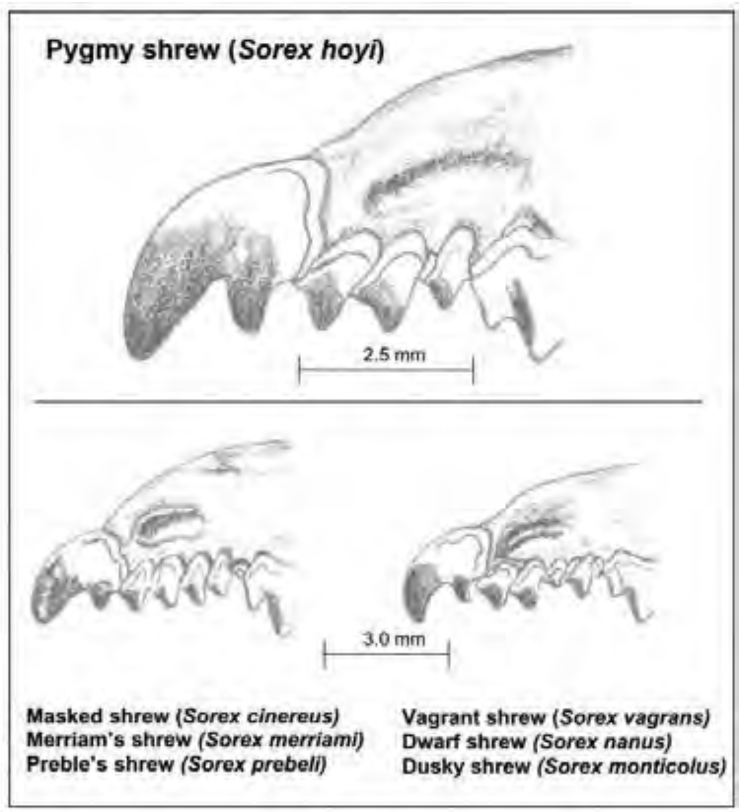

Figure 5: Lateral view of upper tooth rows of some *Sorex* spp. of shrew; American Pygmy Shrew shown at top. Top and bottom panels are not drawn to same scale – note scale bars. (Figure from: Beauvais, G. P., and McCumber, J. (2006) Pygmy Shrew (*Sorex hoyi*): a technical conservation assessment, p 34, USDA Forest Service, Rocky Mountain Region.)

Bighorn Sheep

Ovis canadensis

REGULATORY STATUS

USFWS: No special status
USFS R2: Sensitive
USFS R4: Sensitive
Wyoming BLM: No special status
State of Wyoming: Big Game Animal (see regulations)

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS4 (Bc), Tier II
WYNDD: G4, S2S3
Wyoming Contribution: HIGH
IUCN: Least Concern

STATUS AND RANK COMMENTS

Bighorn Sheep (*Ovis canadensis*) is classified as a big game animal in Wyoming by W.S. § 23-1-101 [1]. Harvest is regulated by Chapter 9 of the Wyoming Game and Fish Commission Regulations [2].

NATURAL HISTORY

Taxonomy:

Two species of wild sheep occur in North America; Dall's Sheep (also called "thin horn sheep"; *O. dalli*) and Bighorn Sheep (*O. canadensis*) [3]. Initial classification of Bighorn Sheep recognized 7 subspecies; Rocky Mountain Bighorn (*O. c. canadensis*), California Bighorn (*O. c. californiana*) and 4 subspecies of Desert Bighorn; Nelson's (*O. c. nelsoni*), Mexican (*O. c. mexicana*), Peninsular (*O. c. cremnobates*), and Weem's (*O. c. weemsi*) [4]. Also recognized was Audubon's Bighorn (*O. c. auduboni*), which may have occupied portions of eastern Wyoming before its extinction shortly after the turn of the 20th century. Recent classifications, however, only recognize 3 subspecies; Rocky Mountain Bighorn (*O. c. canadensis*), Sierra Nevada Bighorn (*O. c. sierrae*), and Desert Bighorn Sheep (*O. c. nelsoni*) [5]. Two populations (both distant from Wyoming) are listed as Endangered under the Endangered Species Act; Sierra Nevada Bighorn and Peninsular Desert Bighorn, a distinct population segment of *O. c. nelsoni* [6, 7]. In an effort to restore populations, nearly 1,500 separate translocations of Bighorn Sheep have been conducted throughout the United States and Canada [8]. In Wyoming, almost all of the 74 translocations conducted to-date have involved sheep from the Whiskey Basin, Wyoming herd to other locations in Wyoming, although 6 translocations of *O. c. canadensis* from Oregon, Montana, and Idaho have been released in Wyoming as well.

Description:

Bighorn Sheep is named for the large, circular horns possessed by adult males (rams). Females (ewes) also possess horns, but they are much smaller compared to those of males. Color patterns include a brown body with a white muzzle, underbelly, and rump patch with white lining down the back of the hind legs. Adult rams weigh 175–300 lbs (80–136 kg), while adult ewes weigh 125–200 lbs (57–91 kg) [9]. Ewes and small rams superficially resemble female Mule Deer (*Odocoileus hemionus*) and Elk (*Cervus canadensis*), and may be briefly confused with those species at a distance, but Bighorn Sheep is largely distinctive in appearance.

Distribution & Range:
Bighorn Sheep occurs in portions of the Cascade and Sierra Nevada mountain ranges, and throughout the Rocky Mountains from the Peace River in British Columbia south into northern Mexico [3]. In Wyoming, the subspecies *O. c. canadensis* occurs in four core herds in the Absaroka, Teton, Gros Ventre, and Wind River mountain ranges. Ten smaller herds which have been augmented or re-established via transplants occur in the Wyoming, Snowy, Sierra Madre, and Laramie mountain ranges, as well as the Seminoe and Ferris Mountains, southern end of the Wind River Mountains, west slope of the Bighorn Mountains, the Black Hills, and Wind River Canyon. Dispersing individuals – especially young rams – are sometimes documented far from mountain population centers. In 2014 the estimated statewide winter population (including those residing in Yellowstone National Park) of Bighorn Sheep was 6,450. The large core herds in the northwest corner of the state account for over 85% of Wyoming's statewide total, and represent some of the largest meta-populations of Bighorn Sheep throughout its range. Still, the fragmented pattern of habitat and population segments in Wyoming is an important management consideration.

Habitat:
Bighorn Sheep evolved in semi-open, high visibility habitats near rocky escape terrain that allow efficient foraging, enhanced detection of predators, and opportunities to evade them [10]. In northwest Wyoming, alpine tundra and areas of associated rocky escape terrain are used during summer. In winter, lower elevation, grassy benches and southerly slopes are used, with some herds or populations segments wintering on wind-swept ridges at high elevations. Bighorn Sheep in the rest of the state are typically non-migratory and use open grassy areas close to rocky canyons, cliffs, buttes, and similar escape terrain as year round habitat.

Phenology:
Bighorn Sheep is a year round resident of Wyoming. Sheep in the core herds of northwest Wyoming exhibit a variety of migratory strategies, from regular seasonal movements between high elevation summer ranges and lower winter ranges to year round occupation of high elevation ranges, and from simple altitudinal shifts to long distance (> 50 mi or 80 km) circuitous migrations. Sheep in other parts of Wyoming are primarily non-migratory, although some shorter seasonal movements may occur. Breeding occurs in late November and early December. Breeding is polygamous, with rams traveling between ewe-lamb groups seeking estrous ewes. Rams do not defend territories, nor tend harems, but establish dominance hierarchies through horn displays and/or physical horn to horn clashes [10]. Lambs are born in late May and early June. Non-migratory populations tend to lamb earlier, often as early as April. Ewes usually give birth to a single lamb - twinning is uncommon. In the wild rams rarely live beyond 10–12 years, while ewes may live 15 years or more.

Diet:
Bighorn Sheep is primarily a grazer, preferring perennial bunchgrasses in all seasons, although use of shrubs can be significant, particularly for non-migratory sheep occupying lower elevations year round [11].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD BUT DISJUNCT
Wyoming: UNCOMMON
In 2014, the Wyoming Game and Fish Department (WGFD) estimated there were 6,450 Bighorn Sheep in Wyoming, which includes approximately 200 in Yellowstone National Park and 100 in Grand Teton National Park. Wyoming has approximately 20% of the total number of *O. c. canadensis* in the contiguous United States and 15% of the total range-wide estimate of sheep (including Canada).

Population Trends:
Historic: INCREASE
Recent: STABLE
Prior to European settlement Bighorn Sheep lived in suitable habitats throughout Wyoming, including the low and rocky Ferris, Granite, Rattlesnake, and Shirley Mountains, and on bluffs along the Sweetwater and North Platte Rivers. While historic numbers were almost certainly greater than current populations, there are no precise estimates of previous abundance. In 1960 there were estimated to be 2,000 Bighorn Sheep in Wyoming, restricted entirely to the northwest corner of the state [12]. By 1990, this estimate had risen to over 7,000 and it has ranged between 6,000 and 7,000 since that time, with populations established in central, eastern, and southern Wyoming. Range wide population trends appear to be downward, but not significantly.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Bighorn Sheep is moderately vulnerable to extrinsic stressors. The species occurs as disjunct populations in relatively restricted habitats, and is particularly susceptible to respiratory pathogens (primarily bacterial pneumonia) [13] which are present in most populations in Wyoming. Coyote (*Canis latrans*) and Golden Eagle (*Aquila chrysaetos*) are effective predators of lambs, while Mountain Lion (*Puma concolor*) and, to a lesser extent, Gray Wolf (*Canis lupus*) prey on adult Bighorn Sheep [14]. Typically, predation is not significant enough to hamper population performance.

Extrinsic Stressors:
MODERATELY STRESSED
In addition to pathogens already possessed by Bighorn Sheep, transmission of respiratory pathogens from domestic sheep and goats can result in disease outbreaks and population declines [13, 15]. The invasion of noxious weeds has and continues to adversely affect Bighorn Sheep habitats [16], primarily by reducing availability and production of favored perennial bunchgrasses. Recreational activities (e.g., backcountry skiing, snowmachine use) can prevent sheep from using some habitats [17, 18]. Expansion of non-native Mountain Goat (*Oreamnos americanus*) has the potential to adversely affect sheep in core herds, particularly through competition for forage and space on high elevation winter ranges [19, 20]. Conifer encroachment and vegetative succession in the absence of periodic fire (either naturally ignited or prescribed) have diminished habitat quality by reducing sight-lines in formerly open areas. Conversely, widespread conifer mortality from Mountain Pine Beetle (*Dendroctonus ponderosae*) infestation may open and improve new Bighorn Sheep habitat. The cumulative impact of climate change is uncertain, as the loss of conifers from persistent insect infestations could increase sight-lines and forage production, but warming could also negatively influence forage quantity and quality on existing ranges. The

effect of warming on the distribution and abundance of important noxious weeds such as Cheatgrass (*Bromus tectorum*) may be especially important for Bighorn Sheep.

KEY ACTIVITIES IN WYOMING

Formed in 2000, the Wyoming Statewide Domestic Sheep-Bighorn Sheep Interaction Working Group (hereafter "Statewide Working Group") has worked collaboratively to prioritize acceptable risk and seek solutions to specific issues in Wyoming where commingling between Bighorn Sheep and domestic sheep and/or goats is possible [21]. The goal of the Statewide Working Group is to "maintain healthy bighorn sheep populations while sustaining an economically viable domestic sheep industry in Wyoming". The statewide plan developed by this working group was adopted into law by the 2015 Wyoming Legislature. The WGFD has embarked on substantial statewide disease surveillance to document the current disease status of all populations in the state. Since 2012 over 600 individual Bighorn Sheep have been captured and sampled (primarily in the core herds of northwest Wyoming), which has greatly increased understanding of Bighorn Sheep diseases. To assist in this effort, the WGFD upgraded facilities at the Thorne-Williams Wildlife Research Center to conduct additional disease related Bighorn Sheep research. Recent collaborations with Washington State University have been completed, current WGFD projects with captive Bighorn Sheep are underway, and future projects are planned. Other recent collaborations with the University of Wyoming and the Wyoming Cooperative Fish & Wildlife Research Unit include an assessment of Bighorn Sheep body condition as it relates to disease susceptibility, and a statewide genetic evaluation of Bighorn Sheep populations. A recently-initiated effort led by Montana State University, the WGFD, Montana Fish, Wildlife & Parks, Idaho Fish & Game, Yellowstone and Grand Teton National Parks, and the Shoshone, Bridger-Teton, Caribou-Targhee, Custer, and Gallatin National Forests will evaluate the impact of expanding Mountain Goats on Bighorn Sheep populations.

ECOLOGICAL INFORMATION NEEDS

Knowledge of Bighorn Sheep disease dynamics requires continued and additional investigation. This is particularly relevant with respect to translocating and/or "mixing" groups of sheep with different pathogens. Any additional increase and/or expansion of Bighorn Sheep in Wyoming will likely depend upon disease issues and the success of translocated herds into low-mid elevation mountain ranges outside of core herds in northwest Wyoming. A better understanding of the influence of expanding Mountain Goat populations on Bighorn Sheep is also needed. Projects are currently ongoing to address both of these issues. Information on the effect of changing climate on the quantity and quality of Bighorn Sheep habitat and the influence of exotic weed proliferation could help predict future impacts to Bighorn Sheep distribution and abundance.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Doug McWhirter. Bighorn Sheep is classified as a Species of Greatest Conservation Need in Wyoming. Monitoring of populations includes aerial and ground-based sex/age classification and/or trend surveys to document recruitment and population trends. Mandatory registration of hunter harvested sheep allows for detailed knowledge of hunter effort and success, average age of harvested rams, and provides opportunities to gather data on horn measurements and obtain biological and/or genetic samples. Voluntary hunter observation logs provide additional information on sheep location and abundance observations. Translocations of Bighorn Sheep are conducted in order to augment existing populations and to establish new herds. Most of these opportunities exist in low-mid elevation mountain ranges outside of the core herds of northwest Wyoming. In order to enhance the likelihood of success, specific attention is paid to closely match habitat selection characteristics and lambing chronology of "source" herds (often out-of-state) with habitats that occur in "target" release sites. Such actions are done in coordination with the Statewide Working Group in order to avoid conflicts between domestic and wild sheep. Monitoring and managing wild sheep disease issues will continue to be a necessary component of wild sheep management in Wyoming. Statewide disease surveillance efforts, disease research (including captive and field studies), and collaborative efforts such as the Statewide Working Group are all important aspects of this work. The WGFD has an internal Bighorn Sheep Working Group, comprised of population and habitat managers and wildlife disease specialists from around the state created to identify, consider, and address wild sheep management priorities in Wyoming. The WGFD also partners with land management agencies to design and implement habitat improvement projects, including prescribed burns, noxious weed treatments, and water guzzler installation. In addition to WGFD funds, research and monitoring efforts are made possible by financial contributions of wild sheep conservation organizations such as the Wyoming Chapter of the Wild Sheep Foundation and the Wyoming Governor's Big Game License Coalition.

CONTRIBUTORS

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Figure 1: Adult male (left) and female (right) Bighorn Sheep in Teton County, Wyoming. (Photo courtesy of Elizabeth Boehm)

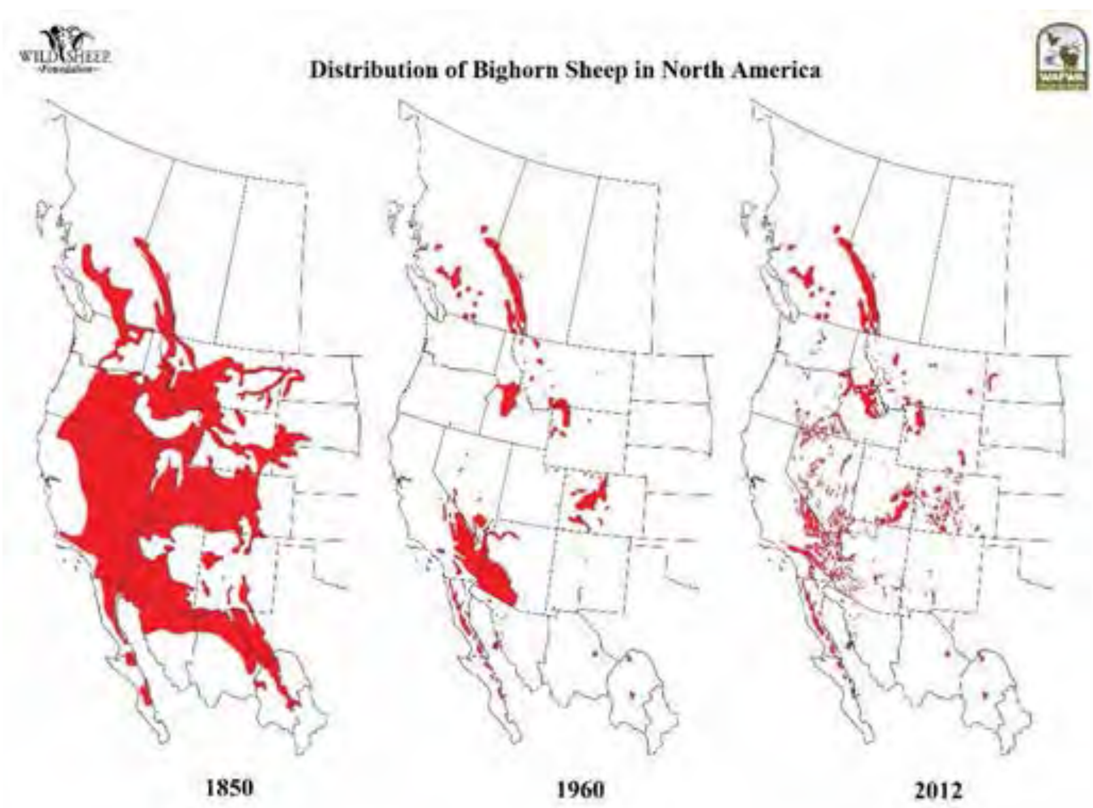

Figure 2: North American range of *Ovis canadensis* in 1850, 1960, and 2012. (Maps courtesy of the WAFWA Wild Sheep Working Group)

Figure 3: Rocky Mountain Bighorn Sheep on grassland winter range. (Photo courtesy of Mark Gocke)

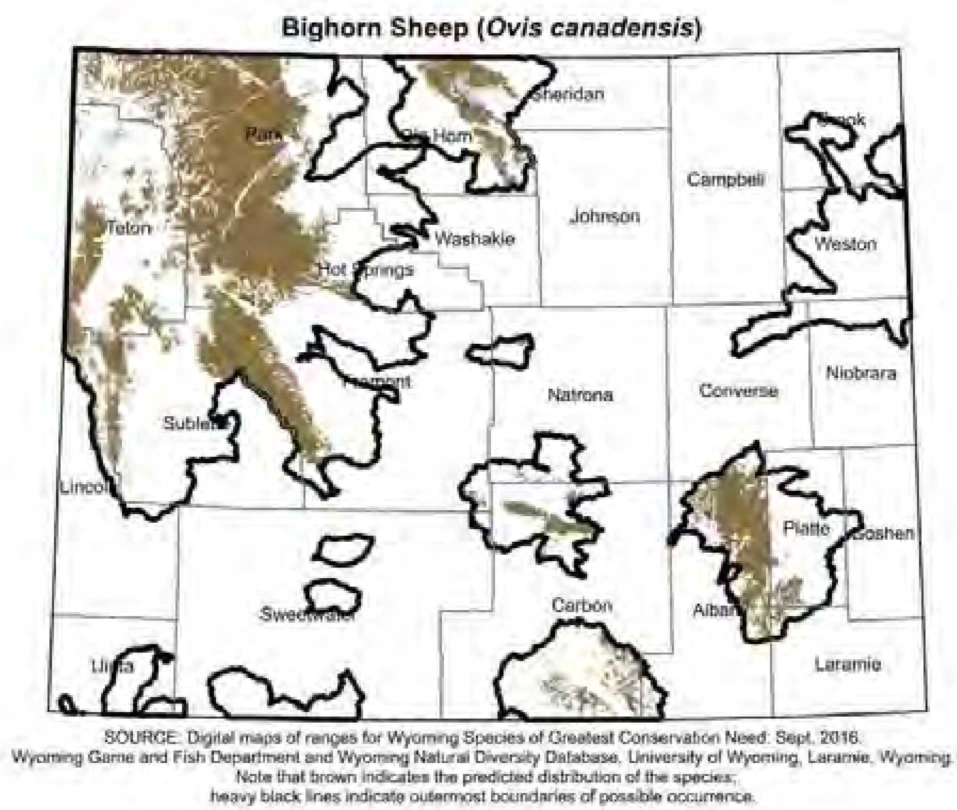

Figure 4: Range and predicted distribution of *Ovis canadensis* in Wyoming.

Black-footed Ferret
Mustela nigripes

REGULATORY STATUS
USFWS: Endangered
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Animal

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS1 (Aa), Tier I
WYNDD: G1, S1
Wyoming contribution: HIGH
IUCN: Endangered

STATUS AND RANK COMMENTS
Black-footed Ferret (*Mustela nigripes*) was listed as Endangered on the first Endangered Species List in 1967 [1]. Until recently, all Black-footed Ferrets in Wyoming were part of a reintroduced population in Shirley Basin, which is considered an Experimental, Non-Essential population under Section 10(j) of the Endangered Species Act [2]. The United States Fish and Wildlife Service (USFWS), in coordination with the Wyoming Game and Fish Department (WGFD), has recently implemented a statewide 10(j) designation for the species [3], which facilitated the addition of a new reintroduction site near Meeteetse. Black-footed Ferret is one of six species protected by Wyoming Statute §23-1-101.

NATURAL HISTORY

Taxonomy:
All Black-footed Ferrets are descended from 15 breeding individuals from a single population, which represented the genetic equivalent of 7 founders [4]. There are no recognized subspecies of Black-footed Ferret [5].

Description:
Black-footed Ferret is easily identified by a black face mask and black feet, legs, and tail tip. The dorsum is yellowish, and the undersides, forehead, muzzle, and throat are white. Males and females have identical markings, but females are approximately 10% smaller than males, which average 500 – 533 mm in length with the tail comprising 114–127 mm. Black-footed Ferret can be distinguished from Long-tailed (*M. frenata*) and Short-tailed (*M. ermine*) Weasels by its larger size and black mask and legs [5, 6].

Distribution & Range:
Historically, Black-footed Ferret existed throughout the Great Plains and generally followed the distribution of prairie dog (*Cynomys* spp.). The last known native population of ferrets was discovered near Meeteetse, Wyoming in 1981. When the last remaining individuals were taken

into captivity in 1987, ferrets were presumed extinct in the wild [6]. Black-footed Ferret has since been reintroduced at over 20 sites across the species' historic range in 8 states, Canada, and Mexico [4, 7]; additional reintroduction activities are on-going. All populations are highly isolated. The only extant populations in Wyoming are in Shirley Basin, where individuals were reintroduced beginning in 1991, and Meeteetse, where individuals were reintroduced in 2016. Wyoming is on the western edge of Black-footed Ferret's historic range [6].

Habitat:
Black-footed Ferret lives exclusively in prairie dog colonies, which are usually found in short and mid-grass prairies and semi-arid grasslands and shrublands [6]. Historically, Black-tailed Prairie Dog (*C. ludovicianus*) likely provided the majority of Black-footed Ferret habitat range-wide, but ferrets were associated with 3 of the 5 species of prairie dogs, including Black-tailed, White-tailed (*C. leucurus*), and Gunnison's (*C. gunnisoni*) Prairie Dogs [4]. In Wyoming, Black-footed Ferret was reintroduced to White-tailed Prairie Dog colonies in Shirley Basin and Meeteetse, which are characterized by mixed-grass prairie with patches of sagebrush (*Artemisia* spp.) and rabbitbrush (*Chrysothamnus* and *Ericameria* spp.). Black-footed Ferret spends most of its time in prairie dog burrows [6].

Phenology:
Breeding begins as early as late February and continues through early April, with gestation lasting 42–45 days [5]. Kits typically begin emerging from burrows in July and August but remain with the female until September to late October, at which time the kits disperse [8]. Dispersal is sex-biased, with juvenile males typically dispersing farther than females and ultimately leaving the natal prairie dog colony [6]. Ferrets do not hibernate and are active throughout the winter.

Diet:
Black-footed Ferret is a prairie dog specialist, with these species making up about 90% of the diet. Other prey items are taken infrequently and include mice, voles, cottontails, jackrabbits, ground squirrels, and potentially birds [5, 6, 8]. The importance of non-prairie dog food items in the diet differs between ages and sexes of ferrets, with adult females utilizing these other food items more often than adult males or juveniles [9].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD BUT PATCHY
Wyoming: VERY RARE
Black-footed Ferret was historically found across the Great Plains but never in high numbers [7]. Since 1991, nearly 4,000 Black-footed Ferrets have been reintroduced. As of 2012, a minimum of 418 breeding adults were estimated in wild populations throughout reintroduction sites [4, 10]. Although the estimated abundance of Black-footed Ferret in Shirley Basin, Wyoming has been stable since 2006 (range 203–229 individuals), the population showed a decrease in 2013 to a minimum of 39 individuals known alive [11]. The most recent surveys in Meeteetse detected 19 individuals.

Population Trends:
Historic: LARGE DECLINE
Recent: INCREASE

Abundance of Black-footed Ferret has declined drastically since the early 1900s [6]. In 1991, the first captive-bred individuals were released in Shirley Basin, Wyoming, with 228 individuals released over a 4-year period [4, 6, 7]. The population subsequently suffered an outbreak of Sylvatic Plague (*Yersinia pestis*) and Canine Distemper (*Morbillivirus*), and only 5 ferrets were located in 1997. Populations began to increase in 2003 and exhibited exponential growth until 2006 [12], when the population began to stabilize [11]. From 2005 to 2007, the population was supplemented with 250 ferrets in areas north and south of Shirley Basin. However, recent survey efforts suggest populations likely declined between 2011 and 2013 [11]. In Meeteetse, 35 ferrets were released in 2016, and additional releases are planned for both 2017 and 2018; population trends at this site will be evaluated in the coming years.

Intrinsic Vulnerability:
HIGH VULNERABILITY
Black-footed Ferret is a prairie dog specialist, depending almost exclusively on prairie dogs for food and burrows for habitat. Consequently, the size of prairie dog colonies and density of burrows are the most important factors in the success of reintroduction sites [13]. Additionally, both ferrets and prairie dogs are very susceptible to sylvatic plague [14], which has historically been responsible for population crashes at both Meeteetse and Shirley Basin [4, 12]. Finally, because all ferrets originated from 15 founding individuals, lack of genetic diversity remains a concern, although captive breeding is highly regulated in order to maintain diversity, thereby minimizing this threat to the greatest extent possible [4]. However, reintroduced populations remain highly isolated, making natural genetic exchange unlikely and nearly eliminating the possibility of natural recovery from local extinctions.

Extrinsic Stressors:
MODERATELY STRESSED
Perhaps the greatest threat to the persistence of Black-footed Ferret is the availability of large prairie dog colonies for food and shelter. Because prairie dogs are classified as a pest species in Wyoming [15], they are exposed to a number of anthropogenic threats, including poisoning and, to a lesser extent, recreational shooting [4, 16]. Loss of prairie dog colonies in Wyoming and across the species' entire range limits successful reintroduction potential for Black-footed Ferret [6, 13]. Wind farms are also becoming more common in Black-footed Ferret habitat, potentially leading to habitat loss, direct mortality through vehicle collisions, and indirect threats through prairie dog control around turbines. Although now established throughout the western United States, plague is an exotic disease that will likely continue to require active management [4].

KEY ACTIVITIES IN WYOMING

Wyoming has been an integral player in the recovery of Black-footed Ferret and developed the first successful captive breeding program, provided the entire breeding stock for reintroduction efforts, and maintains the first and longest-lasting successful reintroduction site at Shirley Basin as well as the newest reintroduction site at Meeteetse. The WGFD conducts annual surveys for Black-footed Ferret at these sites to evaluate distribution, reproduction, survival, and abundance [11] as well as evaluates additional potential reintroduction sites where suitable prairie dog habitat is found. The WGFD is also participating in a multi-state, collaborative trial to evaluate the efficacy of oral baits in vaccinating prairie dogs for plague at Meeteetse [17, 18]. The Black-footed Ferret Recovery Implementation Team (BFFRIT), comprised of members from 48 government agencies, Indian tribes, universities, and conservation organizations, was founded in 1996 with an overall goal of ferret recovery [10], and the Wyoming Black-footed Ferret Working Group was reestablished in 2016. The national Black-footed Ferret Recovery Plan was revised in 2013 [4]. Following the statewide 10(j) rule for Black-footed Ferrets in Wyoming, the WGFD, in collaboration with the USFWS, released 35 Black-footed Ferrets to Meeteetse in July 2016.

ECOLOGICAL INFORMATION NEEDS

The ecology and biology of Black-footed Ferret has been extensively studied. However, new reintroduction sites with sufficient prairie dog populations still need to be identified in Wyoming and throughout the range. This is likely the most pressing information need for the species. Both sylvatic plague and canine distemper are important diseases in ferret populations. Although sylvatic plague and canine distemper vaccinations are provided regularly to captive individuals and prior to release and to wild-born individuals captured during monitoring efforts, capturing individuals to administer vaccines is patchy and time-consuming, and we still lack a vaccine for plague that can be administered to wild ferrets consistently and effectively. However, preliminary results from field trials with an oral plague vaccine for prairie dogs are showing some promise. Additionally, relatively recent threats to habitat, such as wind farms, likely warrant further investigation. Finally, the cause of the recent decline in Shirley Basin and whether it represents a long-term or temporary decline is in need of further investigation.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Recent management priorities for Black-footed Ferret have focused on reintroductions and population monitoring in Shirley Basin and Meeteetse, Wyoming. Moving forward, management activities will include continuing to address these objectives, working with landowners and land managers to conduct additional reintroductions under the statewide 10(j) designation for Black-footed Ferret, developing a statewide management plan for Black-footed Ferrets in Wyoming, and collaborating on projects to evaluate and conduct plague control efforts. The WGFD will also continue to actively participate in the BFFRIT and the Wyoming Black-footed Ferret Working Group and coordinate with landowners and land managers to promote information dissemination, habitat conservation, and management activities. Through this collaborative process, WGFD will work to locate and evaluate additional reintroduction sites throughout the state.

CONTRIBUTORS

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Figure 1: A Black-footed Ferret at a Black-tailed Prairie Dog (*Cynomys ludovicianus*) colony in the short-grass prairie of Logan County, Kansas. (Photo courtesy of Brian Zinke)

Figure 2: Map not available.

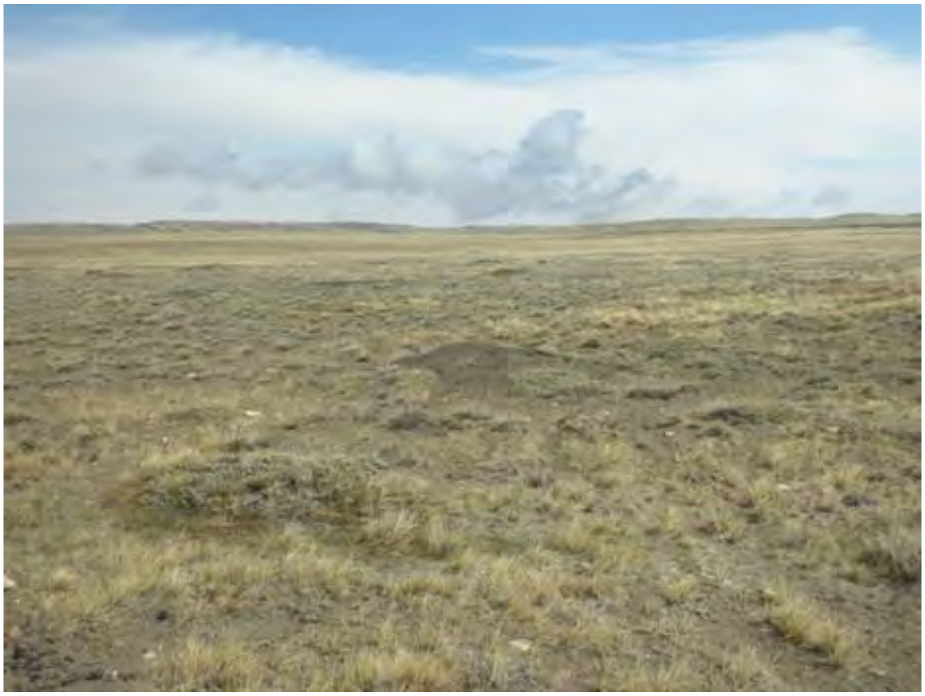

Figure 3: Black-footed Ferret habitat in Shirley Basin, Wyoming. (Photo courtesy of Katie Leuenberger)

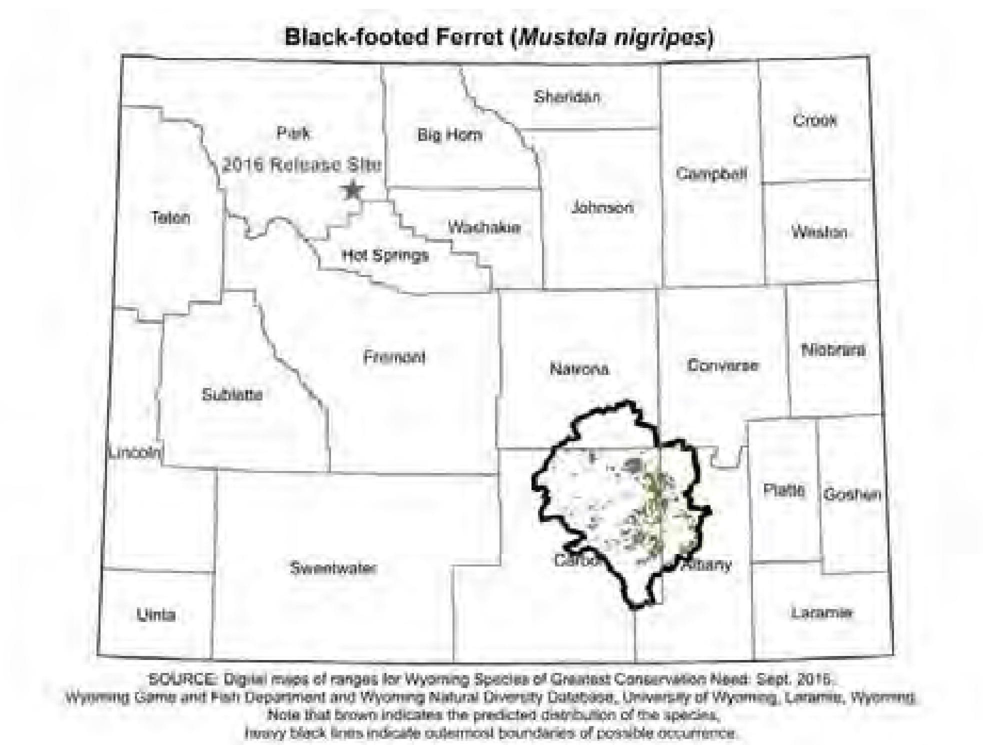

Figure 4: Range and predicted distribution of *Mustela nigripes* in Wyoming.

Black-tailed Prairie Dog

Cynomys ludovicianus

REGULATORY STATUS

USFWS: Listing Not Warranted
USFS R2: Sensitive
USFS R4: No special status
Wyoming BLM: Sensitive
State of Wyoming: Nongame Wildlife; Pest

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS4 (Cb), Tier II
WYNDD: G4, S2S3
    Wyoming contribution: MEDIUM
IUCN: Least Concern

STATUS AND RANK COMMENTS

Black-tailed Prairie Dog (*Cynomys ludovicianus*) has a complicated history with the U.S. Endangered Species Act (ESA) involving several petitions, decisions, litigations, and re-decisions, beginning with a petition to list the species as Threatened or Endangered in 1994. The latest official action was a 2009 decision by the U.S. Fish and Wildlife Service that listing was not warranted under the ESA [1]. The Wyoming Natural Diversity Database has assigned Black-tailed Prairie Dog a range of state conservation ranks because of uncertainty regarding the severity of threats and intrinsic vulnerability in Wyoming.

NATURAL HISTORY

Taxonomy:

Mammalogists currently recognize five species of prairie dog, all within the Genus *Cynomys* and all restricted to North America [1, 2]. Black-tailed Prairie Dog is the most widely distributed of all, occupies the Great Plains proper, and shares range boundaries with the White-tailed Prairie Dog (*C. leucurus*) and Gunnison's Prairie Dog (*C. gunnisoni*) to the west. None of the species apparently hybridizes with any other. Some scientists recognize two subspecies of the Black-tailed Prairie Dog – *C. ludovicianus arizonensis* and *C. ludovicianus* – but others recognize only one form. If subspecies are valid, *C. l. ludovicianus* would be the only subspecies found in Wyoming [3, 4].

Description:

Black-tailed Prairie Dog is identifiable in the field. It is a large (adult total length 370 mm, weight 820 g) ground squirrel with a robust, stocky body and short legs. Pelage is buff brown, and the tail is tipped with black. Black-tailed Prairie Dog almost always occurs in social groupings marked by high densities of individuals and many conspicuous burrow entrances. The black-tipped tail distinguishes Black-tailed Prairie Dog from the otherwise similar White-tailed Prairie Dog, and its large size distinguishes it from other ground squirrels (*Urocitellus*, *Xerospermophilus*, and *Ictidomys*) whose adults reach only ca. 75% of the total length and < 50% the weight of Black-tailed Prairie Dog [5].

Distribution & Range:
Historically, Black-tailed Prairie Dog occupied short- and mixed-grass prairie from southern Saskatchewan to northern Mexico and from the front ranges of the Rocky Mountains east to about the current Nebraska/ Iowa border. It is estimated that occupied range has declined by > 95% relative to historic levels [1, 3]. Although that estimate has been challenged, it is generally accepted that the species has undergone major declines in abundance and occupied area within its historic range boundaries [5, 6]. Black-tailed Prairie Dog still occurs across most of its historic range, but does so now as a scattering of small and highly-segregated colonies as opposed to its more continuous former pattern. This appears to be the case within Wyoming as well, with colonies of various sizes and insularities extending from the state's eastern border west to the Laramie and Bighorn Mountains [5, 7]. Black-tailed Prairie Dog overlaps with White-tailed Prairie Dog along a ca. 60 km-wide zone running roughly between the towns of Casper and Kaycee, Wyoming [5]. The species is not known from the Bighorn Basin, although there are reports of a small, human-introduced colony west of the town of Cody, Wyoming – existence and current status of such a colony is unknown.

Habitat:
Black-tailed Prairie Dog is found in short to mid-grass prairies on flats or shallow slopes. Such environments are likely preferred because they provide abundant food (grasses and forbs; see Diet) as well as long sight distances for predator detection [4]. Persistent grazing by Black-tailed Prairie Dog maintains short vegetation on and near occupied colonies [4, 8]. Shrublands and tall grasses are avoided [3, 9]. Black-tailed Prairie Dog additionally prefers fine, non-sandy soils that can hold burrows, as it lives in extensive self-dug burrow systems year-round. The species is commonly referred to as a keystone species because of the suite of effects it has on occupied grasslands: the concentration of prairie dogs themselves in an occupied colony provides reliable prey for predators such as Black-footed Ferret (*Mustela nigripes*) and Ferruginous Hawk (*Buteo regalis*); prairie dog burrows are used as cover by many other vertebrate and invertebrate animals; and infiltration of air, water, feces, and other biomass into the soil profile via burrows can increase long-term site productivity [10].

Phenology:
Black-tailed Prairie Dog breeds from February to March. Most individuals first breed in the second winter following their birth, with a few breeding in the first winter. Litters of 1–8 pups are born about 5 weeks after breeding. Young remain underground for 5–7 weeks, then emerge and begin independently feeding on vegetation. Juvenile males disperse from their natal burrow system at about 1 year of age. Adult males also relocate to a new burrow when daughters become mature. Females tend to remain in or near their natal burrow for life. Black-tailed Prairie Dog does not hibernate, but will undergo periods of temporary torpor during especially cold winter episodes [2, 4, 11].

Diet:
Black-tailed Prairie Dog is strongly herbivorous, feeding on stems, leaves, seeds, and roots of a variety of plants. Prickly pear cactus (*Opuntia* spp.) pads and roots are a major food source in the winter [2, 3]. Occasional eating of insects is reported, but the degree to which this occurs or is needed to fill particular nutritional gaps is unknown.

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD BUT PATCHY
Wyoming: ABUNDANT
A range-wide survey completed in 2015 estimated 1,932,826 acres of potential Black-tailed Prairie Dog colonies across all 11 states currently occupied. After adjusting for errors of commission, Wyoming is estimated to contain 2,505 active black-tailed prairie dog colonies (90% CI: 2,356–2,656), totaling 216,166 acres (90% CI: 199,776–242,419). Of those colonies, 18 (90% CI: 11–26) were > 1,000 acres each and totaled 33,389 acres (90% CI: 20,826–52,051) combined [7].

Population Trends:
Historic: LARGE DECLINE
Recent: MODERATE DECLINE
Rangewide assessments suggest that in the early 1900s Black-tailed Prairie Dog numbered in the billions, covering > 30 million ha [3]. Large declines have occurred since then due to habitat conversion, deliberate eradication via poisoning and other methods, and disease [6, 12]. Epizootics of sylvatic plague – an exotic disease caused by the bacterium *Yersinia pestis* and carried by fleas – is thought to have continued the decline of the species into recent decades [13]. By 1997, Black-tailed Prairie Dog numbers had decreased by an estimated 98–99% from their historic levels [1, 3], although that estimate is debated [5, 6]. Similarly, occupied area in Wyoming is estimated to have decreased by > 80% from historic levels [14], although determining the precise level of long-term statewide decline is problematic [6]. Even though recent state-wide surveys have utilized different techniques, results suggest little change in total occupied acres since formal surveys were initiated in 2003 [7, 15-17].

Intrinsic Vulnerability:
MODERATE to HIGH VULNERABILITY
Black-tailed Prairie Dog is very susceptible to sylvatic plague, which can kill up to 95% of prairie dogs in infected colonies [13, 18]. Plague outbreaks in prairie dogs can occur anywhere in Wyoming, and the flea-borne pathogen persists in many common mammal species between outbreaks. Although Black-tailed Prairie Dog has the ability to disperse up to 5 km, individuals rarely disperse beyond their natal colony. Low dispersal rates may make it difficult for Black-tailed Prairie Dog to colonize new sites [3, 4].

Extrinsic Stressors:
MODERATELY STRESSED
Sylvatic plague appears to be a constant threat to Black-tailed Prairie Dog as it persists in fleas infecting a range of common mammals throughout the state. Also, Black-tailed Prairie Dog is classified as a pest species in Wyoming, making lethal control activities legal [1]. Common control methods include poisoning and shooting, with the latter pursued for recreation as well as control. When used locally and intensively, both have the potential to remove whole colonies of Black-tailed Prairie Dogs [19, 20]. Conversion of grassland to cropland, urban/exurban development, and industrial infrastructure can threaten Black-tailed Prairie Dog, although these land conversions are relatively uncommon in Wyoming compared other parts of the species' range [3]. Energy-related development is increasing in some portions of Black-tailed Prairie Dog range in Wyoming, but it is unknown how energy development specifically affects the species.

KEY ACTIVITIES IN WYOMING

In 1998, the Interstate Black-tailed Prairie Dog Conservation Team was formed in response to a potential petition for protection of the Black-tailed Prairie Dog under the ESA. The team developed a multi-state conservation plan which provided management guidelines and goals for states [21]. As part of this plan the Wyoming Game and Fish Department (WGFD) has utilized multiple survey techniques, including digitizing colonies from NAIP imagery and aerial surveys, to monitor distribution and area of Black-tailed Prairie Dog colonies every 3–6 years [15-17]. The latest in this series of surveys was completed in 2015 as part of a range-wide survey effort. The survey provided not only the most recent estimates of distribution and size of colonies, but also developed a survey protocol and sampling scheme that can be used by wildlife managers in all states within the species' range [7]. Black-tailed Prairie Dog is also surveyed and mapped at more local scales as part of energy development activities, and colonies on the Thunder Basin National Grassland have been mapped and monitored for several years in the context of U.S. Forest Service management goals. There is active research into the control of sylvatic plague in Black-tailed Prairie Dog colonies, the results of which will be vital to management of the species and its ecological associates [22].

ECOLOGICAL INFORMATION NEEDS

Recently, the WGFD contracted with Western Ecosystems Technology, Inc. to develop and implement protocols to monitor Black-tailed Prairie Dog statewide. Repeating these surveys periodically will be critical in order to track trends in range and abundance in the state. Careful analysis of dispersal distances and colony productivity may reveal optimal spatial arrangements of nearby colonies that can maintain genetic and demographic vigor while simultaneously minimizing the spread of plague during outbreaks. Continued research into the practical control of sylvatic plague – the primary threat to Black-tailed Prairie Dogs – is also needed. Better tracking of the amount and distribution of poisoning and shooting mortality would assist managers in maintaining viable populations at local scales. Research on the keystone ecological effects of Black-tailed Prairie Dog may suggest efficiencies in managing a host of grassland species of concern.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Black-tailed Prairie Dog is classified as both a pest and a nongame species in Wyoming, and, as such, both the Wyoming Department of Agriculture and the WGFD have shared management authority for prairie dogs, which makes management of Black-tailed Prairie Dog difficult. Recent management activities for the WGFD for Black-tailed Prairie Dog have focused on funding surveys to evaluate presence and size of colonies as well as determine total occupied acres statewide. Current priorities include continuing state-wide monitoring efforts to evaluate population trends every 3–5 years and evaluate the impacts of potential threats. Although there are not currently any Black-footed Ferret reintroduction areas located in Black-tailed Prairie Dog colonies, additional priorities will include localized on-the-ground colony mapping and population monitoring in support of Black-footed Ferret reintroduction efforts, if and when they occur. Sylvatic plague control efforts, including insecticide dusting and vaccine baits, will be implemented on a local scale as necessary, with priority given to potential Black-footed Ferret reintroduction sites. Finally, the WGFD will continue active involvement with the interstate Prairie Dog Conservation Team and collaborate with the Western Association of Fish and Wildlife Agencies on the range-wide conservation needs for this species. Outreach and collaboration with private landowners will remain a priority to ensure conservation of prairie dogs and prairie dog habitat.

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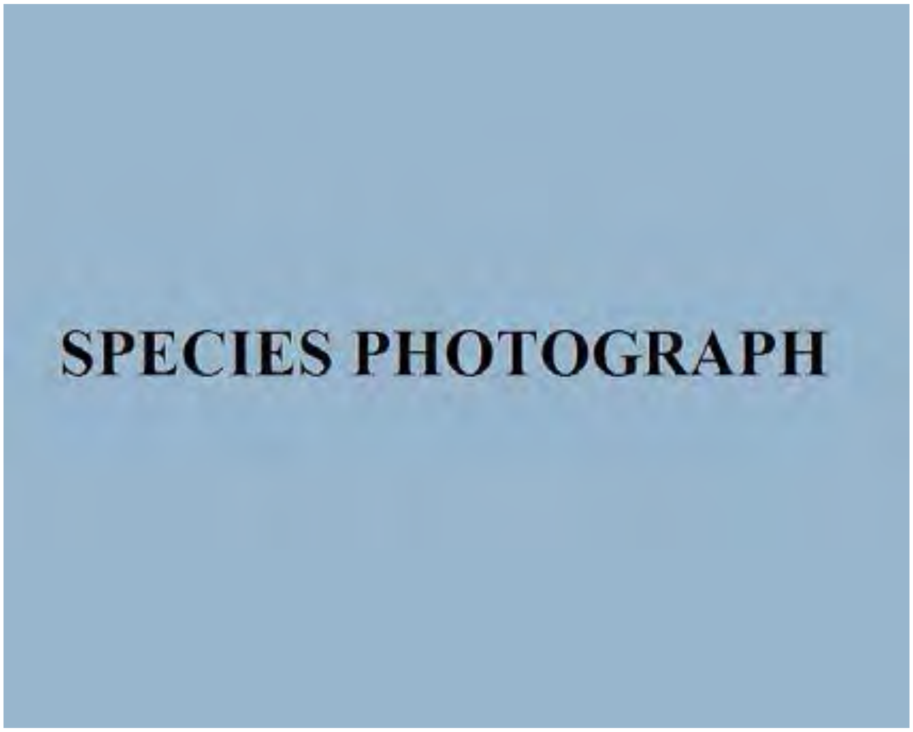

Figure 1: Photo not available.

Figure 2: North American range of *Cynomys ludovicianus*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Black-tailed Prairie Dog habitat in Thunder Basin National Grassland near Newcastle, Wyoming. The mounds of the colony can be seen in the distance. (Photo courtesy of Michael T. Wickens)

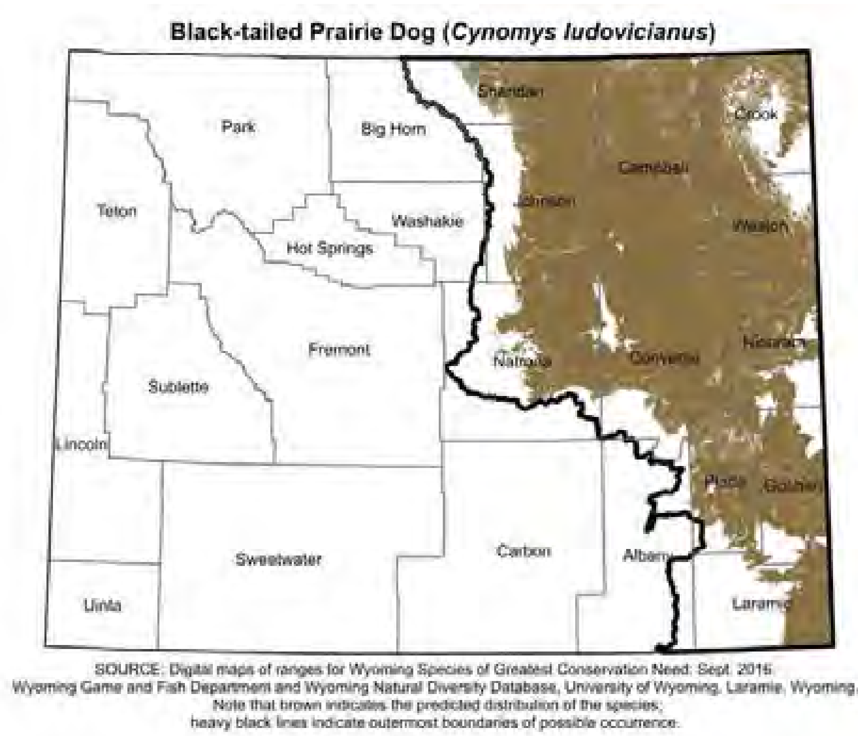

Figure 4: Range and predicted distribution of *Cynomys ludovicianus* in Wyoming.

Canada Lynx
Lynx canadensis

REGULATORY STATUS
USFWS: Threatened
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Animal

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS1 (Aa), Tier I
WYNDD: G5, S1
Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS
Canada Lynx (*Lynx canadensis*) was designated Threatened under the U.S. Endangered Species Act (ESA) in 2000 [1, 2]. The U.S. Fish and Wildlife Service (USFWS) has designated northwestern Wyoming as part of the "Greater Yellowstone Area unit of Critical Habitat" for Canada Lynx recovery. Canada Lynx in southern Wyoming (primarily the Medicine Bow Mountains and Sierra Madre) and Colorado are considered by the USFWS to be part of a Southern Rocky Mountain subpopulation, and the agency originally did not propose Critical Habitat in that region. However, a September 2016 court decision directed the USFWS to re-evaluate the need to designate Critical Habitat in the Southern Rocky Mountains [3].

NATURAL HISTORY

Taxonomy:
Older designations of Canada Lynx as *Felis lynx* and *L. lynx* have formally yielded to *L. canadensis*, but still appear in some relevant literature [1, 4]. Canada Lynx was formerly considered conspecific with Eurasian Lynx (*L. lynx*), but the two species have since been clearly distinguished morphologically, behaviorally, and genetically [5, 6]. Canada Lynx is the only form in North America. There are two recognized subspecies: *L. c. canadensis*, which occurs throughout most of the species' range including Wyoming; and *L. c. subsolanus* which is restricted to Newfoundland [4, 6]. Individuals reintroduced into Colorado (with subsequent dispersal of some into Wyoming) from 1999–2006 were *L. c. canadensis* originally captured in Canada and Alaska [7]. Hybridization with Bobcat (*L. rufus*) is possible, but no such animals have been documented in the western U.S. [2, 8].

Description:
Canada Lynx is identifiable in the field. It is a medium-sized (adult weight 6–12 kg) cat with relatively long legs, short tail, and tufted ears. Winter pelage is brownish-gray with a grayish-white to buff-white underside; summer pelage is reddish to gray-brown. There is a noticeable

flared ruff of fur around the face and jaws. Canada Lynx can be distinguished from the similar-appearing Bobcat by its completely black-tipped tail (Bobcat tail tips are black above and white below), longer legs, more prominent ear tufts, lack of noticeable spotting on fur, and larger paws (especially useful in identifying tracks in snow) [4, 5, 9].

Distribution & Range:
Canada Lynx extend from Alaska eastward to the Atlantic coast of Canada, with southern extensions into the contiguous U.S. along the Rocky Mountains and Cascade Mountains, and also into New England and the Great Lakes region [4, 9]. Historically, the species may have extended throughout the Southern Rocky Mountains to northern New Mexico, but a ca. 40% reduction in the continental range of the species over the past century likely resulted in extirpation from that ecoregion [2, 10]. Despite this range contraction, Canada Lynx likely persisted in the forests of northwestern Wyoming. Canada Lynx has been recently reintroduced into Colorado (1999–2006), and some individuals have dispersed into adjacent states including Wyoming [5, 7]. It is unknown if this reintroduction will result in long-term occupation of the Southern Rocky Mountains. Persistence of Canada Lynx in southern portions of its range, including Wyoming, may depend highly on continued in-migration of individuals from more northerly breeding centers [11, 12]. Canada Lynx can disperse very long distances across non-typical habitats (i.e., grasslands, desert basins), and individual dispersers are occasionally documented far from the species' main mountain centers of occurrence [2, 7, 13]. Home range size fluctuates with prey availability, and adults are known to become nomadic and disperse to new regions when prey is extremely low [2].

Habitat:
Canada Lynx occupies cool, moist coniferous forests at 1,500–3,500 m elevation. The species prefers forested landscapes with cold, snowy winters and abundant Snowshoe Hare (*Lepus americanus*), its primary prey [4, 9]. Preferred forest types in Wyoming differ in subtle but important ways from preferred types in more northern areas. Early-seral, regenerating conifer stands can be good habitat for Snowshoe Hare and Canada Lynx in moist northern forests [14], but in the drier mountains of Wyoming and Colorado such stands often lack the brushy under- and mid-stories apparently preferred by both species. Late-seral, multi-storied conifer stands dominated by Engelmann Spruce (*Picea engelmannii*) and Subalpine Fir (*Abies lasiocarpa*), and mid-seral (i.e., 30–70 year-old) stands of Lodgepole Pine (*Pinus contorta*) with high stem densities, support the most Snowshoe Hare in western Wyoming [15]. Mosaics of these two forest types are recommended for producing high availabilities of Snowshoe Hare and Red Squirrel (*Tamiasciurus hudsonicus*) – an important alternative prey item (see Diet) – in Colorado [2, 16]. Canada Lynx raises kittens in dens established under upturned rootwads, within piles of downed trees, among boulders, and in other natural shelters within or near foraging habitat [2, 17]. Deep, soft, and persistent snow is an important winter habitat feature, as Canada Lynx is better adapted for moving across snow than other carnivores such as Coyote (*Canis latrans*) and Bobcat, which can prey on and compete with Canada Lynx. Southern populations of Canada Lynx coexist with a rather diverse and dense community of generalist carnivores, the consequences of which are likely complex and not well-understood [18].

Phenology:
Canada Lynx is solitary except during breeding season, which occurs in March and April. Kittens are born about two months later. Rangewide, litters typically include 3–4 kittens [9], but in Wyoming and other southern areas litters may be consistently smaller [2, 4]. Females provide all

parental care and often move kittens to different dens during development. Kittens open their eyes at about 15 days, walk at about 27 days, and eat solid food at about 30 days but can continue to nurse for 6 months. Kittens remain with their mother for 8–10 months and then disperse in late winter or early spring [4, 9]. Canada Lynx do not migrate in the classic sense, but they may track deeper snow conditions by generally moving down in elevation in the fall and up in the spring. Dispersing individuals can traverse vast distances and non-typical habitats [1, 7], and dispersal is possible in any season as even adults will disperse in response to low prey availability. Importantly, southern populations of Canada Lynx (and Snowshoe Hare) do not appear to undergo regular multi-year cycles in abundance like core northerly populations [2].

Diet:
Throughout its range Canada Lynx relies heavily upon Snowshoe Hare as primary prey [9], but it is also an effective predator of many birds and small-to-medium sized mammals [2]. Canada Lynx in southern areas relies more heavily on alternative prey, as Snowshoe Hare densities are chronically low relative to Canada and Alaska. Red Squirrel is an important alternative prey in many areas, including Colorado and likely Wyoming [16]. The diet breadth of Canada Lynx in Wyoming may be rather large and requires more state-specific research.

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
Canada Lynx is found at very low densities in Wyoming. The Wyoming Game and Fish Department (WGFD) conducted extensive surveys in the northwest corner of the state in 2005 and 2006, finding a total of three individual Canada Lynx (two of which originated from the Colorado reintroduction) [19, 20]. It is thought that most Canada Lynx in Wyoming originate from populations outside of the state (i.e., Idaho, Montana, and Colorado), with only occasional recruitment of individuals produced within Wyoming itself [4].

Population Trends:
Historic: MODERATE DECLINE
Recent: MODERATE INCREASE
Because of naturally low densities, extreme movement ability, and cryptic lifestyle, there is little information about Canada Lynx population trends in Wyoming or surrounding regions. It is assumed that increased human development of Canada Lynx habitat has caused a decline from historic numbers across the species' southern range [2, 10]. Fragmented landscapes are thought to increase disperser mortality and decrease dispersal rates [2]. Because Canada Lynx abundance in Wyoming is very low and may depend largely on dispersal from populations outside the state, it is difficult to estimate short-term trends in Wyoming [4]. The Colorado reintroduction has provided a new source of animals dispersing into Wyoming [7], but the long-term productivity and persistence of the reintroduced population is still in question [11, 12].

Intrinsic Vulnerability:
HIGH VULNERABILITY
Canada Lynx in Wyoming is a strong habitat specialist that depends on large expanses (home ranges ca. 100–200 km^2 in Wyoming [17, 21]) of mature subalpine forest, making the species vulnerable to habitat fragmentation and alteration [2, 4]. Canada Lynx depends strongly on Snowshoe Hare, and to a lesser extent Red Squirrel, as primary prey, and such prey

specialization further increases intrinsic vulnerability. Canada Lynx has the potential to have large litters (up to 6 kittens) [9], but when prey density is low (as may always be the case in Wyoming relative to northern population centers) litter sizes are smaller and kittens are less likely to survive [2, 4]. Canada Lynx persistence in Wyoming may depend highly on continual in-migration from distant centers of reproduction. Evidence suggests limited local reproduction – failure to reproduce, and complete litter mortality from starvation, have been documented in Wyoming [2, 4, 17, 20].

Extrinsic Stressors:
MODERATELY STRESSED
Across its range Canada Lynx was subjected to unrestricted shooting and trapping, enhanced by bounties and predator/pest designations, until the mid-20th century [1]. The species is now protected from deliberate harvest in Wyoming and adjacent states but still suffers some human-caused mortality. Of 65 known-cause deaths of Canada Lynx documented during the first 8 years of the Colorado reintroduction, 13 (20%) were from vehicle collision, 14 (22%) were from shooting, and 5 (8%) were from probable shooting [7]. Human-caused mortality is commonly noted elsewhere in the species' range [2]. Compared to northern areas, habitat quality (measured primarily by Snowshoe Hare density) and connectivity is generally low in Wyoming, and thus populations may be less resilient to habitat disturbances in the state [2]. Large scale habitat conversion is unlikely, but activities like clearcut timber harvesting, wildfire fuel reductions, changes to fire regimes, and increased recreation decrease habitat quality for Canada Lynx [2]. Disturbances to low-elevation habitats may also threaten the species' persistence if it impedes dispersal into the state [4]. Plowed roads, packed ski paths, and snow-machine trails allow Coyotes and other generalist carnivores to extend their winter ranges into formerly snow-bound areas [22-24], although if and to what degree this impacts Canada Lynx populations is still unknown. The effects of global climate change on boreal ecosystems is still debated in the expert community, but there is substantial concern about potential negative effects on boreal forests and associated species like Canada Lynx [2, 25].

KEY ACTIVITIES IN WYOMING

The Lynx Conservation Assessment and Strategy was developed in 1998 by federal agencies to provide guidelines to better conserve Canada Lynx on federal lands. The document has been revised, with the latest version (3rd Edition) published in 2013 [2]. In 2005 the USFWS outlined a recovery plan for Canada Lynx in the U.S. [25], and a final Recovery Plan is expected by January 2018. The USFWS is also currently developing a Species Status Assessment and 5-year review for Canada Lynx. The reintroduction of Canada Lynx into Colorado (1999–2006) has generated a new source of individuals that occasionally disperse into Wyoming [7]. WGFD conducted extensive surveys in the northwest corner of the state in 1997-2000 and again in 2005-2006. The first set of surveys documented Canada Lynx tracks in the Wyoming, Absaroka, and Wind River Ranges, and a male and female were captured and collared. Although they produced kittens, none were thought to survive, and the female eventually died, likely from starvation [17, 26, 27]. The second set of surveys resulted in detections of 3 Canada Lynx (2 of which originated from the Colorado reintroduction program) [19]. The U.S. Forest Service began conducting remote-camera, occupancy surveys in Canada Lynx habitat throughout the Bridger-Teton and southern Shoshone National Forests in Wyoming in 2015; surveys have not yet resulted in any detections. The WGFD will begin incorporating a lynx-specific lure into on-going Wolverine (*Gulo gulo*) occupancy surveys in northwestern Wyoming in an attempt to document Canada Lynx. Recent work has helped clarify Snowshoe Hare habitat preferences in Wyoming [15], which is a critical piece of information for managers.

ECOLOGICAL INFORMATION NEEDS

Canada Lynx has been well-researched within the core of its range, but, due to extremely low densities, relatively little is known about the species in southern areas like Wyoming, although research into population metrics and threats to the Colorado subpopulation is on-going. Given the species' apparently tenuous residency in Wyoming, research that elucidates the relative dependence of the state population segment on immigrants versus recruitment of individuals produced within Wyoming itself will be valuable to resource managers. Several aspects of Canada Lynx life history may be different in Wyoming compared to better-understood northern areas, and thus within-state research – although difficult given low densities – could also assist managers. Relevant topics include diet breadth and use of prey other than Snowshoe Hare, competition with and predation by generalist carnivores such as Coyote and Bobcat, and Canada Lynx (and Snowshoe Hare) use of forests recovering from Mountain Pine Beetle (*Dendroctonus ponderosae*) epidemics. Continued use of occupancy-based detection methods, coordinated both spatially and temporally with similar efforts in surrounding states, would be an efficient and effective way to monitor Canada Lynx in Wyoming [28].

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Survey efforts for Canada Lynx in Wyoming in the last 2 decades have resulted in decreasing numbers of detections, with no verified observations in roughly the last 10 years. Consequently, management priorities in the short term include collaborating with partners to evaluate current status and presence of Canada Lynx in the state, including incorporating protocols to detect Canada Lynx with other ongoing forest carnivore surveys. In the longer term, priorities include working with the USFWS to develop a final Recovery Plan and implementing recommended management and conservation actions to ensure recovery objectives are being met.

CONTRIBUTORS

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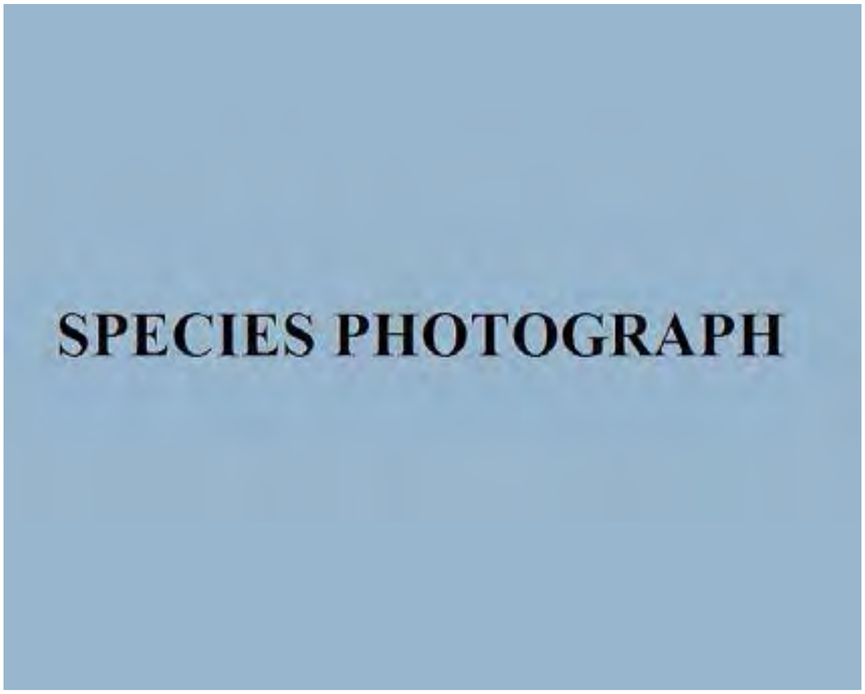

Figure 1: Photo not available.

Figure 2: North American range of *Lynx canadensis*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

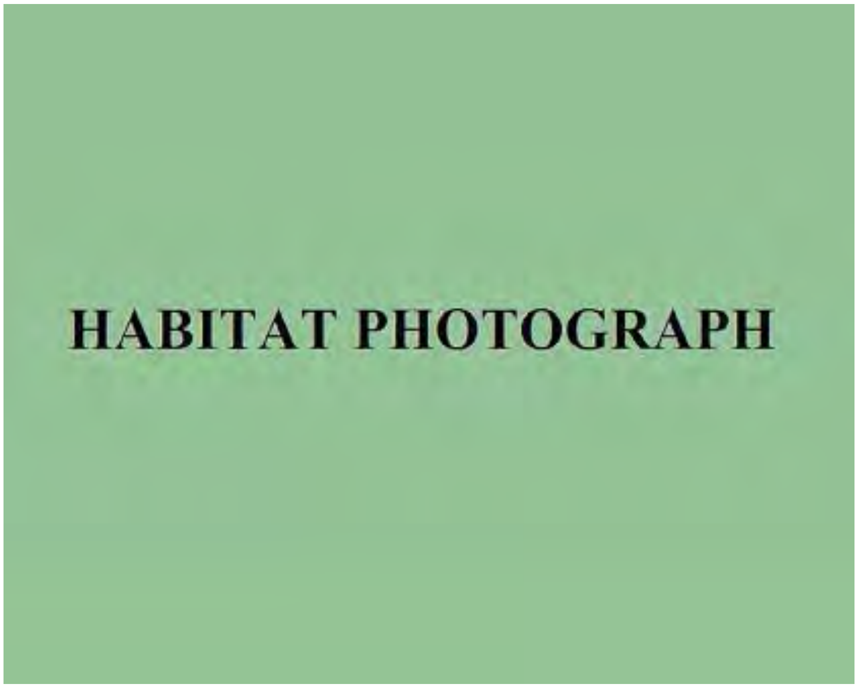

Figure 3: Photo not available.

Figure 4: Range and predicted distribution of *Lynx canadensis* in Wyoming.

Canyon Deermouse

Peromyscus crinitus

Regulatory Status

USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

Conservation Ranks

USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G5, S1
Wyoming Contribution: LOW
IUCN: Least Concern

Status and Rank Comments

Canyon Deermouse (*Peromyscus crinitus*) has no additional regulatory status or conservation rank considerations beyond those listed above.

Natural History

Taxonomy:

Historically, there were up to twelve recognized subspecies of Canyon Deermouse [1]. There are currently eight recognized subspecies, but only *P. c. doutii* is found in Wyoming [2-4].

Description:

Identification of Canyon Deermouse is possible in the field. Canyon Deermouse is a small to medium-sized *Peromyscus* with long, silky dorsal hair; finely-furred ears that are as long as the hind foot; white feet; and a pointed snout with long whiskers [2-5]. The bi-colored tail is hair-covered with a terminal tuft and typically longer than the combined length of the head and body [2-5]. The color of the dorsal pelage, which ranges from brown to orange-buff to light cinnamon, varies geographically across subspecies and may be similar to the predominant substrate at a microgeographic scale [2, 3, 5]. Canyon Deermouse has a naturally oily coat, which it maintains by bathing in dust and fine sand [2-4]. The underbelly hairs are white with gray at the base [2, 5]. Males and females are comparable in size [3, 4]. Adults weigh between 14–20 g and can reach total lengths of 165–180 mm [4]. Tail, hind foot, and ear length ranges from 84–95 mm, 20–22 mm, and 20–22 mm, respectively [4]. Three other species of *Peromyscus* are found in Wyoming, but only North American Deermouse (*P. maniculatus*) and Piñon Deermouse (*P. truei*) have distributions that overlap with Canyon Deermouse in the state [4]. Canyon Deermouse can be distinguished from North American Deermouse by its longer tail, and from Piñon Deermouse by its smaller, finely-furred ears and more obvious terminal tuft of hair on the tail [4, 6].

Distribution & Range:
The distribution of Canyon Deermouse extends from north-central Oregon south along eastern California to the northern Baja Peninsula, and as far east as western Colorado and northwestern New Mexico [2, 7]. Canyon Deermouse is a peripheral resident in Wyoming and is limited to the far southwestern part of the state [4, 8]. Most of the existing habitat for this species in Wyoming is likely found near Flaming Gorge Reservoir in Sweetwater County [4]. Confirmed breeding has been documented in just 1 of 28 latitude/longitude degree blocks in the state [8]. Both availability of habitat and competition with other deermice species may drive local distribution patterns [9].

Habitat:
Canyon Deermouse is an arid, rocky habitat specialist and is always associated with rocky substrates including gravel pavement, slickrock, lava beds, boulders, canyons, and cliffs [2, 4, 10, 11]. Plant associations do not strongly influence local distribution of this species [2]. In Wyoming, Canyon Deermouse is found in rocky cliff habitat with high amounts of rock and canopy cover and dense trees in woodlands dominated by Utah Juniper (*Juniperus osteosperma*) [4, 9, 12]. Nests are typically constructed in rock crevices and lined with shredded vegetation, although this species may dig burrows in sandy substrate [3, 4].

Phenology:
Canyon Deermouse is nocturnal and active all year [3]. Females are seasonally polyestrous, typically producing 2 or 3 litters per year starting in early spring [2, 4]. Litter size ranges from 1–5 with litters of 4 being the most common, and gestation lasts 24 or 25 days [2, 4]. This species has a 28-day lactation period, which is long compared to the average across 18 species of *Peromyscus* [2, 4]. Young leave the nest after 4–6 weeks and are able to reproduce at 10 weeks of age [2-4].

Diet:
Canyon Deermouse is omnivorous, consuming seeds, fruits, berries, fungi, insects, and green vegetation, with seasonal priority given to seeds during the colder months and insects during the warmer months [2, 3, 5]. All water required for survival is obtained from food [2, 3, 5].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
There are no robust estimates of abundance available for Canyon Deermouse in Wyoming. The species has a statewide abundance rank of VERY RARE and appears to be rare even within suitable environments in the occupied area [8]. Canyon Deermouse historically lost habitat in Wyoming to flooding when the Green River was dammed to create Flaming Gorge Reservoir in 1962 [4, 9]. Research conducted in 1998 and 1999 recorded just 13 individuals across 2 cliff habitat sites out of 7 cliff and 7 rocky slope sites sampled in juniper woodlands east of Flaming Gorge Reservoir for an overall capture rate of 0.007 captures per trap night throughout suitable habitat [9, 13]. Abundance in Wyoming seems to be much lower than nearby populations in northeastern Utah [13].

Population Trends:
Historic: MODERATE DECLINE
Recent: UNKNOWN

Because of its restricted distribution in Wyoming, Canyon Deermouse likely experienced historic moderate population declines due to the aforementioned habitat loss following the creation of Flaming Gorge Reservoir half a century ago. However, recent population trends for this species in Wyoming are unknown.

Intrinsic Vulnerability:
HIGH VULNERABILITY
Canyon Deermouse has high intrinsic vulnerability in Wyoming due to very low abundance, specific habitat requirements within a very restricted distribution, and limited dispersal ability. The species has high fecundity but is likely to be affected by any natural or anthropogenic disturbance to occupied habitat within its already restricted distribution. The environment of Flaming Gorge is unique in Wyoming and supports wildlife species, including Canyon Deermouse, that are not found anywhere else in the state. Therefore, this species has little to no opportunity for range expansion within the state and would likely have an increased risk of extirpation should disturbance or loss of existing habitat occur.

Extrinsic Stressors:
MODERATELY STRESSED
Loss and degradation of existing habitat as well as disturbance, both natural and anthropogenic, could negatively impact Canyon Deermouse in Wyoming. Rocky habitats in southwestern Wyoming are threatened by potential oil-shale and other energy development, as well as exposure to anthropogenic disturbances from recreational activities [12, 14]. Furthermore, juniper woodlands are potentially vulnerable to changes in fire regime; invasive species such as Cheatgrass (*Bromus tectorum*); drought and climate change; habitat fragmentation; and human disturbance, including juniper removal and thinning programs [12]. However, recent expansion of juniper woodlands into shrub-grasslands might provide additional habitat that could offset some of these threats. Canyon Deermouse may be exposed to some anthropogenic disturbance within its Wyoming distribution, and the species has shown susceptibility to fires in the desert environments of southwestern Utah and southern California [15, 16]. Currently, it is not known how these potential extrinsic stressors could be impacting Canyon Deermouse in Wyoming.

KEY ACTIVITIES IN WYOMING
Canyon Deermouse is classified as a Species of Greatest Conservation Need by the Wyoming Game and Fish Department (WGFD). In 1998 and 1999, the WGFD funded a University of Wyoming graduate research project that examined habitat use for three rare, small mammal species in southwestern Wyoming, including Canyon Deermouse [9]. In 2016, the WGFD began a two-year project designed to collect crucial data on the distribution, relative abundance, and habitat use of piñon-juniper obligate species, including Canyon Deermouse, in the woodlands of southwestern Wyoming.

ECOLOGICAL INFORMATION NEEDS
Very little is known about the current status of Canyon Deermouse in Wyoming [4]. The species would benefit from research to determine its actual distribution, current abundance, habitat use, reproductive rates, and basic life history in Wyoming. Additionally, the distribution of juniper forests in Wyoming is far vaster than the distribution of Canyon Deermouse, and a better understanding of habitat use and requirements at this northernmost range boundary is needed, including a better understanding of the current range boundary for both the species as well as the juniper habitat on which it depends. Perhaps most importantly, potential extrinsic stressors

should be identified within the species' limited distribution to ensure the persistence of available habitat for this species in Wyoming.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Little is known about Canyon Deermouse in Wyoming. Consequently, management priorities for the species in the short-term will focus on addressing these data deficiencies. Of particular importance are data on presence, distribution, population status and trends, and the impact of extrinsic threats. Upcoming projects will address these needs, including evaluating habitat requirements and potential changes in presence and distribution in response to juniper removal and juniper expansion. These results will be used to develop management and conservation recommendations as well as develop monitoring protocols to establish trends.

CONTRIBUTORS

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Figure 1: Adult Canyon Deermouse in-hand following capture in Flaming Gorge, Sweetwater County, Wyoming. (Photo courtesy of Madelyn Voelker, WGFD)

Figure 2: North American range of *Peromyscus crinitus*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Rocky juniper woodland habitat east of Flaming Gorge Reservoir in Sweetwater County, Wyoming. (Photo courtesy of Kaylan A. Hubbard)

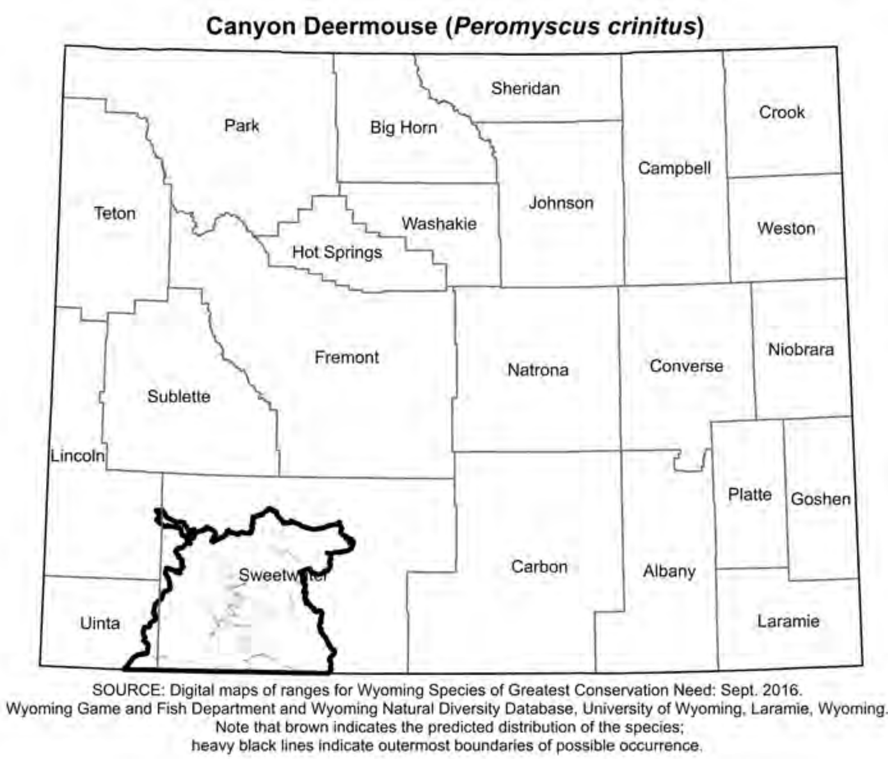

Figure 4: Range and predicted distribution of *Peromyscus crinitus* in Wyoming.

Cliff Chipmunk

Tamias dorsalis

REGULATORY STATUS

USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G5, S1
Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS

Cliff Chipmunk (*Tamias dorsalis*) has no additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:

There are six recognized subspecies of Cliff Chipmunk, but only *T. d. utahensis* is found in Wyoming [1-5]. Global chipmunk taxonomy remains disputed, with some arguing for three separate genera (i.e., *Neotamias*, *Tamias*, and *Eutamias*) [6-8], while others support the recognition of a single genus (i.e., *Tamias*) [9]. Cliff Chipmunk was briefly referred to as *N. dorsalis* [10] but has recently been returned to the currently recognized genus *Tamias*, along with all other North American chipmunk species [11].

Description:

Cliff Chipmunk is a medium-large chipmunk that can be easily identified in the field by its mostly smoke gray upperparts, indistinct dorsal stripes (with the exception of one dark stripe along the spine), brown facial stripes, long bushy tail, stocky body, short legs, and white underbelly [2-5]. This species exhibits sexual size dimorphism, with females averaging larger than males [2, 3]. Adults weigh between 55–90 g with total length ranging from 208–240 mm [4]. Tail, hind foot, and ear length range from 81–110 mm, 30–33 mm, and 17–21 mm, respectively [4]. Within its Wyoming distribution, Cliff Chipmunk is easy to distinguish from Yellow-pine Chipmunk (*T. amoenus*), Least Chipmunk (*T. minimus*), and Uinta Chipmunk (*T. umbrinus*) by its mostly gray dorsal coloring and indistinct dorsal stripes [4].

Distribution & Range:

The distribution of Cliff Chipmunk extends from extreme southern Idaho and Wyoming to north central mainland Mexico [2, 12]. In Wyoming, Cliff Chipmunk is a peripheral resident and is restricted to rocky habitats along the Flaming Gorge Reservoir in Sweetwater County [4, 5, 13, 14].

Confirmed breeding has been documented in 2 of 28 latitude/longitude degree blocks in the state [14].

Habitat:
Cliff Chipmunk is typically associated with steep rocky slopes, outcrops, and cliffs in arid woodlands dominated by juniper (*Juniperus* spp.), Piñon Pine (*Pinus edulis*), Ponderosa Pine (*P. ponderosa*), and/or Gamble Oak (*Quercus gambelii*) [2, 4, 13, 15, 16]. In Wyoming, this species is found in rocky slopes and cliff habitats in woodlands dominated by Utah Juniper (*J. osteosperma*), and nests are located deep within cliff crevices [4, 13, 14, 17].

Phenology:
Cliff Chipmunk has a long breeding season compared to other species of chipmunk in the western United States, but adult females typically produce only one litter per year [3, 4]. In Wyoming, Cliff Chipmunk breeds in early March following winter hibernation and produces a litter of 4–6 young after a gestation period of 28–31 days [4]. Young begin to venture from the nest after nursing for about one month [4].

Diet:
Cliff Chipmunk is primarily herbivorous and opportunistically forages on a wide variety of plant blossoms, stems, and seeds [2, 4]. However, this species may also consume insects and insect larvae, frogs, salamanders, snakes, and bird nestlings and eggs [2, 18].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
There are no robust estimates of abundance available for Cliff Chipmunk in Wyoming. Cliff Chipmunk was once locally abundant along the Green River in southwestern Wyoming; however, this species lost historic habitat to flooding when the river was dammed to create Flaming Gorge Reservoir in 1962 [4, 5, 13]. Research conducted in 1998 and 1999 recorded 113 individuals across 13 of 14 rocky slope and cliff habitat sites sampled in juniper woodlands east of Flaming Gorge Reservoir [13]. Cliff Chipmunk has a statewide abundance rank of RARE and appears to be rare even within suitable environments in the occupied area [14].

Population Trends:
Historic: MODERATE DECLINE
Recent: UNKNOWN
In Wyoming, Cliff Chipmunk likely experienced historic moderate population declines due to the aforementioned habitat loss following the creation of Flaming Gorge Reservoir half a century ago. However, recent population trends for this species in Wyoming are unknown.

Intrinsic Vulnerability:
HIGH VULNERABILITY
Cliff Chipmunk has high intrinsic vulnerability in Wyoming due to low abundance, specific habitat requirements within a very restricted distribution, and limited dispersal ability. This species is likely to be affected by any natural or anthropogenic disturbance to occupied habitat within its already restricted distribution. The environment of Flaming Gorge is unique in Wyoming and supports wildlife species, including Cliff Chipmunk, that are not found anywhere else in the state. Therefore, this species has little to no opportunity for range expansion within the

state and would likely have an increased risk of extirpation should disturbance or loss of existing habitat occur.

Extrinsic Stressors:
MODERATELY STRESSED
Loss and degradation of existing habitat as well as disturbance, both natural and anthropogenic, could negatively impact Cliff Chipmunk in Wyoming. Rocky habitats in southwestern Wyoming are threatened by potential oil shale and other energy development, as well as exposure to anthropogenic disturbances from recreational activities [17, 19]. Furthermore, juniper woodlands are potentially vulnerable to changes in fire regime; invasive species such as Cheatgrass (*Bromus tectorum*); drought and climate change; habitat fragmentation; and human disturbance, including juniper removal and thinning programs [17]. However, recent expansion of juniper woodlands into shrub-grasslands might provide additional habitat that could offset some of these threats. Cliff Chipmunk may be exposed to some disturbance from recreational activities within its Wyoming distribution, and the species is predicted to face extinction in parts of its Great Basin range due to effects of global warming [20]. Currently, it is not known how these potential extrinsic stressors could be impacting Cliff Chipmunk in Wyoming.

KEY ACTIVITIES IN WYOMING
Cliff Chipmunk is classified as a Species of Greatest Conservation Need by the Wyoming Game and Fish Department (WGFD). In 1998 and 1999, the WGFD funded a University of Wyoming graduate research project that examined habitat use for three rare, small mammal species in southwestern Wyoming, including Cliff Chipmunk [13]. In 2016, the WGFD began a two-year project designed to collect crucial data on the distribution, relative abundance, and habitat use of piñon-juniper obligate species, including Cliff Chipmunk, in the woodlands of southwestern Wyoming.

ECOLOGICAL INFORMATION NEEDS
Cliff Chipmunk is not well studied, and little is known about the status or natural history of this species in Wyoming [4]. This species would benefit from research to determine its detailed distribution and current abundance in the state, especially in potential habitat west of Flaming Gorge Reservoir. Likewise, it would be valuable to quantify adult survival and reproductive success and to examine if and how Cliff Chipmunk is being impacted by anthropogenic disturbance from recreational activities within its already limited Wyoming distribution.

MANAGEMENT IN WYOMING
This section authored solely by WGFD; Nichole L. Bjornlie. Little is known about Cliff Chipmunk in Wyoming. Consequently, management priorities for the species in the short-term will focus on addressing these data deficiencies. Of particular importance are data on presence, distribution, population status and trends, and the impact of extrinsic threats. Upcoming projects will address these needs, including evaluating habitat requirements and potential changes in presence and distribution in response to juniper removal and juniper expansion. These results will be used to develop management and conservation recommendations as well as develop monitoring protocols to establish population trends.

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Figure 1: A Cliff Chipmunk. (Photo courtesy of Robert J. Luce)


Figure 2: North American range of *Tamias dorsalis*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Rocky juniper woodland habitat east of Flaming Gorge Reservoir in Sweetwater County, Wyoming. (Photo courtesy of Kaylan A. Hubbard)

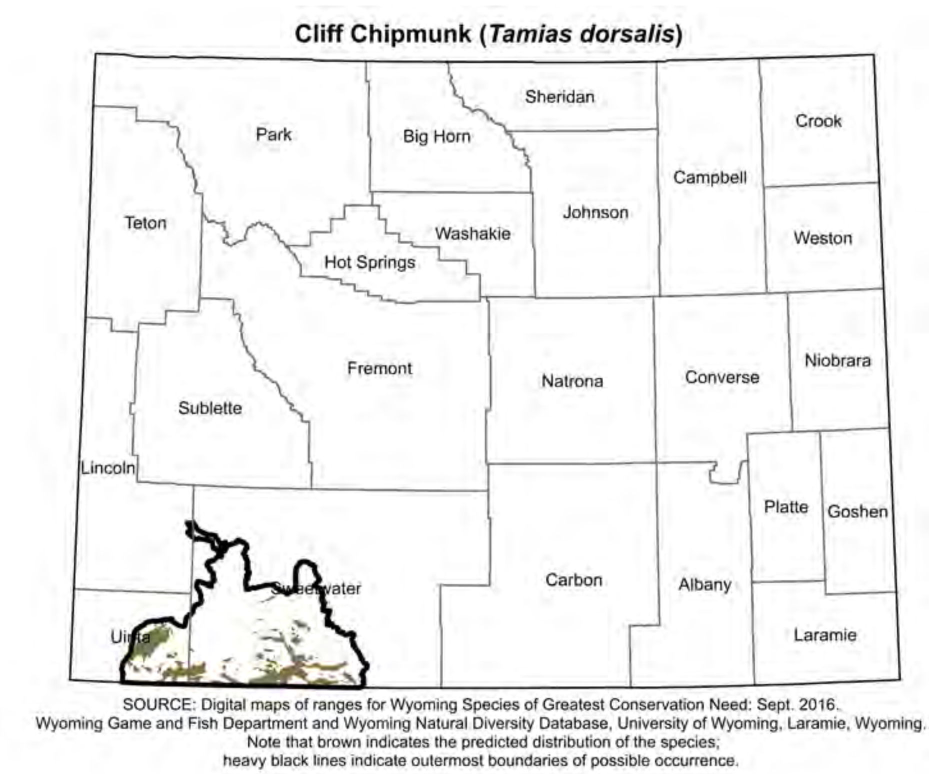

Figure 4: Range and predicted distribution of *Tamias dorsalis* in Wyoming.

Dwarf Shrew
Sorex nanus

REGULATORY STATUS
USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G4, S4S5
Wyoming Contribution: HIGH
IUCN: Least Concern

STATUS AND RANK COMMENTS
The Wyoming Natural Diversity Database has assigned Dwarf Shrew (*Sorex nanus*) a state conservation rank ranging from S4 (Apparently Secure) to S5 (Secure) because of uncertainty over extent of range and actual abundance of the species in Wyoming.

NATURAL HISTORY
Taxonomy:
Dwarf Shrew may have only recently diverged from Inyo Shrew (*S. tenellus*). Current ranges of the two taxa do not overlap (the latter occupies a small portion of the far western Great Basin), and most investigators consider them each as distinct and valid species [1-3]. Dwarf Shrew has no recognized subspecies [1].

Description:
Dwarf Shrew is an extremely small mammal – it is likely the smallest mammal species in Wyoming - and is very similar in appearance to other Wyoming shrew species. Adult dimensions include total length 83–105 mm; tail length 27–40 mm; and weight 1.8–3.2 g. Like other *Sorex* species, Dwarf Shrew has a relatively long and flexible snout, bicolored tail, proportionally small eyes, uniformly brownish or grayish fur on the back, and silvery-whitish fur below. Identification to species requires a combination of body measurements, skull measurements, and, especially, dental characteristics [1, 4], which typically requires the individual shrew to be sacrificed. Figure 5 illustrates important differences in shrew dentition, and a technical key such as in Clark and Stromberg (1987) is an important aid in identifying Wyoming shrews to species [4].

Distribution & Range:
Dwarf Shrew occurs along and near the Rocky Mountain cordillera from Canada to Mexico. Until recently, the species' range was assumed to be rather fragmented across this region [1], but subsequent captures have resulted in a more continuous and widespread range estimate [3, 5]. Mapping the species' distribution at finer scales is complicated by the lack of sampling effort

(thus a paucity of documented Dwarf Shrew locations) and a superficial knowledge of habitat associations. The species has been captured in and near all major mountain ranges in Wyoming [3, 6].

Habitat:
Habitat associations of Dwarf Shrew have not been extensively studied. Recent summaries of available information indicate an apparent preference for the foothills-to-alpine environment, with occasional use of adjacent lower regions. Dwarf Shrew has been documented in especially rocky terrain (e.g., talus fields, rubble slopes), and may have a greater tolerance for xeric conditions relative to other shrews [1, 3]. Results of Brown (1967) emphasize the association of Dwarf Shrew with alpine talus fields in southern Wyoming [7]. A 2010–2012 study documented six Dwarf Shrews in spruce-fir forests of southern Wyoming [8]. In general, shrews are assumed to seek out certain microhabitats (e.g., specific litter depths, debris densities, or soil textures) that may not align well with traditional categories of wildlife habitat based on dominant overstory plants [3, 9].

Phenology:
Dwarf Shrew is active year-round. Breeding phenology is not well known, but it is assumed that mating occurs in early-mid summer and first litters (consisting of 6–7 young) are produced in mid-late summer. Dwarf Shrews at lower elevations may reproduce over a longer period, and have a higher likelihood of second litters, than those at higher elevations [1, 3, 4].

Diet:
Dwarf Shrew diet is likely similar to that of other *Sorex* shrews, with small invertebrates forming the bulk of consumed items [1, 3, 4]. Specific prey preferences and seasonal diet shifts are unknown.

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: UNCOMMON
There are no population estimates of Dwarf Shrew at continental, national, or state scales. The UNCOMMON abundance in Wyoming is inferred from the moderate portion of the state known to be occupied and an apparent rarity within that range [10]. However, dedicated sampling effort for shrews in the state has been so low that the species may actually extend beyond the currently assumed range and may be common in some localities.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends of Dwarf Shrew are unknown.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Though relatively little is known about Dwarf Shrew, the general breeding biology of *Sorex* shrews makes them moderately vulnerable. Many *Sorex* have a life expectancy of one year, and under some conditions may produce only one litter per year. Also, limited mobility restricts shrews' ability to re-colonize suitable habitats and expand populations [4]. These characteristics may predispose *Sorex* populations to fragmentation and local extirpation if breeding is disrupted for even a single season [9]. If Dwarf Shrew is found to be more strongly specialized to particular

habitats (e.g., talus and rubble fields at high elevations) than is currently assumed, the species' intrinsic vulnerability would need to be increased to "high".

Extrinsic Stressors:
UNKNOWN
So little is known about Dwarf Shrew in Wyoming that any outline of extrinsic threats is somewhat speculative. Assuming a preference for mountain environments, significant disturbances to such landscapes would likely negatively affect the species. Better information on the degree to which Dwarf Shrews prefer particular habitats would allow a more useful assessment of extrinsic threats. In general, shrews may rely on certain microhabitats that remain relatively unaffected by some large-scale disturbances, allowing populations to persist in otherwise disturbed areas.

KEY ACTIVITIES IN WYOMING

Dwarf Shrew is classified as a Species of Greatest Conservation Need by the Wyoming Game and Fish Department (WGFD). Currently, there is no research being conducted on Dwarf Shrew in Wyoming. A 2010–2012 study documented six Dwarf Shrews in spruce-fir stands in the Medicine Bow National Forest of southern Wyoming [8]. In 2014 the WGFD funded and conducted an evaluation of the potential to use guard hairs to identify shrews to species, thus allowing for identification without the need to sacrifice individuals. However, only Western Water Shrew (*S. navigator*) was identifiable by guard hair, which is also the only shrew in Wyoming that is identifiable in hand [11].

ECOLOGICAL INFORMATION NEEDS

Very little is known about Dwarf Shrew anywhere in the species' range. There are so few records of the species in Wyoming that basic distribution, habitat preferences, dietary needs, breeding phenology, and potential threats are poorly understood. A better estimate of actual distribution in the state may be the top priority information need at this time and could be efficiently generated as part of a larger field survey effort targeting multiple *Sorex* species simultaneously.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Very little is known about shrews overall. Consequently, management priorities for Dwarf Shrew in the short-term will focus on addressing these data deficiencies. Of particular importance are data on presence, distribution, population trends, habitat needs, and the impact of potential threats. Because shrews are rarely trapped as part of other small mammal projects, addressing these needs will require systematic surveys designed to target shrews (i.e., pitfall traps). However, these species would also benefit from the development of new capture and identification techniques that would not require sacrificing individuals. Results from these efforts will ultimately be used to develop management and conservation recommendations.

CONTRIBUTORS

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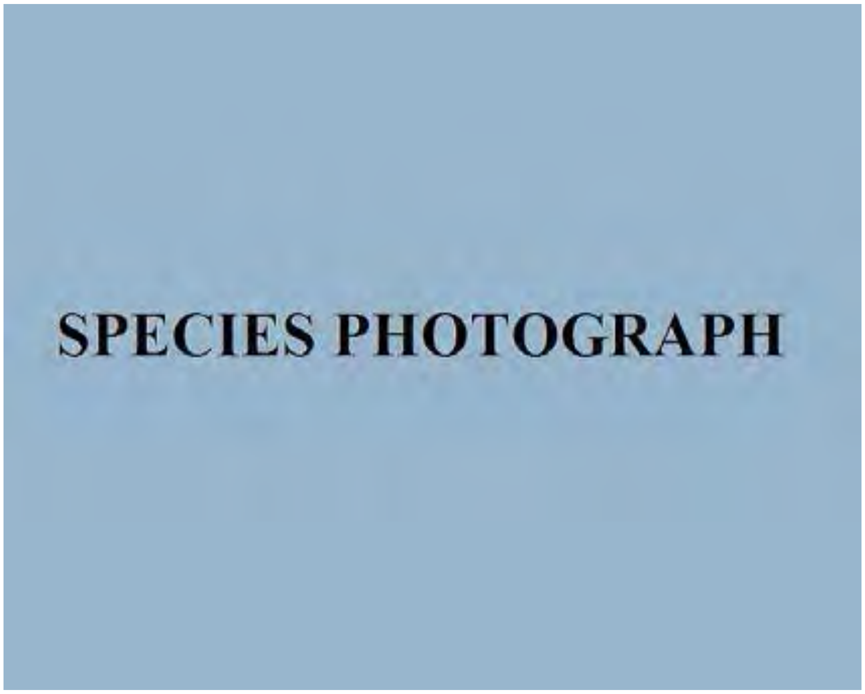

Figure 1: Photo not available.

Figure 2: North American range of *Sorex nanus*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

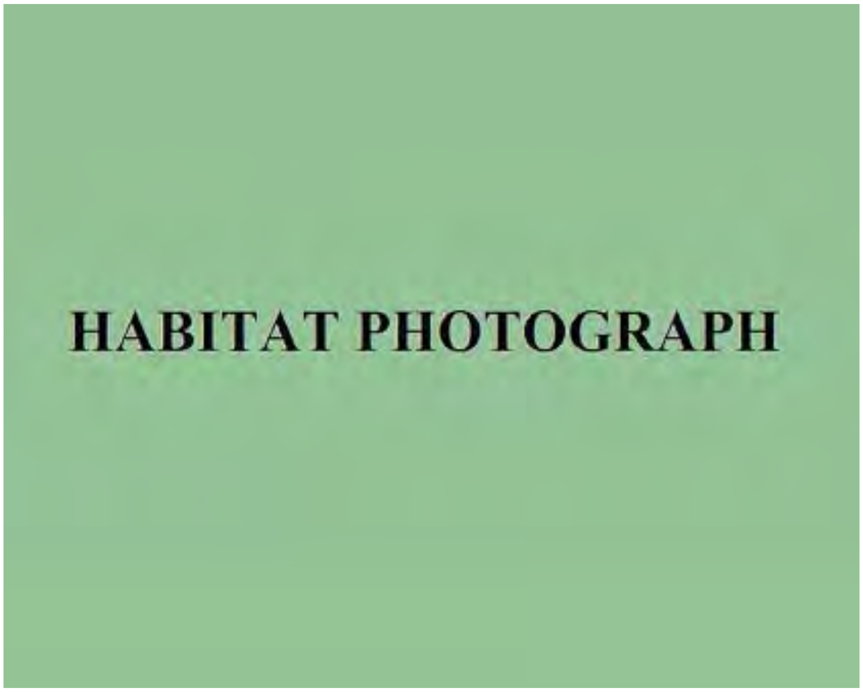

Figure 3: Photo not available.

Figure 4: Range and predicted distribution of *Sorex nanus* in Wyoming.

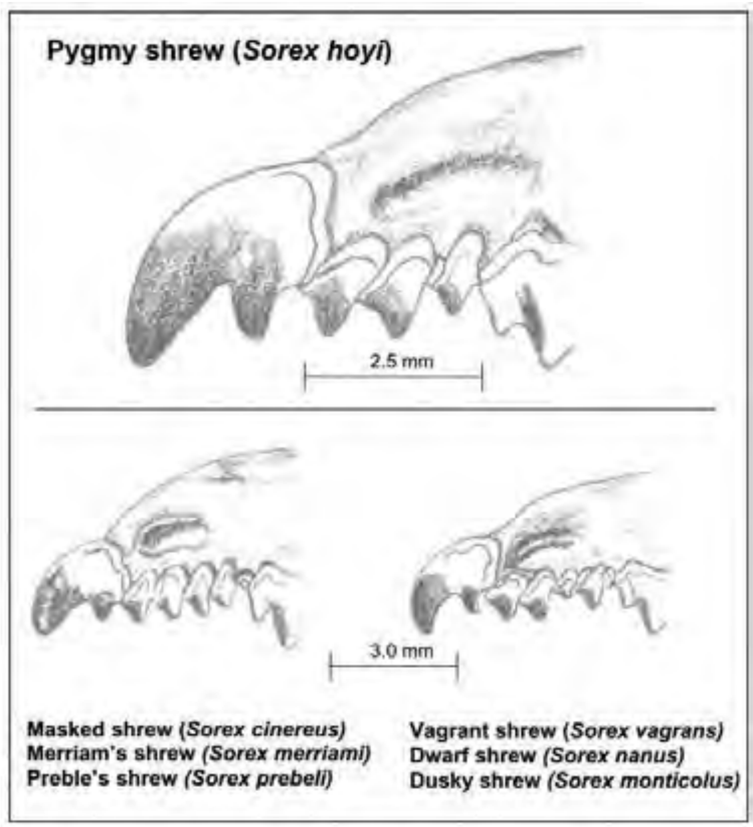

Figure 5: Lateral view of upper tooth rows of some *Sorex* spp. of shrew; Dwarf Shrew shown on lower right. Top and bottom panels are not drawn to same scale – note scale bars. (Figure from: Beauvais, G. P., and McCumber, J. (2006) Pygmy Shrew (*Sorex hoyi*): a technical conservation assessment, p 34, USDA Forest Service, Rocky Mountain Region.)

Eastern Red Bat

Lasiurus borealis

REGULATORY STATUS

USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS4 (Bc), Tier III
WYNDD: G3G4, S3
  Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS

Eastern Red Bat (*Lasiurus borealis*) has no additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:
No subspecies of Eastern Red Bat are currently recognized [1]. Formerly, Eastern Red Bat was considered a subspecies of Red Bat [2]. Genetic evidence led to the separation of Red Bat into two unique species: Eastern Red Bat and Western Red Bat (*L. blossevillii*) [3]. These taxonomic designations are currently accepted [1].

Description:
Eastern Red Bat is easily identified in the field. It is a medium sized bat. As indicated by its name, Eastern Red Bat has distinctively red pelage. More specifically, it has a brick red or rusty red dorsum with buffy white patches on the shoulders. The venter is similar in color but slightly paler. Eastern Red Bat has a long tail and a fully furred tail membrane [2, 4]. The ears are short and rounded with a triangular tragus [2]. Eastern Red Bat is similar in appearance to Western Red Bat, but only Eastern Red Bat occurs in Wyoming. Where sympatric, Eastern Red Bat is distinguished by its slightly larger size, long tail, and frosted appearance [4].

Distribution & Range:
Eastern Red Bat is widely distributed east of the Continental Divide from southern Canada to northern Mexico. The species migrates from northern portions of its range, including Wyoming, and winters in northeastern Mexico and the southeastern United States [5]. Wyoming marks the far western margin of the species' range, and Eastern Red Bat is limited to the eastern half of the state. Evidence suggests that the species' range may be expanding north and west as far as northern Alberta, perhaps as a result of warming temperatures associated with global climate change [6].

Habitat:
Eastern Red Bat has been documented in a variety of habitats but is typically associated with forested areas. The species prefers large tracts of mature deciduous forests but has also been documented in shelterbelts and riparian and urban areas with large trees [7]. Habitat associations of Eastern Red Bat in Wyoming are poorly understood, but the species is probably restricted to mesic sites with deciduous tree cover [7]. The species forages in riparian areas, above the forest canopy, near forest edges, and in open areas near forest habitats. In summer, the species roosts in the canopy of deciduous trees and shrubs. Roost selection of males and females is similar [8]. Roosting sites are typically surrounded by dense foliage but are open below [2, 4]. Additionally, Eastern Red Bat roosts in trees that are taller and have a larger diameter at breast height than other trees in the forest stand [8]. Eastern Red Bat does not hibernate and migrates out of Wyoming in winter. Habitat use during migration is poorly understood. Within winter range, when winter ambient temperatures remain above freezing, the species roosts on the south side of trees on slopes with southerly aspects. When ambient temperatures fall below freezing, Eastern Red Bat roosts on the ground in leaf litter and enters into torpor until temperatures increase [9, 10].

Phenology:
Phenology of Eastern Red Bat in Wyoming is largely unknown but is assumed to be similar to other portions of the species' range. Eastern Red Bat breeds in August or September, but fertilization of the egg does not occur until the following spring [2]. One to five young are born in late May to mid-June after an 80- to 90-day gestation. Juveniles can fly between three and four weeks of age and are fully weaned at five to six weeks [2, 4]. Timing of migration is poorly understood, but evidence suggests that the species migrates south and east in September and October [5]. In other northerly portions of its range, Eastern Red Bat has been documented in late May through June, suggesting it migrates north in late spring [11, 12].

Diet:
Eastern Red Bat is insectivorous and consumes a wide variety of insects. Soft-bodied moths in the order Lepidoptera comprise the majority of the diet, but insects in the orders Coleoptera, Diptera, Ephemeroptera, and Hymenoptera, among others, have also been identified as prey items [2, 4, 13].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
Estimates of abundance for Eastern Red Bat in Wyoming are not available. Survey data from portions of Wyoming where the species occurs indicate that Eastern Red Bat comprises only a small proportion of mist-net captures and acoustic recordings, suggesting the species is rare, even where suitable habitat exists in the state [14-16].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Population trends of Eastern Red Bat are unknown in Wyoming. Evidence from other parts of North America suggest large declines in abundance over the past four decades [17]. It is unclear if these trends are applicable to Wyoming.

Intrinsic Vulnerability:
LOW VULNERABILITY
Eastern Red Bat has low fecundity. On average, two offspring are born each spring (range 1–5) [2, 4]. The species also requires suitable roosting habitat, which may be limited in Wyoming. Eastern Red Bat has tested positive for the pathogenic fungus *Pseudogymnoascus destructans* that causes White-Nose Syndrome (WNS). Because the species is usually active during winter, it is hypothesized that Eastern Red Bat is not likely to be negatively affected by WNS [18].

Extrinsic Stressors:
MODERATELY STRESSED
Eastern Red Bat is heavily impacted by wind turbines. The species is one of the most frequently recovered bats during mortality surveys at wind power facilities across North America [19]. A small number of Eastern Red Bat mortalities have been documented at wind power facilities in Wyoming. Several large-scale wind power facilities have been proposed within the predicted range of the species in the state. Eastern Red Bat will likely be increasingly impacted by wind energy in Wyoming and range-wide as new facilities are constructed. Timber harvest of deciduous trees may reduce the availability of suitable roost locations for Eastern Red Bat [20], but it is unknown how this may affect the species in Wyoming. Pesticide use to control insects may adversely affect Eastern Red Bat by reducing food availability and by causing acute and chronic toxicity from the pesticide itself.

KEY ACTIVITIES IN WYOMING

Bats have recently received increasing research attention in Wyoming, and several studies have been completed or are underway that have increased our understanding of bat species in the state, including Eastern Red Bat. Pre-construction and post-construction bat monitoring are being conducted at wind energy facilities across Wyoming. In 2011, the Wyoming Game and Fish Department (WGFD) conducted a bat inventory within forested habitats in northeastern Wyoming using mist nets and acoustic recording units. Only four Eastern Red Bats were captured during this investigation [14]. In 2010 and 2011, the Wyoming Natural Diversity Database (WYNDD) conducted a bat inventory at Devils Tower National Monument, where one Eastern Red Bat was captured in mist nets, and a small number of acoustic recordings were made [21]. WYNDD began a bat monitoring effort in southern Wyoming in 2011 and captured two Eastern Red Bats along the Little Snake River in extreme south-central Wyoming in 2012 [15]. In 2014, WYNDD initiated a bat inventory in northeastern Wyoming. One Eastern Red Bat was captured in both 2014 and 2015, and a small number of acoustic detections of the species were made in each year [22, 23].

ECOLOGICAL INFORMATION NEEDS

Distribution and habitat use of Eastern Red Bat in Wyoming is poorly understood. Little is known about reproductive or migratory phenology of the species, particularly in the Rocky Mountain region. Estimates of abundance and population trends for this species are largely unknown range-wide. While Eastern Red Bat has been impacted by wind energy facilities in other portions of its range, it is unknown to what degree the species is affected in Wyoming.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Little is known about Eastern Red Bat in Wyoming. Consequently, management priorities for the species in the short-term will focus on addressing these data deficiencies, including data on presence, trends, and distribution. In 2016, the WGFD will begin a project in collaboration with the state of Nebraska to evaluate occurrence, abundance, and reproductive status of bats in eastern Wyoming, which represents an important zone of overlap between eastern and western bat species, including Eastern Red Bat. Mist-net surveys will continue to implement WNS protocols and assessment in an effort to assist with early detection should the disease reach the state. Habitat assessments will also be incorporated with survey efforts to better understand what influences species presence and distribution at a finer scale. In addition to inventory projects, WGFD, in collaboration with the Wyoming Bat Working Group and other state-wide partners, will implement the North American Bat Monitoring Program that will use acoustic monitoring to assist with state and region-wide assessments of bat trends. The WGFD has also developed baseline data collection and monitoring recommendations for bats at sites of wind energy development [24], which are provided to industry personnel for all current and proposed wind energy facilities. Furthermore, WGFD, in collaboration with the Wyoming Bat Working Group, published "A Conservation Plan for Bats in Wyoming" in 2005 that provides additional recommendations to minimize bat mortality at wind energy facilities [7]. Additional priorities will include updating and revising the "Conservation Plan as well as the Strategic Plan for WNS in Wyoming". Finally, outreach and collaboration with private landowners will remain a priority to ensure conservation of bats and bat habitat.

CONTRIBUTORS

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Figure 1: Adult female Eastern Red Bat captured in Goshen County, Wyoming. (Photo courtesy of Leah H. Yandow, WGFD)

Figure 2: North American range of *Lasiurus borealis*. This map does not accurately show the species' range in Wyoming. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Eastern Red Bat habitat near Devils Tower National Monument in Crook County, Wyoming. (Photo courtesy of WYNDD)

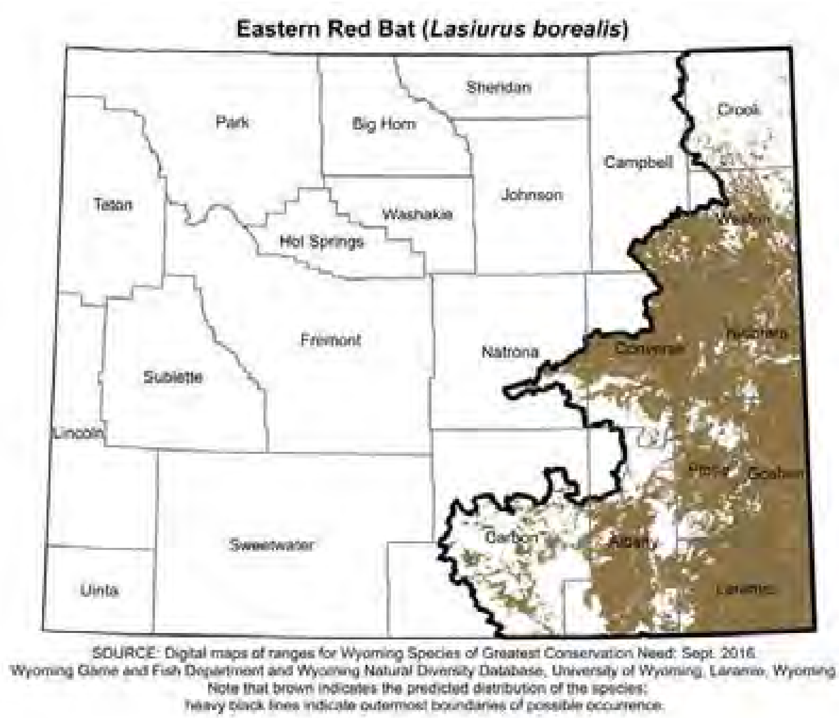

Figure 4: Range and predicted distribution of *Lasiurus borealis* in Wyoming.

Figure 5: Eastern Red Bats at a day roost underneath oak (*Quercus* spp.) leaves in southeastern Missouri. (Photo courtesy of Michael T. Wickens)

Eastern Spotted Skunk
Spilogale putorius

REGULATORY STATUS
USFWS: Petitioned for Listing
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Predatory Animal

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G4, S3S4
    Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS
The plains subspecies of Eastern Spotted Skunk (*Spilogale putorius interrupta*) is petitioned for listing under the United States Endangered Species Act (ESA). The species as a whole is assigned a range of state conservation ranks by the Wyoming Natural Diversity Database (WYNDD) due to uncertainty concerning the proportion of its Wyoming range that is occupied, the resulting impact of this on state abundance estimates, and, to a lesser extent, due to uncertainty about extrinsic stressors and population trends in the state.

NATURAL HISTORY

Taxonomy:
There are currently two species of spotted skunk commonly recognized in the United States: the Eastern Spotted Skunk (*S. putorius*) and the Western Spotted Skunk (*S. gracilis*) [1-3]. The distinction between the eastern and western species has been questioned over the years, with some authors suggesting that the two are synonymous [4], while others maintain that they are distinct based on morphologic characteristics, differences in breeding strategy, and molecular data [5-7]. There are 3 subspecies of *S. putorius* recognized by most authorities [3], but only *S. p. interrupta* (Plains Spotted Skunk) occurs in Wyoming, while the other two are restricted to portions of the southeastern United States [1].

Description:
Spotted skunks are the smallest skunks in North America and are easily distinguished by their distinct pelage consisting of many white patches on a black background, compared to the large, white stripes of the more widespread and common striped skunk (*Mephitis mephitis*). It is very difficult to tell Eastern and Western Spotted Skunk from each other in the field, particularly based on visual sighting rather than a captured animal. The primary (and somewhat subjective) differentiating characteristic is that Eastern Spotted Skunk has less extensive white markings than Western Spotted Skunk. In particular, Eastern Spotted Skunk has a mostly black tail with a

small white tip, while Western Spotted Skunk has extensive white on the end and underside of tail. Pending development of suitable genetic differentiation, the two species are ultimately distinguished by chromosome number (Eastern has 64 chromosomes; Western has 60 chromosomes) and reproductive strategy (Eastern has a gestation period of 50–65 days with no delayed implantation; Western has a gestation period of 210–250 days and exhibits delayed implantation) [1, 6].

Distribution & Range:
Wyoming is on the western periphery of Eastern Spotted Skunk range and represents less than 5% of the species' global range. In Wyoming, it is assumed to occur throughout suitable habitat in the eastern basins of the state (i.e., east of the Laramie and Bighorn mountain ranges), but this is largely conjecture based on relatively limited occurrences [8, 9]. Initially more restricted to the southeastern states, agricultural development may have facilitated the expansion of Eastern Spotted Skunk into the Great Plains early in the 1900s [1]. Population declines have been reported in the Great Plains (see Population Trends), but there does not appear to have been a concurrent contraction or shift in the species' range nationally or in Wyoming.

Habitat:
Eastern Spotted Skunk occurs in a variety of habitats but consistently avoids open areas in favor of those with dense vegetative cover [1]. It is often associated with dry, brushy, and rocky woodlands with thick understory such as second-growth deciduous forest, dense palmetto thickets, and oak-hickory forests [1, 10]. Eastern Spotted Skunk uses dens, which can be virtually any natural cavity (e.g., talus or rock piles, hollow logs, stumps), burrow (self-excavated or from other small mammals), or man-made structure (e.g., haystacks, wood piles, farm buildings) as long as they provide shelter from the elements, protection from predators, and minimal human disturbance [1]. Limited information from Wyoming suggests a preference for wooded areas with rock outcrops and moderate to low overstory canopy cover [9].

Phenology:
Eastern Spotted Skunk does not exhibit delayed implantation, which distinguishes it from the Western Spotted Skunk. Mating occurs in spring (March to April, depending on locality) and implantation occurs within a couple weeks [5]. Gestation lasts roughly 60 days; litters of 5–6 are born in late May or June; and weaning occurs after about 54 days [1, 5]. Eastern Spotted Skunk typically has one litter per year, although there are reports of two litters in a year in warm climates [11]. Hibernation has not been reported, and spotted skunks appear active year-round throughout their range.

Diet:
Across its range, Eastern Spotted Skunk is omnivorous, but it may focus on particular dietary components depending on location and season [11]. The species is largely insectivorous where insects are consistently plentiful, but shifts to other prey sources (e.g., small mammals, birds and bird eggs, carrion, and plant material) during seasons when insects are not available [1].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE

In areas where they are not abundant, their secretive nocturnal nature means that spotted skunks can be difficult to detect unless targeted surveys are conducted to identify them. Population density is highly variable across the range. Eastern Spotted Skunk seems to be most plentiful in parts of Florida where densities can exceed 40 individuals per km^2 in good habitat, but densities seem to be much lower (e.g., ~8 per km^2) in most other parts of their range [1, 12]. Abundance of Eastern Spotted Skunk in Wyoming is largely unknown, since there are no formal, quantitative estimates of abundance in the state, and most previous accounts report only few, opportunistic observations [8]. A recent survey effort targeting spotted skunks in Wyoming documented *Spilogale* spp. in 16 out of 160 locations that straddled the range of both species in the state [9] and likely includes detections of both species. Limited survey effort in Wyoming, combined with difficulty in identifying spotted skunks to the species level, has made it difficult to quantify abundance of *S. putorius* in the state.

Population Trends:
Historic: MODERATE DECLINE
Recent: UNKNOWN
Range-wide, the International Union for Conservation of Nature classifies populations of Eastern Spotted Skunk as decreasing [12]. Since the 1940s, the plains subspecies of Eastern Spotted Skunk (*S. p. interrupta*) has undergone large declines across the Midwest and Great Plains states [1, 13], leading to its petition for listing under the ESA and subsequent positive 90-day finding suggesting that listing may be warranted [14]. This has resulted in an increase in its conservation status across most Midwestern states [1, 15]. It is unclear whether population declines have also occurred in Wyoming. The species has ever been abundant in the state [8], but it does not seem to have experienced a change in distribution [9], so it is possible that populations in Wyoming have not recently declined as markedly as elsewhere in *S. p. interrupta* range.

Intrinsic Vulnerability:
LOW VULNERABILITY
Although Eastern Spotted Skunk is found almost exclusively where there is ample vegetative cover, cover type is not restrictive. The species is quite opportunistic in den selection and is a relative omnivore, so den sites and diet are not limiting. It appears quite adaptable to human presence, which could even facilitate its persistence in some areas, such as the Great Plains [1]. Although it is hypothesized to be susceptible to a variety of diseases [13], there is no evidence that any of them severely affect distribution or population abundance. From a reproductive perspective, Eastern Spotted Skunk does not have particularly limiting reproductive biology or unusually low fecundity.

Extrinsic Stressors:
MODERATELY STRESSED
Widespread declines in populations of *S. p. interrupta* have led to much speculation regarding stressors that could be driving such trends. Some of these stressors include the advent of large-scale pesticide use in agricultural systems, thus reducing insect prey and/or directly affecting spotted skunks; the advent of large-scale farming and concurrent reduction in wildland edge habitats, fence rows, and haystack construction that spotted skunks prefer; extensive trapping for the fur trade; long-term drought; changes in forest management practices that reduced brushy understory; and diseases such as distemper, rabies, and parvo viruses [10, 13]. However, there is no direct link between any of these stressors and population declines, and, moreover, is it unlikely that any of them are the sole cause [13]. Additionally, some of these stressors likely do not apply

directly to Wyoming's spotted skunk populations, since most of the species' Wyoming range is not subject to intensive, crop-based agriculture, and very few skunks are trapped in the state. The remaining stressors could impact spotted skunk populations in Wyoming, but there is substantial uncertainty regarding their actual level of stress in the state.

KEY ACTIVITIES IN WYOMING

The Wyoming Game and Fish Department (WGFD) has recently funded a number of projects pertaining to spotted skunks. The WGFD conducted pilot surveys in the winter of 2014–2015 to assess the presence of spotted skunks in central Wyoming [9]. A subsequent project has been funded through the WYNDD and the University of Wyoming Department of Zoology and Physiology to conduct an extensive inventory of Eastern Spotted Skunk in Wyoming and assess its genetic divergence from and likelihood of introgression with Western Spotted Skunk. This project is expected to begin in the fall of 2016 and has an expected completion in 2018. Finally, the WGFD is coordinating with the University of Wyoming to solicit and compile trapping and observational records of spotted skunks throughout the state in order to help direct research efforts and develop a baseline distribution throughout the state.

ECOLOGICAL INFORMATION NEEDS

Assessment of Eastern Spotted Skunk status in Wyoming is hampered by limited information regarding its distribution, abundance, population trends, and taxonomic distinctness. Improved distribution and habitat information are necessary to develop refined estimates of potential impacts from development activities across Wyoming's basins. Estimates of abundance and/or occupancy rates are important for establishing an accurate state conservation rank and as a baseline for eventual population monitoring that can be used to assess trends over time. Assessing taxonomic distinctness of *S. putorius* and its subspecies will help direct conservation efforts relative to the current petition to list *S. p. interrupta* as a threatened or endangered species.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Little is known about Eastern Spotted Skunk in Wyoming. The current classification of all skunks in Wyoming as predatory animals makes management of Eastern Spotted Skunk difficult. Consequently, conservation concerns for both spotted skunk species in the state may necessitate the need to reevaluate the current classification of these species. Management priorities for the species in the short-term will focus on addressing data deficiencies, including data on presence, distribution, population status and trends, and the impact of extrinsic stressors, which will ultimately be used to develop management and conservation recommendations. Additionally, a better understanding of habitat use, range boundaries, and areas of overlap with the sympatric Western Spotted Skunk are needed at this western range boundary. Because of the difficulty in distinguishing between Eastern and Western Spotted Skunk in the field and the recent listing petition for Plains Spotted Skunk, upcoming projects will focus on the use of genetic analyses for positive identification, to delineate distribution, and to evaluate the potential for and degree of hybridization between the species.

CONTRIBUTORS

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Figure 1: A recently released adult spotted skunk (*Spilogale* spp.) that was captured in Albany County, Wyoming. (Photo courtesy of Kristina M. Harkins)

Figure 2: Map not available.

Figure 3: Spotted skunk (*Spilogale* spp.) habitat in the Pedro Mountains in Carbon County, Wyoming. (Photo courtesy of Jesse Boulerice, WGFD)

Figure 4: Map not available.

Fringed Myotis
Myotis thysanodes

REGULATORY STATUS
USFWS: No special status
USFS R2: Sensitive
USFS R4: No special status
Wyoming BLM: Sensitive
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G4, S2S3
Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS
The Wyoming Natural Diversity Database (WYNDD) has assigned Fringed Myotis (*Myotis thysanodes*) a range of state conservation ranks because of uncertainty in the population trend of the species in Wyoming.

NATURAL HISTORY

Taxonomy:
There are three recognized subspecies of Fringed Myotis, with some researchers recognizing a fourth [1-3]. Two subspecies occur in Wyoming with *M. t. thysanodes* found across most of the state. A unique subspecies, *M. t. pahasapensis* is found in the Black Hills of northeastern Wyoming [3].

Description:
Identification of Fringed Myotis is possible in the field by experienced observers. Fringed Myotis is a medium-sized bat overall but large among *Myotis* species. Pelage color varies across the species' range. Dorsal fur ranges from yellow-brown to dark olive-brown. Ventral fur is similar in coloration but paler. Appearance of *M. t. pahasapensis* in the Black Hills is unique. Dorsally, the subspecies is brown ochraceous buff and ventrally it is light ochraceous buff [4]. The ears are long (16–20 mm) and very dark in color with a long tragus [3, 5]. Wing and tail membranes are very dark and nearly opaque [5, 6]. Females are significantly larger than males but are otherwise identical in appearance [3]. Juveniles are indistinguishable from adults by around 21 days of age except for open epiphyseal closures [4]. The species is similar in appearance to other *Myotis* species in the "Long-eared" group. Members of this group that occur in Wyoming include Northern Long-eared Myotis (*M. septentrionalis*) and Long-eared Myotis (*M. evotis*). Fringed Myotis can be differentiated from both by the presence of distinct fringe of hairs protruding from the posterior edge of the uropatagium [5].

Distribution & Range:
Fringed Myotis is widely distributed across western North America from southern Mexico north to southwestern Canada. Wyoming is on the northeastern edge of the species' range. Locally, seasonal changes in distribution may be observed as individuals move between summer range and winter hibernacula. In Wyoming, the species is widely distributed across much of the state with the exception of portions of the Great Divide and Powder River Basins in southcentral and northeastern Wyoming respectively [7].

Habitat:
Fringed Myotis is associated with a broad range of habitat types but generally occupies dry habitats such as grasslands, deserts, and shrublands. More specifically, Fringed Myotis is found where these habitats are interspersed with mature Ponderosa Pine (*Pinus ponderosa*), pinyon-juniper (*Pinus* spp.-*Juniperus* spp.), or oak (*Quercus* spp.) forest [4]. In the summer, a variety of day roost structures are used depending on local availability of structures [8]. Reproductive females congregate in maternity colonies, sites where they raise offspring, in a variety of structures including caves, abandoned mines, human-made structures, rock crevices, and trees [4]. Males roost in similar structures but generally singly or in small groups [4]. Roost use studies conducted in and around Wyoming indicate that Fringed Myotis roosted in rock crevices, Ponderosa Pine trees [9], interstitial spaces of the boulder field at the base of Devils Tower [10], and abandoned mines, cabins, and large rock structures [8]. While roost use of the species has not been evaluated across most of Wyoming, it is likely similar to that observed in these studies. In winter, Fringed Myotis hibernates, but few hibernation sites have been documented across the species' range, and only 1 hibernaculum is known from a cave in southeastern Wyoming [11]. The few documented hibernation sites range-wide have included caves and abandoned mines [4].

Phenology:
Phenology of Fringed Myotis is largely unknown in Wyoming but is likely similar to that observed in other parts of the species' range [3]. Breeding occurs in late summer or early fall after females leave maternity roosts [3, 4]. Like most bat species in North America, females store spermatozoa through the winter, and fertilization and implantation of the egg occurs from late April to mid-May [3]. Gestation ranges from 50 to 60 days, and females bear a single, altricial offspring in late June to mid-July. Young are capable of flight around 16 days after birth [4]. Fringed Myotis migrates towards hibernation sites in late summer or early fall, where it hibernates during winter, entering hibernation sometime in September and emerging in April [3].

Diet:
Fringed Myotis is insectivorous, and beetles comprise the majority of the diet. However, a variety of other insect classes including Lepidoptera, Diptera, Neuroptera, Hymenoptera, and Homoptera among others are consumed when abundant [4].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: UNCOMMON
There are no estimates of abundance of Fringed Myotis in Wyoming. In Wyoming and elsewhere, evidence suggests that the species is uncommon at a statewide scale but is locally abundant where suitable habitat exists [4]. During bat inventories across Wyoming, Fringed Myotis comprised a very small proportion of total bat captures and acoustic recordings [12-18], but was one

of the most commonly captured bat species at Devils Tower National Monument [10, 19, 20], supporting the notion that the species is generally uncommon but locally abundant.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Both historic and recent population trends of Fringed Myotis are largely unknown in Wyoming and elsewhere throughout its range.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Fringed Myotis is moderately vulnerable to extrinsic stressors. The species has low fecundity, giving birth to only a single pup each year [3]. Fringed Myotis demonstrates high site fidelity, with individuals returning to the same general area season after season. Reproductive females in particular utilize the same maternity roost sites on an interannual basis [4]. This vulnerability is exacerbated by the specific combination of limited habitat characteristics such as arid habitats interspersed with mature forests that contain both suitable roosting structures and surface water that the species requires, and disturbance to any component of these habitats may result in local declines or extirpations [4].

Extrinsic Stressors:
MODERATELY STRESSED
Fringed Myotis may face potential population declines resulting from global climate change, as the number of pregnant or lactating Fringed Myotis was significantly lower in years that had below average precipitation [21]. Following climate models, these precipitation patterns are predicted to become more frequent throughout the western United States, including Wyoming, and may result in population declines from decreased reproductive rates [21]. While in summer day roosts, Fringed Myotis is easily disturbed by human activity. This is particularly true for females nearing parturition and may result in abandonment of maternity roost sites [4]. Similarly, Fringed Myotis is likely negatively affected by recreational activities. For example, rock climbing has been cited as a potential stressor for the species in northern Colorado, where a number of maternity colonies exist in areas that receive frequent use by climbers [8]; the combination of high-use rock climbing areas and roosts of Fringed Myotis in Wyoming is unknown and in need of further evaluation. Disturbance from visitors to caves and abandoned mines used as hibernacula represents a substantial threat to cave-roosting bats and bat habitat where human visitors occur [22]. Even a small number of short duration disturbances lead to significant increases in arousal events and subsequent energy expenditures that may lead to increased mortality of hibernating bats [23, 24]. White-nose Syndrome (WNS) is a fungal disease that affects hibernating bats. WNS has killed several million bats in North America [25, 26]. The pathogenic fungus *Pseudogymnoascus destructans* (formerly *Geomyces destructans*) that causes WNS has not been detected within the range of Fringed Myotis or in Wyoming to date [27], but it is thought that the disease will continue to expand westward. It is unknown if Fringed Myotis will be affected by WNS, but other bat species in the genus *Myotis* have experienced large population declines from the disease [25].

KEY ACTIVITIES IN WYOMING
Bats have received increasing research attention across North America and in Wyoming. To address concerns regarding potential WNS infection of bats in Wyoming, the Wyoming Game and Fish Department (WGFD) in cooperation with the Wyoming Bat Working Group authored

"A strategic plan for white-nose syndrome in Wyoming" in 2011. This document presents a plan of action to minimize impacts of WNS if it is detected in states adjacent to or in Wyoming [28]. To facilitate early detection of the disease, WGFD requires researchers to evaluate all bats captured during research activities for signs of WNS infection using the Reichard Wing-Damage Index [29]. Beginning in 2012, WGFD personnel placed temperature and humidity loggers in a number of known or suspected hibernacula across Wyoming to determine if climatic conditions at those sites are favorable for growth of *P. destructans*. Personnel have also begun collecting swabs from hibernating bats and hibernacula substrates in an effort to assist with early detection of *P. destructans*. While placing loggers, surveyors also searched for hibernating bats but no Fringed Myotis were documented during these surveys [30-32]. WGFD conducts periodic surveys at known hibernacula throughout the state, resulting in a single known hibernaculum for Fringed Myotis, despite the fact that the species occurs in many portions of Wyoming [11]. Several studies have been completed or are underway that have increased our understanding of bat species in the state, including Fringed Myotis. Both WGFD and the WYNDD have conducted numerous bat inventories across the state including a statewide forest bat inventory from 2008 to 2011 [12-15, 33, 34], a statewide inventory of cliffs, caves, and rock outcroppings from 2012 to 2015 [16-18, 35], an inventory of bats at Devils Tower National Monument from 2010 to 2011, a bat monitoring effort in southern Wyoming from 2011 to 2013 [36-38], and bat surveys in northeastern Wyoming in 2014 and 2015 [7]. Fringed Myotis was captured and recorded during these investigations, but, with the exception of surveys at Devils Tower National Monument, Fringed Myotis represented a small proportion of the bat community [7, 12, 16-19, 33-35]. In 2015, WYNDD developed a bat monitoring plan and initiated survey activities at Bighorn Canyon National Recreation Area (BICA). The primary objective of this monitoring plan is to develop a baseline activity level or other index of abundance for Little Brown Myotis (*M. lucifugus*) that can be used to detect changes in populations within BICA through time, but Fringed Myotis was frequently recorded throughout the area [39]. In 2016, WYNDD fitted four pregnant or lactating female Fringed Myotis with radio transmitters and tracked them to day roosts. These individuals utilized crevices in rock outcroppings and interstitial spaces among boulders near the base of the tower [10]. In addition to research activities, many conservation organizations and federal and state agencies, including WGFD, have developed outreach and education materials to inform the general public of the importance bats and concerns regarding the persistence of bats in the future.

ECOLOGICAL INFORMATION NEEDS

Habitat associations and use of Fringed Myotis in Wyoming are poorly understood. This is particularly true in regards to summer day roost and winter hibernacula use and selection. All aspects of phenology are poorly understood, especially for this species in Wyoming. There are no robust estimates of abundance or population trends for Fringed Myotis but these data would be useful in the face of potential stressors such as WNS, human recreation, and land management practices. As of 2016, WNS has not been documented in Wyoming but continued monitoring of this disease is an essential component of minimizing potential effects of the disease on bats in Wyoming.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Very little is known about the wintering locations of Fringed Myotis in Wyoming. Although WNS has not been detected in the state, the westward progression of the fungus necessitates the need for these data before it reaches Wyoming. Consequently, priorities will focus on locating and systematically surveying hibernacula to monitor populations and recommend and assist with bat-friendly closures of important caves and mines where needed. In 2016, WGFD began a project in collaboration with the state of Nebraska to evaluate occurrence, abundance, and reproductive status of bats in eastern Wyoming, which represents an important zone of overlap between eastern and western bat species, including Fringed Myotis. Mist-net surveys will continue to implement WNS protocols and assessment in an effort to assist with early detection should the fungus reach the state. Habitat assessments will be incorporated with survey efforts to better understand what influences species presence and distribution at a finer scale and to develop management and conservation recommendations. In addition to inventory projects, WGFD, in collaboration with the Wyoming Bat Working Group and other state-wide partners, will implement the North American Bat Monitoring Program that will use acoustic monitoring to assist with state and region-wide assessment of bat trends, which are currently lacking. Additional priorities will include updating and revising the Conservation Plan for Bats in Wyoming and the Strategic Plan for WNS in Wyoming. Finally, outreach and collaboration with private landowners will remain a priority to ensure conservation of bats and bat habitat.

CONTRIBUTORS

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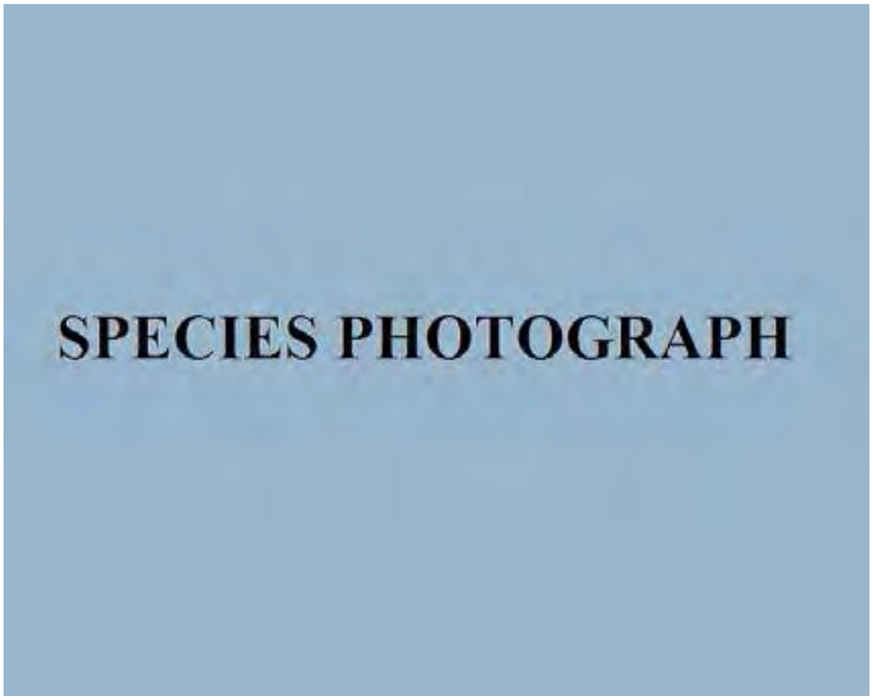

Figure 1: Photo not available.


Figure 2: North American range of *Myotis thysanodes*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

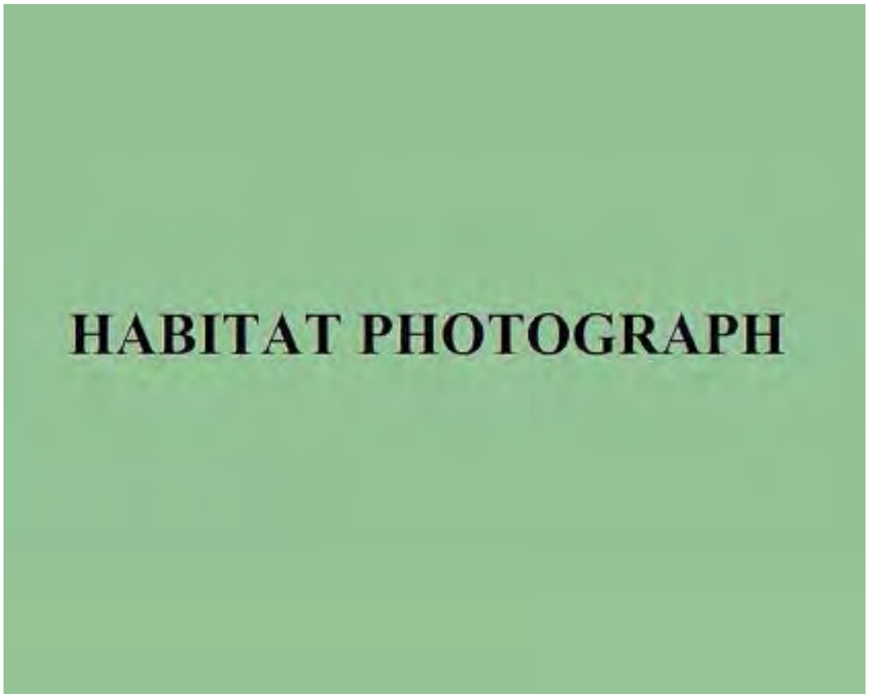

Figure 3: Photo not available.

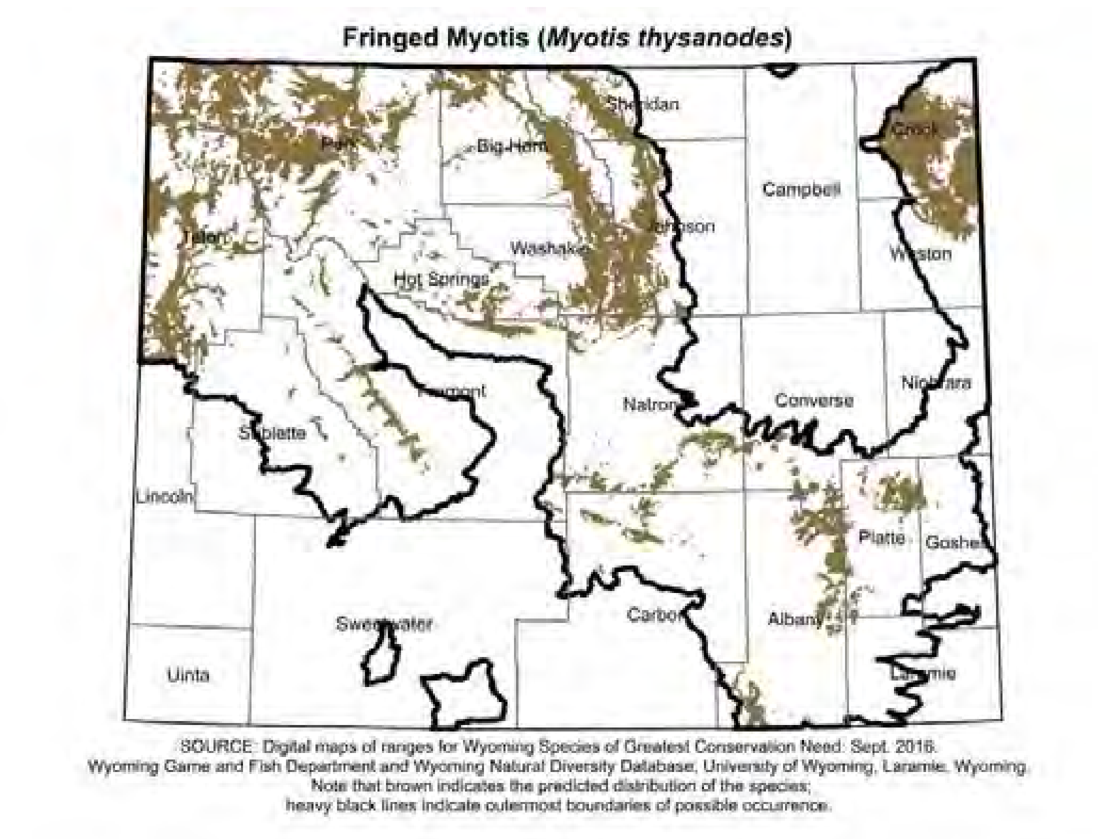

Figure 4: Range and predicted distribution of *Myotis thysanodes* in Wyoming.

Great Basin Pocket Mouse

Perognathus mollipilosus

REGULATORY STATUS

USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS

USFWS: No special status
WGFD: NSSU (U), Tier III
WYNDD: G5, S3S4
    Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS

The Wyoming Natural Diversity Database has assigned Great Basin Pocket Mouse (*Perognathus mollipilosus*) a state conservation rank ranging from S3 (Vulnerable) to S4 (Apparently Secure) because of uncertainty about the abundance and population trends for this species in Wyoming. Also, note that the Global rank (G5) is provisional at this time – NatureServe (Arlington, Virginia) has not yet formalized a Global rank for this species.

NATURAL HISTORY

Taxonomy:
In 2014, Great Basin Pocket Mouse (*P. parvus*) was split into two distinct species based on genetic evidence: Great Basin Pocket Mouse (*P. mollipilosus*) and Columbia Plateau Pocket Mouse (*P. parvus*) [1]. Only *P. mollipilosus* is found in Wyoming, but subspecies designations of this newly defined species have not been finalized [1]. Due to the extremely recent nature of this taxonomic revision, most references cited in this account refer to Great Basin Pocket Mouse (*P. parvus*) as it was recognized before the split. Research conducted prior to 2014 in areas outside the currently accepted range of *P. mollipilosus* has been excluded from this account because it likely involved Columbia Plateau Pocket Mouse or occurred in areas where distributions of the new species remain in question [1].

Description:
Identification of Great Basin Pocket Mouse is possible in the field. The sexes are similar in appearance, with males averaging slightly larger than females [2-4]. Great Basin Pocket Mouse is the largest species of *Perognathus* [5]. Adult weight ranges from 16–30 g, and total length ranges from 148–198 mm [3]. Tail, hind foot, and ear length ranges from 77–97 mm, 19–27 mm, and 6–10 mm, respectively [3]. Pelage color is variable among individuals and populations [2, 5]. Dorsal pelage is buff and interspersed to varying degrees with black hairs, leading to an overall appearance ranging from gray to brownish buff to buff [2, 3]. The venter ranges from buff to white.

The hair-covered tail is darker above, light below, and lacks an obvious crest or terminal tuft [3, 4]. Some individuals may have a clear lateral line between the dorsum and venter and/or light auricular patches behind the ears; however, the characteristics of these features appear to be variable across the continental distribution [2-4]. Like all pocket mice, Great Basin Pocket Mouse has external cheek pouches that are lined with hair and used for transporting food [3, 4]. Where sympatric, Olive-backed Pocket Mouse (*P. fasciatus*) can be distinguished from Great Basin Pocket Mouse by its shorter tail (57–68 mm) and smaller hind-feet (16–18 mm) [3].

Distribution & Range:
The continental distribution of the appropriately named Great Basin Pocket Mouse is centered over the Great Basin of the western United States [6]. Exact range boundaries have not been established for the newly defined *P. mollipilosus* but definitely include areas of central and southern Oregon, western California, most of Nevada and Utah, northwestern Arizona, and southwestern Wyoming [1]. Southwestern Wyoming falls on the far eastern edge of the known distribution of *P. mollipilosus*, and confirmed breeding has been documented in 3 of the 28 latitude/longitude degree blocks in the state [7]. Questions remain about the detailed distribution of *P. mollipilosus* in Oregon, whether the species' range extends into southern Idaho and far southwestern Montana, and the extent of sympatry and/or hybridization with Columbia Plateau Pocket Mouse.

Habitat:
Great Basin Pocket Mouse primarily inhabits arid, open, shrublands dominated by Big Sagebrush (*Artemisia tridentata*) and/or Greasewood (*Sarcobatus vermiculatus*), shrub grasslands, and piñon-juniper (*Pinus* spp.-*Juniperus* spp.) woodlands [2, 4, 8]; however, the species may also occur in more mesic habitats [2, 8-10]. In Wyoming, the species is found primarily in low-elevation, sagebrush-dominated shrublands and shrub grasslands and occasionally in grassy piñon-juniper foothills [3, 5]. Burrow systems can be up to 1 m in depth and are used for food storage, refuge, and nesting [2, 3].

Phenology:
The phenology of Great Basin Pocket Mouse in Wyoming is not well known. The species is nocturnal and does not hibernate, but it will enter periods of torpor when temperatures are low or food is limited [3, 4]. Great Basin Pocket Mouse is solitary outside of the breeding season, which occurs from May to August [3]. Litters of 4 or 5 young (range 2–8) are likely born in May or June, although females may produce a second litter in years when sufficient food resources are available [2-4, 11].

Diet:
The specific diet composition of Great Basin Pocket Mouse in Wyoming is unknown. Throughout its range, the species primarily consumes a variety of seeds, as well as succulent leaves and insects depending on availability [2-5]. Great Basin Pocket Mouse stores seeds in burrows for consumption during the winter and is also known to scatter-hoard seeds in more shallow caches [3, 4, 12, 13]. The species obtains all water necessary for survival from food [2, 4].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE

There are no robust abundance estimates available for Great Basin Pocket Mouse in Wyoming. An ongoing study designed to survey pocket mouse distributions across the state captured just 9 individuals across 2 of 47 trapping sites surveyed in 2015; however, only 6 of the 47 sites fell within the predicted range of Great Basin Pocket Mouse [14, 15]. The statewide abundance rank of RARE is based on the species' restricted distribution in Wyoming, and Great Basin Pocket Mouse also appears to be rare within suitable environments in the occupied area [7].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends for Great Basin Pocket Mouse in Wyoming are unknown.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Great Basin Pocket Mouse has moderate intrinsic vulnerability in Wyoming because it appears to have low abundance in the state, even within suitable habitat. Although arid sagebrush shrublands are found across much of Wyoming, the environment in southwestern Wyoming is unique in the state and represents the furthest northeast extension of the Great Basin Desert region. As a small mammal with relatively limited dispersal ability, Great Basin Pocket Mouse may have little opportunity for range expansion within the state should major disturbance or loss of existing habitat occur.

Extrinsic Stressors:
SLIGHTLY STRESSED
Primary potential extrinsic stressors to Great Basin Pocket Mouse in Wyoming are loss or degradation of habitat from natural or anthropogenic disturbances. Sagebrush and desert shrublands in the state are vulnerable to energy and infrastructure development, invasive plant species such as Cheatgrass (*Bromus tectorum*), disturbance from off-road vehicles, overgrazing by livestock, drought and climate change, conflicting conservation and management practices, and in some areas expanding conifer woodlands [7]. Great Basin Pocket Mouse appears tolerant of some disturbance in other parts of its distribution, including grazing, burning, mowing, and road effects [9, 13, 16, 17]. However, the species showed lower abundance in mechanically and chemically treated sagebrush shrublands in Utah [18]. Great Basin Pocket Mouse is known to consume seeds from some exotic plants and to utilize environments dominated by invasive Cheatgrass [2, 19], but both abundance and sprint velocity may be significantly reduced in Cheatgrass habitats [19, 20]. Drought conditions may shorten the breeding season of this species leading to fewer litters in a year [21]. Great Basin Pocket Mouse did not experience any range shifts or contractions over an 80-yr period of increasing maximum summer temperature and precipitation in the Ruby Mountains of northeastern Nevada [22], which may suggest that the species is less likely to be impacted by the effects of global warming than some other small mammal species. It is not known how potential extrinsic stressors might impact Great Basin Pocket Mouse in Wyoming.

KEY ACTIVITIES IN WYOMING

Great Basin Pocket Mouse is classified as a Species of Greatest Conservation Need by the Wyoming Game and Fish Department. In 2015, the University of Wyoming initiated a two-year graduate research project to better understand the distribution, occupancy, habitat, and diet partitioning of small mammals in the state, including Great Basin Pocket Mouse, through statewide surveys of pocket mice and other small mammals. Great Basin Pocket Mouse was detected at several sites during the first season of trapping in 2015, and this project is already providing valuable information on the distribution and habitat associations of this species in Wyoming [14, 15].

ECOLOGICAL INFORMATION NEEDS

Great Basin Pocket Mouse is not well-studied in Wyoming, and little is known about the detailed distribution, abundance, natural history, or reproductive habits of this species in the state. As a rare, peripheral species, Great Basin Pocket Mouse would benefit from research to identify potential natural and anthropogenic disturbances to its already limited Wyoming distribution. Additional research will likely be necessary to re-establish subspecies designations for *P. mollipilosus* in Wyoming and across its distribution.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Great Basin Pocket Mouse is assigned an NSSU rank because survey data that would provide for an assessment of population status are lacking. Consequently, priorities in Wyoming in the short-term will focus on addressing these data deficiencies. Of particular importance are data on population status and trends and a more refined understanding of distribution within the state. Because of the low density and patchy distribution of Great Basin Pocket Mouse on the landscape, acquiring these data will likely require targeted survey efforts. Additional priorities will focus on assessing limiting factors and habitat requirements, including the impact of invasive species, energy development, and other anthropogenic factors, which will ultimately be used to develop management and conservation recommendations.

CONTRIBUTORS

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Figure 1: Great Basin Pocket Mouse captured in Uinta County, Wyoming. (Photo courtesy of Kristina M. Harkins)

Figure 2: North American range of Great Basin Pocket Mouse (*Perognathus parvus*) prior to the 2014 taxonomic split. New species boundaries for Great Basin Pocket Mouse (*P. mollipilosus*) and Columbia Plateau Pocket Mouse (*P. parvus*) have not yet been finalized. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Sagebrush shrubland habitat where Great Basin Pocket Mouse has been captured in Uinta County, Wyoming. (Photo courtesy of Kristina M. Harkins)

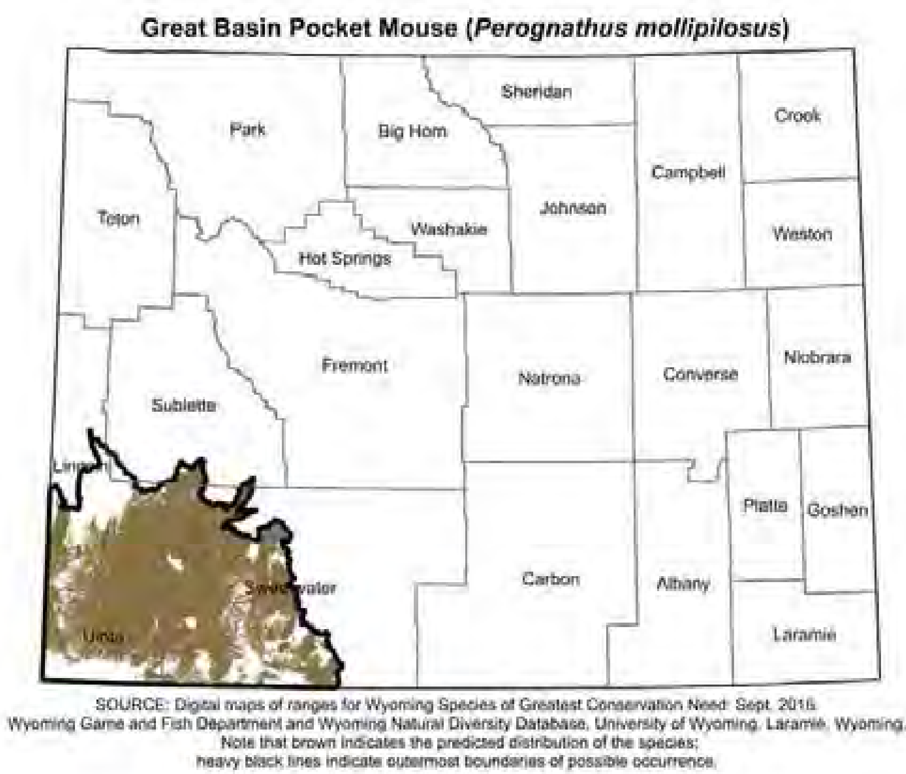

Figure 4: Range and predicted distribution of *Perognathus mollipilosus* in Wyoming.

Wyoming Species Account

Hayden's Shrew

Sorex haydeni

REGULATORY STATUS

USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS

USFWS: No special status
WGFD: NSSU (U), Tier III
WYNDD: G5, S2S3
    Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS

The Wyoming Natural Diversity Database has assigned Hayden's Shrew (*Sorex haydeni*) a state conservation rank ranging from S2 (Imperiled) to S3 (Vulnerable) because of uncertainty about population trends and the proportion of mapped range actually occupied by the species in Wyoming.

NATURAL HISTORY

Taxonomy:

Formerly considered a subspecies of Masked Shrew (*S. cinereus*), Hayden's Shrew is now known as a full species [1, 2]. Like many other North American shrews, it appears to have evolved relatively recently, during the Pleistocene [3]. There is both genetic and morphological evidence for introgression between *S. cinereus* and *S. haydeni* [4]. There are no currently accepted subspecies of Hayden's Shrew.

Description:

Hayden's Shrew is an extremely small mammal, and is very similar in appearance to other Wyoming shrew species. Adult dimensions include total length 88-99 mm, tail length 34-40 mm, hind foot 10-12 mm, and mass 3-5 g. Like other *Sorex* species, Hayden's Shrew has a relatively long and flexible snout, bicolored tail, proportionally small eyes, uniformly brownish or grayish fur on the back, and silvery-whitish fur below. Identification to species requires a combination of body measurements, skull measurements, and, especially, dental characteristics, which typically requires the individual shrew to be sacrificed. A technical key such as in Clark and Stromberg (1987) is an important aid in identifying Wyoming shrews to species [5].

Distribution & Range:

Hayden's Shrew occupies prairie environments across the northern Great Plains, extending from southern Saskatchewan and Manitoba south to central Kansas, and from the Rocky Mountain front to the Mississippi River [6]. The species is known from the vicinity of the Bighorn Mountains and Black Hills in Wyoming. As with many shrews, current understanding of range and distribution is based on rather few confirmed observations. Genetic analysis of specimens previously assumed to be *S. cinereus* suggest presence of *S. haydeni* in New Mexico [2], highlighting the incomplete nature of shrew sampling and range mapping in the region. Given the relatively low sampling effort for shrews in Wyoming, the species may occupy more of the state than is currently assumed.

Habitat:
Habitat associations of Hayden's Shrew have not been extensively studied. The species is generally associated with grasslands, and may prefer wet patches (e.g., wetlands, pond edges, riparian zones) within grass-dominated landscapes [5]. Its known distribution in Wyoming – Bighorn Mountains and Black Hills – suggests more of a montane association, and it is possible that Hayden's Shrew in this region favors the more mesic grasslands of montane and foothills zones over more xeric grasslands at lower elevations. In general, shrews are assumed to seek out certain microhabitats (e.g., specific litter depths, debris densities, or soil textures) that may not align well with traditional categories of wildlife habitat based on dominant overstory plants [7, 8].

Phenology:
Hayden's Shrew is active year round. Breeding phenology is not well known, but limited data (from Turner 1974, as cited in Clark and Stromberg 1987) suggest Hayden's Shrews reproduce first as 2 year-olds, and females produce up to 2–3 litters of 4–10 young each per year. Litters are likely produced from mid-June through July. Young mature and leave the nest, which is typically made of plant material and placed under logs or in rock crevices, in 20–30 days [5].

Diet:
Hayden's Shrew diet is likely similar to that of other *Sorex* shrews, with small invertebrates forming the bulk of consumed items [5]. Specific prey preferences and seasonal diet shifts are unknown.

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: UNCOMMON
There are no population estimates of Hayden's Shrew at continental, national, or state scales. The UNCOMMON abundance in Wyoming is inferred from the small portion of the state known to be occupied and an apparent rarity within that range [9]. However, sampling effort for shrews in the state has been so low that the species may actually extend beyond the currently-assumed range and may be common in some localities.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends of Hayden's Shrew in Wyoming are unknown.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Though little is known about Hayden's Shrew, the general breeding biology of *Sorex* shrews makes them moderately vulnerable. Many *Sorex* have a life expectancy of one year, and under some conditions may produce only one litter per year. Also, limited mobility restricts shrews'

ability to re-colonize suitable habitats and expand populations [5]. These characteristics may predispose *Sorex* populations to fragmentation and local extirpation if breeding is disrupted for even a single season [8]. Hayden's Shrew populations may be especially sensitive to such fragmentation if they are strongly specialized to moist patches within grassland landscapes.

Extrinsic Stressors:
UNKNOWN
So little is known about Hayden's Shrew in Wyoming that any outline of extrinsic threats is somewhat speculative. Assuming a relatively narrow habitat preference for moist areas within grassland landscapes, significant disturbances to such habitat would likely negatively affect the species. Conversely, shrews in general may rely on certain microhabitats that remain relatively unaffected by some large-scale disturbances, allowing populations to persist in otherwise disturbed areas.

KEY ACTIVITIES IN WYOMING

Hayden's Shrew is classified as a Species of Greatest Conservation Need by the Wyoming Game and Fish Department (WGFD). Currently, there is no research being conducted on Hayden's Shrew in Wyoming. In 2014 the WGFD funded and conducted an evaluation of the potential to use guard hairs to identify shrews to species, thus allowing for identification without the need to sacrifice individuals. However, only Western Water Shrew (*S. navigator*) was identifiable by guard hair, which is also the only shrew in Wyoming that is identifiable in hand [10].

ECOLOGICAL INFORMATION NEEDS

Very little is known about Hayden's Shrew anywhere in the species' range. There are so few records of the species in Wyoming that basic distribution, habitat preferences, dietary needs, breeding phenology, and potential threats are poorly understood. A better estimate of actual distribution in the state may be the top priority information need at this time and could be efficiently generated as part of a larger field survey effort targeting multiple *Sorex* species simultaneously.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Hayden's Shrew is assigned an NSSU rank because survey data that would provide for an assessment of population status are lacking. Consequently, management priorities for the species in the short-term will focus on addressing these data deficiencies. Of particular importance are data on presence, distribution, population status and trends, habitat needs, and the impact of potential threats. Because shrews are rarely trapped as part of other small mammal projects, addressing these needs will require systematic surveys designed to target shrews (i.e., pitfall traps). However, these species would also benefit from the development of new capture and identification techniques that would not require sacrificing individuals. Results from these efforts will ultimately be used to update status and develop management and conservation recommendations.

CONTRIBUTORS

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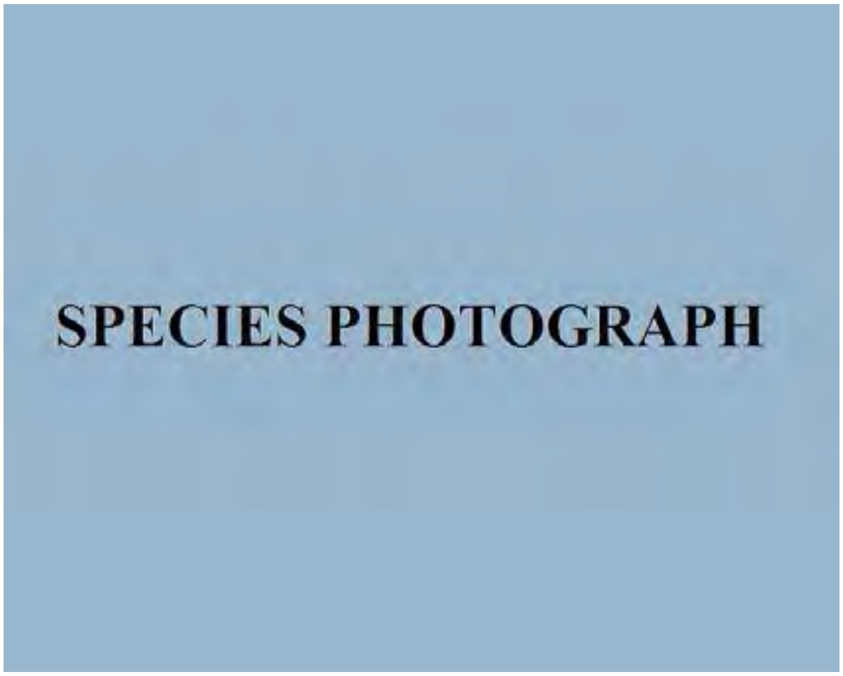

Figure 1: Photo not available.

Figure 2: North American range of *Sorex haydeni*. Map fails to extend far enough west to encompass known range in Wyoming (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

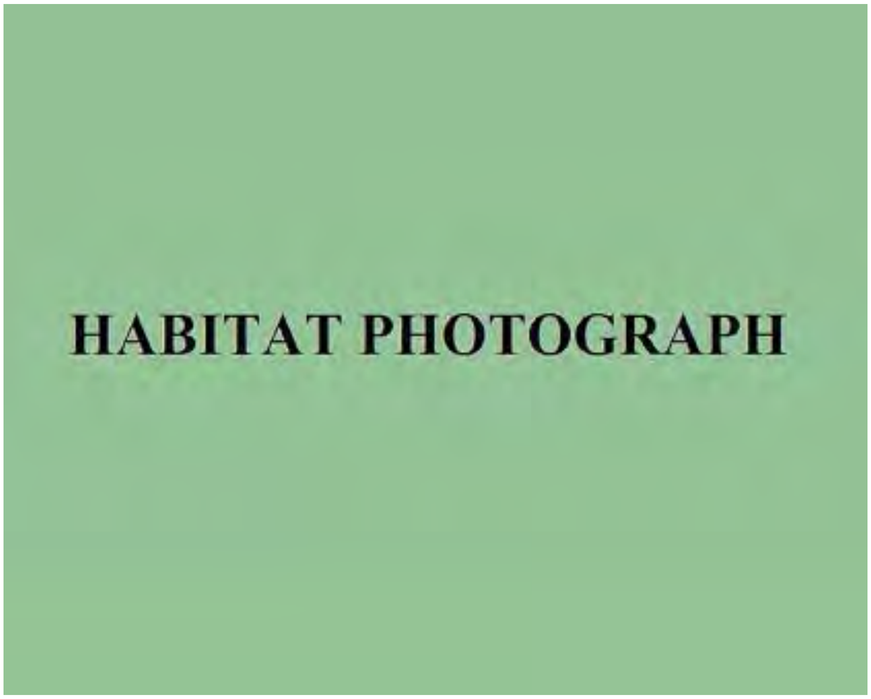

Figure 3: Photo not available.

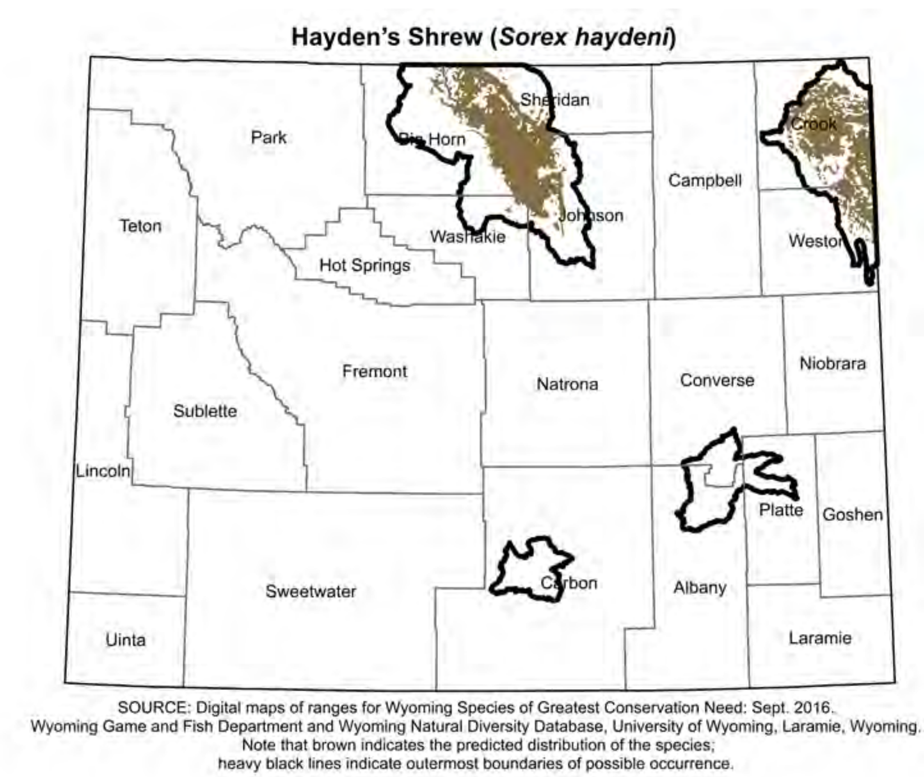

Figure 4: Range and predicted distribution of *Sorex haydeni* in Wyoming.

Hispid Pocket Mouse

Chaetodipus hispidus

REGULATORY STATUS

USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS

USFWS: No special status
WGFD: NSSU (U), Tier III
WYNDD: G5, S1S3
    Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS

The Wyoming Natural Diversity Database has assigned Hispid Pocket Mouse (*Chaetodipus hispidus*) a state conservation rank ranging from S1 (Critically Imperiled) to S3 (Vulnerable) because of uncertainty about the proportion of range occupied and population trends for this species in Wyoming.

NATURAL HISTORY

Taxonomy:

Historically, there were four recognized subspecies of Hispid Pocket Mouse, and only *C. h. paradoxus* was found in Wyoming [1-5]. A recent DNA-based study determined that the previously accepted subspecies are neither morphologically nor genetically distinct and instead proposed new subspecies boundaries delineated by four geographically and ecologically disjunct mitochondrial clades [6]. Following this taxonomic revision, Wyoming remains within the distribution of the newly defined subspecies *C. h. paradoxus* [6].

Description:

It is possible to identify Hispid Pocket Mouse in the field. It is the largest Wyoming pocket mouse species; adults weigh between 40–60 g and can reach total lengths of 200–223 mm [2]. Tail, hind foot, and ear length ranges from 90–113 mm, 25–28 mm, and 12–13 mm, respectively [2]. Hispid Pocket Mouse is named for its distinctly coarse dorsal pelage, which is buff to yellowish orange mixed with black hairs, thus leading to an overall brownish or even olive appearance [1, 2, 4, 5, 7]. The species has a prominent band of buff to yellowish orange hair running laterally along the side and around the eyes, and the venter is white. The hair-covered tail does not have an obvious crest or terminal tuft and is white or buff with a dark mid-dorsal stripe [1, 2, 4, 5, 7]. Like all pocket mice, Hispid Pocket Mouse has external cheek pouches that are lined with hair and used for transporting food [2, 5]. Where sympatric, Olive-backed Pocket Mouse (*Perognathus fasciatus*; weight 8–14 g), Plains Pocket Mouse (*P. flavescens*; 7–15 g), and Silky Pocket Mouse (*P. flavus*;

5–10 g) can all be distinguished from Hispid Pocket Mouse by their much smaller size and soft dorsal pelage [2].

Distribution & Range:
Hispid Pocket Mouse is widely distributed across the Great Plains of central North America, from southeastern Montana and southwestern North Dakota, south into central Mexico [8]. Far eastern Wyoming is on the northwestern edge of the species' continental range [4, 9]. Confirmed or suspected breeding has been documented in 3 of the 28 latitude/longitude degree blocks in Wyoming [9].

Habitat:
Hispid Pocket Mouse inhabits a wide range of arid grassy environments across its continental range including shortgrass, bunchgrass, and tallgrass prairie; mixed grasslands; shrub grasslands; piñon-juniper (*Pinus* spp.-*Juniperus* spp.) mesas; oak (*Quercus* spp.) uplands; and active and inactive cropland [1, 5, 10-16]. However, the species is typically most abundant in short-grass and bunch-grass environments with relatively sparse vegetation [1]. In Wyoming, Hispid Pocket Mouse is found in short-grass prairie, mixed-grass prairie, sagebrush (*Artemisia* spp.) and Soapweed Yucca (*Yucca glauca*) grasslands, and vegetated dunes [2, 4]. Shallow burrow systems are constructed in a variety of soil types and are used for food storage, refuge, and nesting. Older animals tend to build more complex burrow systems than younger animals [1, 5].

Phenology:
The phenology of Hispid Pocket Mouse in Wyoming is largely unknown. The species is nocturnal and does not hibernate; however, it will enter periods of torpor when temperatures are low, especially when food is limited [1, 2]. Hispid Pocket Mouse is solitary outside of the breeding season, which occurs during the spring and summer in the northern parts of its range. Females may have several litters of 5 or 6 young (range 2–9) per season, which are likely dependent on the mother for approximately 30 days [1, 2, 5].

Diet:
Nothing is known about the specific diet composition of Hispid Pocket Mouse in Wyoming. In other parts of its range, the species eats an assortment of seeds (i.e., grass, forb, shrub, tree, and succulent), as well as some insects and green vegetation depending on availability [1, 2, 5]. Hispid Pocket Mouse stores seeds in burrows for consumption during the winter [1, 2, 4, 5].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
There are no robust estimates of abundance available for Hispid Pocket Mouse in Wyoming. An ongoing study designed to survey pocket mouse distributions across the state captured just 5 individuals across 3 of 47 trapping sites surveyed in 2015; however, only 8 of the 47 sites fell within the predicted range of Hispid Pocket Mouse [17, 18]. The species has a statewide abundance rank of RARE, and appears to be rare within suitable environments in its predicted range [9].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends for Hispid Pocket Mouse in Wyoming are unknown.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Hispid Pocket Mouse has moderate intrinsic vulnerability in Wyoming because it has a restricted distribution and apparent low abundance in the state, even within suitable habitat. As a small mammal with relatively limited dispersal ability, Hispid Pocket Mouse would likely have little opportunity for range expansion within the state should major disturbance or loss of existing habitat occur.

Extrinsic Stressors:
MODERATELY STRESSED
Primary potential extrinsic stressors to Hispid Pocket Mouse in Wyoming are loss or degradation of habitat from natural or anthropogenic disturbances. Grassland environments in the state are vulnerable due to development for energy, infrastructure, and agriculture; invasive plant species; anthropogenic disturbance from off-road recreational activities; altered fire and grazing regimes; and drought and climate change [9]. Like other pocket mouse species that typically favor open environments with sparse vegetation, Hispid Pocket Mouse may be negatively impacted by invasive plant species that grow in tall and/or dense stands such as Cheatgrass (*Bromus tectorum*) [19]. Hispid Pocket Mouse had higher abundance in interior versus edge plots in mixed grasslands in Colorado, and was trapped most frequently in landscapes with little surrounding development [10]. However, the species appears to be very tolerant of fire and grazing across much of its distribution, even showing preference for grazed and recently burned habitat in some areas [15, 16, 20-23]. Hispid Pocket Mouse will also use some agricultural landscapes including cornfields, wheat fields, and fallow fields, but may be more abundant in nearby natural habitat [10, 12-15]. It is not known how potential extrinsic stressors might impact Hispid Pocket Mouse in Wyoming.

KEY ACTIVITIES IN WYOMING

Hispid Pocket Mouse is classified as a Species of Greatest Conservation Need by the Wyoming Game and Fish Department (WGFD). From 2013–2015, the WGFD funded a project at the Wyoming Cooperative Fish and Wildlife Research Unit to evaluate the impact of Cheatgrass on small mammal communities in Thunder Basin National Grassland; however, Hispid Pocket Mouse was not detected during this study [19]. In 2015, the University of Wyoming and WGFD initiated a two-year graduate research project to better understand the distribution, occupancy, habitat, and diet partitioning of small mammals in the state, including Hispid Pocket Mouse, through statewide surveys. Hispid Pocket Mouse was detected at several sites during the first season of trapping in 2015, and this project is already providing valuable information on the distribution and habitat associations of this species in Wyoming [18, 24]. Data from this project's 2016 field season is not yet available, but is expected to add important new information in this context.

ECOLOGICAL INFORMATION NEEDS

Hispid Pocket Mouse is not well-studied in Wyoming, and little is known about the detailed distribution, abundance, natural history, or reproductive habits of this species in the state. As a rare, peripheral species, Hispid Pocket Mouse would benefit from research to identify potential natural and anthropogenic disturbances to its already limited Wyoming distribution.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Hispid Pocket Mouse is assigned an NSSU rank because survey data that would provide for an assessment of population status are lacking. Consequently, priorities in Wyoming in the short-term will focus on addressing these data deficiencies. Of particular importance are data on population status and trends and a more refined understanding of distribution within the state. Because of the low density and patchy distribution of Hispid Pocket Mice on the landscape, acquiring these data will likely require targeted survey efforts. Additional priorities will focus on assessing limiting factors and habitat requirements, including the impact of invasive species and energy development, which will ultimately be used to develop management and conservation recommendations.

CONTRIBUTORS

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Figure 1: Hispid Pocket Mouse captured in Goshen County, Wyoming. (Photo courtesy of Tegan May)

Figure 2: North American range of *Chaetodipus hispidus*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Grassland habitat where Hispid Pocket Mouse has been captured in Goshen County, Wyoming. (Photo courtesy of Kristina M. Harkins)

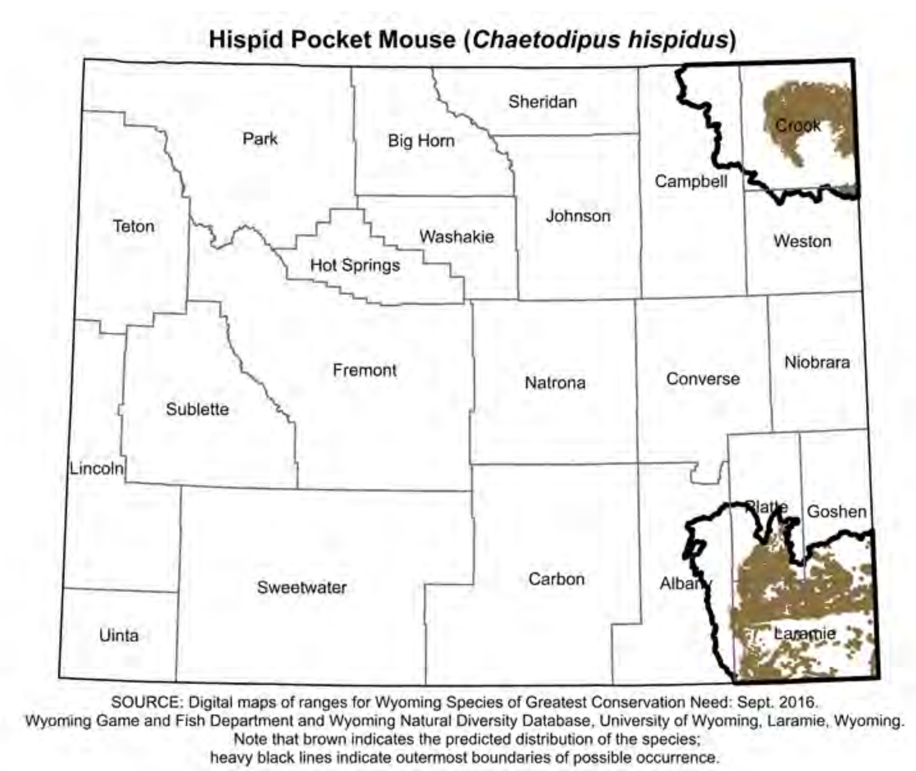

Figure 4: Range and predicted distribution of *Chaetodipus hispidus* in Wyoming.

Idaho Pocket Gopher
Thomomys idahoensis

REGULATORY STATUS
USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: Sensitive
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G4, S1S2
Wyoming Contribution: VERY HIGH
IUCN: Least Concern

STATUS AND RANK COMMENTS
Idaho Pocket Gopher (*Thomomys idahoensis*) is assigned a range of state conservation ranks by the Wyoming Natural Diversity Database (WYNDD) due to uncertainty about the species' abundance, proportion of range occupied, and population trends in Wyoming.

NATURAL HISTORY

Taxonomy:
Although Idaho Pocket Gopher was initially described as a unique species, revisions of the *Thomomys* genus in 1939 classified Idaho Pocket Gopher as a subspecies of Northern Pocket Gopher (*T. talpoides idahoensis*) [1, 2]. In 1972, genetic analyses confirmed that Idaho Pocket Gopher is a unique species. Two subspecies of Idaho Pocket Gopher are recognized, *T. i. idahoensis* and *T. i. pygmaeus*; only *T. i. pygmaeus* is found in Wyoming [1].

Description:
Idaho Pocket Gopher is a small member of the genus *Thomomys* (total length: 167–203 mm; weight: 46–63 g) [3]. Like other pocket gophers, Idaho Pocket Gopher has a heavily muscled head and shoulders that taper into relatively narrow hips and short legs. The species has fur-lined, external cheek pouches and small ears and eyes. The front feet are large with claw-like nails [4]. Pelage may be variable in color across the species range. Generally, the species has pale yellowish fur that is tipped with dark brown along the back, whitish feet, and dark gray coloring around the nose [1]. Tentative field identification can be made from the presence of dark post-auricular patches that do not extend dorsally and lighter-colored hair on the fringe of the pinnae that is the same color as the dorsum [5]. However, the presence of dark post-auricular patches is debated [1, 5]. This species can also be identified by its much smaller size overall when compared to the sympatric Northern Pocket Gopher [1]. However, distinguishing between Idaho and Northern Pocket Gopher in the field remains difficult [5]. Figure 5 illustrates the similarities and differences among three *Thomomys* species in Wyoming that might be useful to identification.

Identification from other pocket gophers is possible by using a combination of genetics, pelage characteristics, morphology, and geographic location [1, 5, 6].

Distribution & Range:
Idaho Pocket Gopher is restricted to portions of Wyoming, Idaho, Utah, and Montana. The distribution of the species has two centers of occurrence, one in eastern Idaho and extreme southwestern Montana (*T. i. idahoensis*) and another in southwestern Wyoming and extending slightly into southeastern Idaho and northeastern Utah (*T. i. pygmaeus*) [1]. In Wyoming, the species is found in the foothills of the Wyoming Range, Uinta Mountains, and Wind River Mountains in Lincoln, Sublette, and Uinta Counties west of the Green River [4, 5, 7]. Confirmed breeding has been documented in 1 of the 28 latitude/longitude degree blocks in Wyoming [8].

Habitat:
Habitat associations of Idaho Pocket Gopher are poorly understood. The limited research on Idaho Pocket Gopher suggests that it prefers mountain foothills and sagebrush shrublands. The presence of Ponderosa Pine (*Pinus ponderosa*), sagebrush (*Artemisia* spp.), and topographic ruggedness were the best predictors of presence from a relatively limited sample of capture locations of Idaho Pocket Gopher in Wyoming [7]. Additionally, Idaho Pocket Gopher occupies areas with relatively shallow and rocky soils [1]. The species may also use shrub-steppe, grassland, subalpine meadow, and open sagebrush habitats [9].

Phenology:
Phenology of the species is unknown but is expected to be similar to the closely related and well-studied Northern Pocket Gopher [4]. Northern Pocket Gopher is fossorial and active year-round, with above-ground movements limited to nighttime or overcast daytime conditions. Breeding occurs from mid-March to mid-June with juveniles dispersing from early June to late July, at which time they begin to develop their own burrow systems [2]. Litter size of Idaho Pocket Gopher is unknown.

Diet:
Diet of Idaho Pocket Gopher is also unknown but is thought to be similar to sympatric *Thomomys* species [4]. Primary dietary components likely include roots, tubers, shoots, and leaves of forbs, grasses, and shrubs. Most food items are likely collected underground, although aboveground food items are also collected and pulled into burrow entrances. Food is likely cached [2].

CONSERVATION CONCERNS

Abundance:
Continental: REGIONAL ENDEMIC
Wyoming: RARE to UNCOMMON
There are no robust estimates of abundance for Idaho Pocket Gopher in Wyoming. It is not thought to be abundant throughout its range, including Wyoming.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends for Idaho Pocket Gopher in Wyoming are unknown.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Idaho Pocket Gopher is a regional endemic with a global distribution limited to a very small area of Idaho, Montana, Utah, and Wyoming. Basic biological and ecological aspects of Idaho Pocket Gopher do not appear to present significant intrinsic threats to the species. However, due to poor understanding of this species, this vulnerability rating should be viewed with caution. Basic habitat associations and habitat use are poorly understood. It is thought that the species may be restricted to a small variety of habitats, but these habitats are relatively common throughout the species range in Wyoming. Pocket gophers often exclude other sympatric pocket gopher species from preferred habitat, but it is unknown how much of a threat this presents to Idaho Pocket Gopher. In general, pocket gophers have limited dispersal capability, which may limit the species' ability to colonize new areas and lead to limited gene flow [9].

Extrinsic Stressors:
SLIGHTLY STRESSED
Extrinsic threats to Idaho Pocket Gopher are largely unknown. The species is likely restricted to dry upland habitats, with relatively shallow and stony soil, which minimizes the risk of control activities that are often implemented to reduce damage to agricultural lands. Development of energy resources and construction of associated infrastructure has the potential to result in the loss, fragmentation, and degradation of Idaho Pocket Gopher habitat; soil compaction from oil and gas exploration and extraction may be particularly detrimental to this fossorial species and may limit its dispersal ability [9]. However, effects of these activities on Idaho Pocket Gopher are unquantified.

KEY ACTIVITIES IN WYOMING

Most work on Idaho Pocket Gopher to-date has occurred in conjunction with efforts directed toward Wyoming Pocket Gopher (*T. clusius*). In 2010, WYNDD and other partners completed field efforts to further improve range estimates, habitat descriptions, and live-trapping methodology for pocket gophers in southwestern Wyoming. However, only 5 Idaho Pocket Gophers were trapped as part of this effort, and small sample sizes limited the ability to develop a predictive distribution model and precluded detailed habitat analyses [5, 7]. Genetic analyses from these captures were completed in 2010, which further elucidated the relatedness among pocket gophers in southwestern Wyoming and confirmed species identification determined in the field [10].

ECOLOGICAL INFORMATION NEEDS

Very little is known about the basic biology of Idaho Pocket Gopher including habitat use, phenology, diet, and dispersal behavior. Distribution, abundance, and population densities and trends are also not well known for this species. Similar to other geographically restricted pocket gophers (i.e., Wyoming Pocket Gopher), potential threats for Idaho Pocket Gopher include soil compaction from energy development; habitat loss and fragmentation; and stochastic weather events, including runoff from melting snow, high groundwater tables, late and early season freezes, and weather-caused limitations on the availability of food and cover; however, an understanding of the impacts from these threats is still needed. Finally, the distribution of Idaho Pocket Gopher is completely overlapped by the distribution of Northern Pocket Gopher, and, where they co-exist, both species show more restricted habitat use than when the other species is absent [1]. Consequently, additional information is needed to determine whether and to what extent this larger species competes with and potentially limits Idaho Pocket Gopher.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Very little is known about Idaho Pocket Gopher in general, and detailed information on distribution, abundance, density, and population trends are not available for Wyoming. Consequently, priorities for the species include conducting systematic surveys throughout its predicted range and incorporating habitat assessments with survey efforts to better understand what influences presence and distribution. Because of the presumed low density and limited distribution of Idaho Pocket Gopher on the landscape, acquiring these data will likely require targeted survey efforts. The most pressing management needs for Idaho Pocket Gopher in the short-term are an understanding of the current population status and impacts of potential limiting factors, particularly threats resulting from energy development. Long-term priorities will focus on increasing the understanding of basic biology for the species, all of which will ultimately be used to develop management and conservation recommendations.

CONTRIBUTORS

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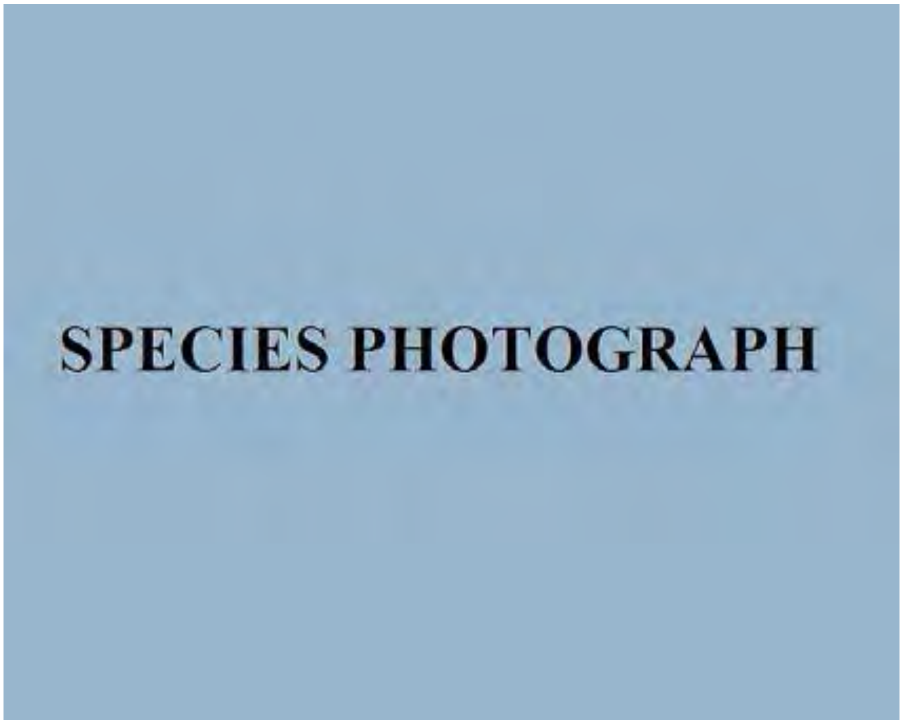

Figure 1: Photo not available.

Figure 2: North American range of *Thomomys idahoensis*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Idaho Pocket Gopher habitat in southwest Wyoming. (Photo courtesy of Hayden-Wing Associates, LLC)

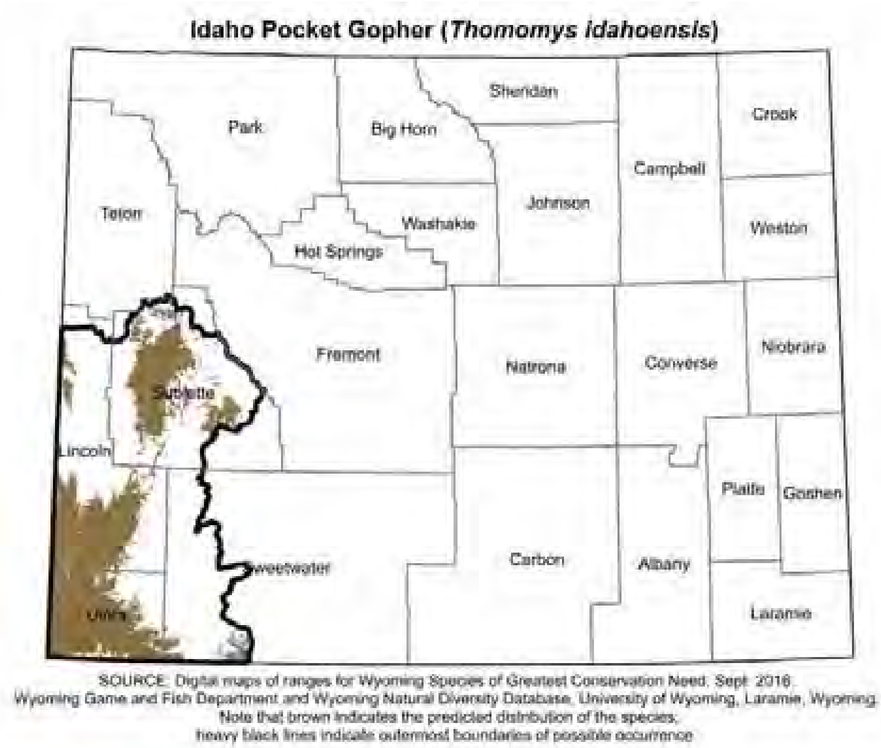

Figure 4: Range and predicted distribution of *Thomomys idahoensis* in Wyoming.

Figure 5: Species comparison between pocket gopher species. From left to right: *Thomomys talpoides* (Northern Pocket Gopher), *T. clusius* (Wyoming Pocket Gopher) and *T. idahoensis* (Idaho Pocket Gopher). (Photo courtesy of WYNDD, specimens courtesy of New Mexico State University)

Least Weasel
Mustela nivalis

REGULATORY STATUS
USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Furbearing Animal (see regulations)

CONSERVATION RANKS
USFWS: No special status
WGFD: NSSU (U), Tier III
WYNDD: G5, S1S2
Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS
The Wyoming Natural Diversity Database has assigned Least Weasel a state conservation rank ranging from S1 (Critically Imperiled) to S2 (Imperiled) because of uncertainty about the species' range and population trends in the state.

NATURAL HISTORY

Taxonomy:
Confusion exists over the taxonomic status of Least Weasel and its subspecies. Four subspecies are generally accepted in North America. *M. n. campestris* and *M. n. rixosa* occur near the eastern and northern borders, respectively, of Wyoming [1, 2]. Least Weasel in North America is sometimes considered a separate species (*M. rixosa*) from that found in the Palearctic, but this taxonomic revision has not yet been formally accepted [3-5].

Description:
Identification of Least Weasel is possible in the field. Least Weasel is the smallest member of the Order Carnivora in North America, ranging in total length from 166–225 mm [2, 6, 7]. The species has a long narrow body, short legs, and a tail that is approximately 25% of the length of the head and body. Ears are relatively large and round. Dorsal color ranges from pale ginger to dark chocolate brown, and the underside is white, cream, or yellow. Pelage turns entirely white during winter in northern populations. The tail does not have a black tip in either summer or winter. Males are noticeably larger than females; however, substantial geographic and individual variation exists with respect to size and color, and individuals from North America are among the smallest members of the species [2, 3]. In Wyoming, Least Weasel is most similar to Short-tailed Weasel (*M. erminea*) and Long-tailed Weasel (*M. frenata*), but both species are larger than Least Weasel, have longer tails, and have a black tip on the end of the tail in both summer and winter [2].

Distribution & Range:
Least Weasel is circumboreal, occurring throughout both the Nearctic and Palearctic regions of the world [2]. In North America, the species occurs as far south as Kansas and northern Georgia [8, 9]. In Wyoming, Least Weasel is known from limited confirmed records just west of Sheridan in north-central Wyoming [6] and in the Newcastle area in northeastern Wyoming [10]. The species also likely occurs along the northeastern border of the state adjacent to known records in southern Montana, the Black Hills in South Dakota, and western Nebraska [11-14]. Confirmed or suspected breeding has been documented in 5 of the 28 latitude/longitude degree blocks in the state, all in north-central and northeastern Wyoming [11]. Least Weasel has been expanding southward in the Great Plains since the 1960s [15, 16].

Habitat:
Least Weasel habitat use varies across its distribution and with fluctuating abundance of small rodent prey, including grasslands, prairies, shrub-steppe, semi-desert, riparian corridors and woodlands, open/sparse coniferous or deciduous forests, alpine meadows, tundra, hedgerows, and farmlands [2, 17]. In Wyoming, Least Weasel habitat likely consists of gently rolling ridges in sagebrush steppe and/or grasslands with willow and cottonwood riparian corridors [6]. Least Weasel prefers hunting in areas with cover from predators, especially raptors, and often hunts along forest edges and in talus, rock outcrops, and debris piles [2, 17, 18]. In Central Europe, the species also has been documented using a variety of urban landscapes [19].

Phenology:
Least Weasel is active throughout the year and does not hibernate. Throughout much of its distribution, the species can breed at any time of the year; however, litters in spring and late summer are most common. Least Weasel typically has two litters per year in the wild. Litters from arctic regions are generally larger than those in temperate regions. In North America, litters range from 1–15 young, averaging 5 in temperate North America. Gestation lasts 34–37 days. Altricial young are weaned at 42–56 days of age and reach adult size in 12–15 weeks. Spring-born individuals can reach sexual maturity in approximately 3 months [2].

Diet:
Least Weasel specializes on small rodent prey, especially voles, lemmings, and mice. The proportion of different rodent species in the diet varies geographically and with prey abundance, and Least Weasel will opportunistically switch among prey species based on availability and type of hunting habitat available [2]. Least Weasel will take a variety of prey species when small rodents are scarce, including eggs and nestling birds, moles, shrews, young rabbits, chipmunks, squirrels, amphibians, lizards, fish, and invertebrates [2, 20]. Weasels in the Italian Alps have been documented eating fruits, mainly in the Rosaceae family [21].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
There are no robust estimates of Least Weasel abundance in Wyoming. However, a statewide abundance rank of VERY RARE can be inferred from its restricted distribution and limited detections in the state, and the species appears to be rare even within suitable environments in the occupied area [11].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends for Least Weasel in Wyoming are unknown. Studies in Eurasia show that Least Weasel populations vary substantially with density of small rodent prey [2, 18, 22], complicating assessment of long-term population trends for this species. NatureServe considers the global population to be stable [8]; however, no recent long-term trend studies have been conducted.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Least Weasel has moderate vulnerability to extrinsic stressors in Wyoming because the species is known to use a variety of habitats in other areas yet has a severely limited distribution and low abundance in Wyoming. Least Weasel is capable of high reproductive productivity when prey is abundant and populations are large enough to allow individuals to find mates [2, 22, 23]. The species does not appear to skip breeding in low-prey years; rather, productivity is regulated by mortality of embryos or young [23].

Extrinsic Stressors:
MODERATELY STRESSED
Factors that impact abundance of small rodent prey and abundance of sympatric mustelids will likely affect Least Weasel populations [2, 24]. Populations of Least Weasel fluctuate substantially with prey abundance [22]. Furthermore, during low-prey years Least Weasel can be outcompeted by larger more dominant sympatric Mustelid species (e.g., *M. erminea*, *M. frenata*) capable of taking a wider range of prey species, excluding Least Weasel from foraging habitat, and even preying on Least Weasel [2, 17, 24]. Secondary poisoning from anticoagulant rodenticides used to control rodent populations can have lethal or sub-lethal (i.e., poor body condition) effects on Least Weasel, but exposure risks in Wyoming are unknown [25, 26]. As a furbearer, pelts of Least Weasel may be collected and sold; however, given its small size and overall rarity in the Wyoming, targeted trapping for Least Weasel is not likely to occur. Regular sources of mortality in Wyoming include vehicles and cats; however, the impact of these mortality sources on Least Weasel populations in the state are unknown [10].

KEY ACTIVITIES IN WYOMING
Least Weasel is classified as a Species of Greatest Conservation Need by the Wyoming Game and Fish Department. Currently, there are no research projects designed specifically for Least Weasel in Wyoming.

ECOLOGICAL INFORMATION NEEDS
Least Weasel would benefit from research to determine its detailed distribution and abundance in Wyoming, as well as factors limiting populations in the state. Information on diet is needed to determine how Least Weasel populations respond to variations in prey availability and density of competitors. Nothing is known about basic population demographic parameters (i.e., adult survival, recruitment, dispersal) for Least Weasel in Wyoming. Targeted research and monitoring for Least Weasel is hampered by the lack of a proven survey technique to detect the species. Finally, Least Weasel would also benefit from an assessment of potential extrinsic stressors in the state, such as potential exposure to secondary poisoning from rodenticides,

unintentional capture by fur-traders, and mortalities due to other anthropogenic activities and domestic cats.

Management in Wyoming

This section authored solely by WGFD; Nichole L. Bjornlie. Least Weasel is assigned an NSSU rank because survey data that would provide for an assessment of population status are lacking. Consequently, priorities in Wyoming in the short-term will focus on addressing these data deficiencies. Of particular importance are data on population status and trends and a more refined understanding of distribution within the state. Because of the low density of Least Weasel on the landscape, acquiring these data will likely require targeted survey efforts. However, survey techniques for Least Weasel still need to be developed before other objectives for the species can be addressed. Additional priorities will focus on assessing habitat requirements and limiting factors, which will ultimately be used to develop management and conservation recommendations.

Contributors

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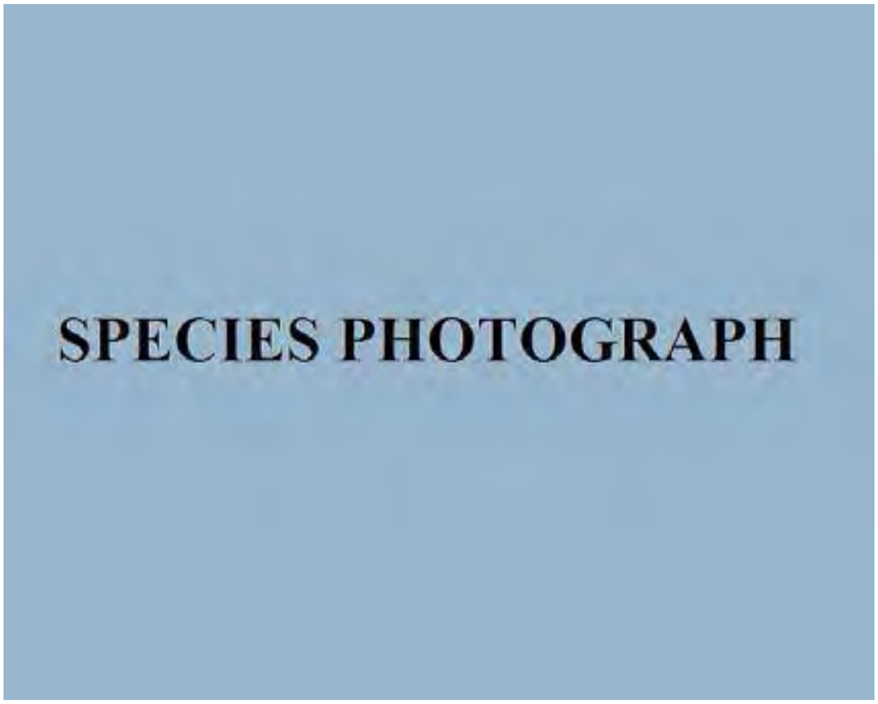

Figure 1: Photo not available.

Figure 2: North American range of *Mustela nivalis*. This map does not accurately reflect the species' range in Wyoming. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

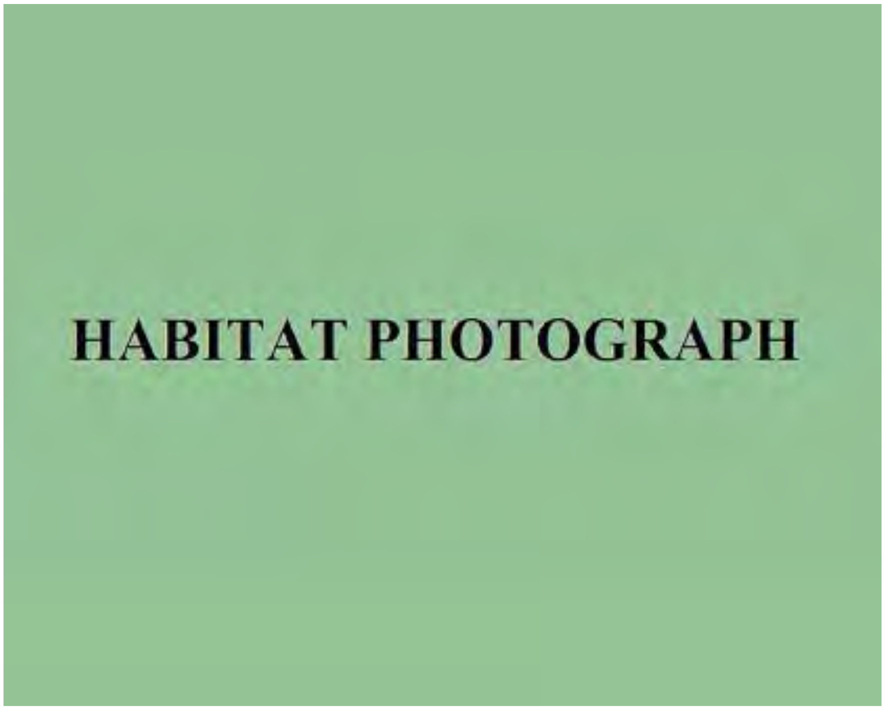

Figure 3: Photo not available.

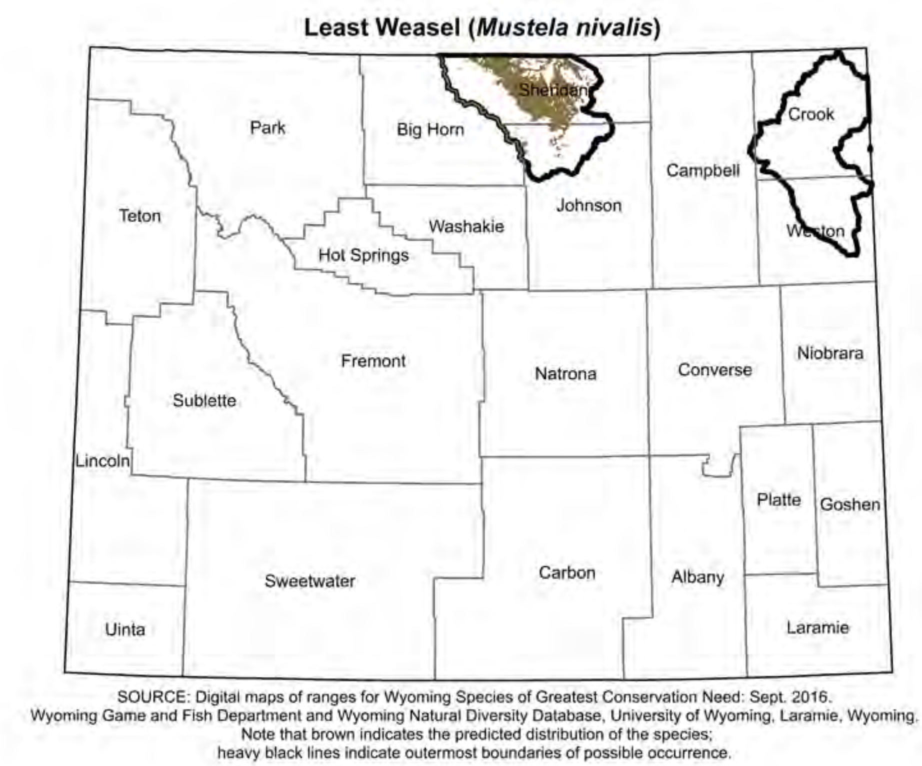

Figure 4: Range and predicted distribution of *Mustela nivalis* in Wyoming.

Little Brown Myotis

Myotis lucifugus

REGULATORY STATUS

USFWS: Petitioned for Listing
USFS R2: No special status
UWFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G3, S5
    Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS

In 2011, a status review was submitted to the U.S. Fish and Wildlife Service (USFWS) suggesting that Little Brown Myotis (*Myotis lucifugus*) be listed as Endangered on an emergency basis because of massive population declines in the northeastern U.S. from White-nose Syndrome (WNS) [1]. As of 2016, the USFWS had not yet completed this assessment or issued any decision on whether Threatened or Endangered status was warranted.

NATURAL HISTORY

Taxonomy:

There are five recognized subspecies of Little Brown Myotis: *M. l. alascensis*, *M. l. carissima*, *M. l. lucifugus*, *M. l. pernox*, and *M. l. relictus* [2, 3]. In Wyoming, *M. l. carissima* is the only known subspecies[3]. These sub-specific designations have been questioned as recently as 2008 because of the overlapping ranges of subspecies and evidence of subspecies-level hybridization from mitochondrial and nuclear DNA analyses [4].

Description:

Little Brown Myotis is, with few exceptions, identifiable in the field [5]. The species is a small vespertilionid bat, but medium in size among *Myotis* species [5]. Pelage is variable in color. Generally, the dorsal side is glossy and sooty brown to pale golden brown, while the ventral side is a lighter yellow or olive brown [3, 5, 6]. In early summer, juveniles can be distinguished from adults by noticeably darker pelage and lower mass [3]. These differences become less apparent by late summer [3], although the growth plate in the phalanges of juveniles are visible throughout the first summer [7, 8]. Little Brown Myotis has a moderately sloped forehead and pointed ears of moderate length (14–16 mm) with a short, blunt tragus [3]. Little Brown Myotis is similar in appearance to other co-occurring *Myotis* species. In Wyoming, these include Long-legged Myotis (*M. volans*), Northern Long-eared Myotis (*M. septentrionalis*), and Yuma Myotis (*M. yumanensis*). Little Brown Myotis can be distinguished from Long-legged Myotis by lack of a keeled calcar and can be distinguished from Northern Long-eared Myotis by its short, blunt tragus. Although it can be difficult to distinguish from Yuma Myotis in the field, Little Brown Myotis has hair that extends past the toes of the hind feet, a more gradually sloped forehead, and echolocates at a distinctly lower frequency [3, 5, 6].

Distribution & Range:
Little Brown Myotis is widely distributed across the United States and Canada. Wyoming falls within the center of its distribution and comprises a relatively small proportion of the species global range. There are no known range contractions, but WNS has greatly reduced numbers of Little Brown Myotis in the northeastern United States [9].

Habitat:
Little Brown Myotis is generally associated with woodland habitats, but is considered a generalist species since it has been documented in many habitat types. In Wyoming, this species has been documented in coniferous forests, riparian areas, woodlots, shelterbelts, and urban areas [7]. Little Brown Myotis requires 3 roost types: day roosts, night roosts, and hibernacula [3]. Roost use varies by season. In spring and summer, reproductive females form maternity colonies at roost sites with warm microclimates [3]. Day roosts are varied and include buildings, trees, rock piles, wood piles, and caves. Non-reproductive bats roost singly or in small groups at sites with cooler microclimates [3]. Various structures are used as night roosts. In Wyoming, caves, abandoned mines, buildings, rock shelters, and railroad tunnels have been identified as night roost sites [7]. At night, large numbers of Little Brown Myotis pack tightly into a confined space following an initial feeding bout that begins at dusk [3]. In late summer and fall, individuals migrate up to several hundred km to winter hibernacula, using a variety of roost sites along the way [3]. Hibernacula are used in winter and are usually caves or abandoned mines with high humidity and temperatures above 0° C [1, 3]. Little Brown Myotis is common throughout Wyoming where suitable habitat is present [7]. Yellowstone National Park and Devils Tower National Monument are known to support relatively large numbers of Little Brown Myotis [10, 11].

Phenology:
Mating generally occurs in the fall at swarming sites in the vicinity of hibernacula shortly before hibernation but hibernating bats have also been observed copulating [3, 6]. Fertilization occurs in the spring when females emerge from hibernation [3]. A single altricial pup is born in early summer after a 50 to 60 day gestation period [3]. In the Rocky Mountain region, most pups are born in May and June [6]. Young are volant at around 22 days after birth [1]. Duration and timing of hibernation varies with latitude [3]. Across the species range, hibernation begins in mid-August at northern latitudes and early November at more southern latitudes [12]. Emergence from hibernation ranges from mid-March at southern latitudes to mid-May at northern latitudes [3, 12].

Diet:
Little Brown Myotis feeds on small aerial insects that emerge from aquatic habitats [6]. The species consumes a diverse array of insects of the orders Diptera, Lepidoptera, Coleoptera, Trichoptera, Ephemeroptera, and Neuroptera, among others [1, 6, 13]. Diet composition generally relates to the relative abundance of insect orders available at foraging areas, suggesting that the species is a dietary generalist [1, 13].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: COMMON
There are no estimates of abundance of Little Brown Myotis range-wide or in Wyoming. However, Little Brown Myotis is frequently reported as one of the most common bat species across its range[1]. In Wyoming, Little Brown Myotis was the most frequently documented bat species in several studies across the state [10, 11, 14-18].

Population Trends:
Historic: UNKNOWN
Recent: STABLE
Historic population trends of Little Brown Myotis in Wyoming are unknown. Little Brown Myotis numbers were thought be stable or slightly increasing range-wide up to 2006 [1, 9]. Since then, the species has undergone large declines in the eastern United States where it is affected by WNS [9, 19]. Between 2006 and 2012, it is estimated that between 5.7 and 6.7 million bats died from WNS infection, many of which were Little Brown Myotis [19]. Regional extirpations are projected by 2026 in the northeastern United States [9]. While no estimates of population trends are available for the species in Wyoming, WNS is currently not present in the state and it is likely that population trends are stable [9].

Intrinsic Vulnerability:
HIGH VULNERABILITY
Little Brown Myotis has low fecundity, giving birth to one pup per year [3]. Because the species congregates in large numbers at hibernacula and other roost sites, regional populations are susceptible to single catastrophic events at these sites [3, 7, 9]. Congregating at hibernacula also makes this species highly susceptible to large declines from WNS, a disease to which Little Brown Myotis is extremely susceptible.

Extrinsic Stressors:
MODERATELY STRESSED
Little Brown Myotis faces numerous extrinsic stressors in Wyoming. Wind-energy development has and will continue to increase in Wyoming, and post-construction mortality surveys indicate that Little Brown Myotis is killed by wind turbines in Wyoming and other states [20, 21]. Little Brown Myotis may also be negatively affected by climate change [22, 23]. In northern Colorado, long-term monitoring of bat species, including Little Brown Myotis, indicated that the number of reproductive (i.e., pregnant, lactating, or post-lactating) females declined significantly, ≤ 64%, under drought conditions that mimicked drought conditions predicted by climate change models [24]. Given the geographic proximity and habitat similarities between this study location and Wyoming, it likely that similar patterns could occur in Wyoming. Disturbance from visitors to caves and abandoned mines used as hibernacula represents a significant threat to cave-roosting bats and bat habitat [7]. Even a small number of short duration disturbances lead to significant increases in arousal events and subsequent energy expenditures that may lead to increased mortality of Little Brown Myotis [25, 26]. Timber harvest might also affect the species by reducing the density of suitable spring, summer, and fall roost sites [7], although it is unknown to what degree this may affect Little Brown Myotis in Wyoming. Similar to other insectivorous organisms, Little Brown Myotis is affected by pesticide use. Effects come from both reduced food availability and acute and chronic toxicity from the pesticides themselves [3, 7]. Perhaps the

greatest threat to the Little Brown Myotis is WNS, unintentionally introduced to the United States in 2006. Little Brown Myotis is highly susceptible to WNS and has undergone large population declines in the northeastern United States from the disease [9]. The pathogenic fungus *Pseudogymnoascus destructans* (formerly *Geomyces destructans*) that causes WNS has not been detected in Wyoming as of 2015 [27]. It is unknown what effect WNS would have on Little Brown Myotis in Wyoming, but, given their sensitivity to the disease, population declines are likely should WNS be introduced into Wyoming. Research from other geographic areas suggests that bats may experience non-lethal effects from exposure to environmental contaminants, including but not limited to reduced reproduction and increased susceptibility to WNS [28]

KEY ACTIVITIES IN WYOMING

In recent years, bats have received increasing research attention across North America and in Wyoming. Across the state, pre-construction bat inventories are being conducted at wind energy development sites. To address concerns regarding potential WNS infection of bats in Wyoming, the Wyoming Game and Fish Department (WGFD) in cooperation with the Wyoming Bat Working Group authored “A strategic plan for white-nose syndrome in Wyoming” in 2011. This document presents a plan of action to minimize impacts of WNS if it is detected in states adjacent to or in Wyoming [29]. To facilitate early detection of the disease, WGFD requires researchers to evaluate all bats captured during research activities for signs of WNS infection using the Reichard Wing-Damage Index [30]. Beginning in 2012, WGFD personnel placed temperature and humidity loggers in a number of known or suspected hibernacula across Wyoming to determine if climatic conditions at these sites are favorable for growth of *P. destructans*. Personnel have also begun collecting swabs of hibernating bats and hibernacula substrates in an effort to assist with early detection of *P. destructans*. While placing loggers, surveyors also searched for hibernating bats and detected Little Brown Myotis at two sites [31, 32]. WGFD conducts periodic surveys at known hibernacula throughout the state, including 10 Little Brown Myotis hibernacula. Several studies have been completed or are underway that have increased our understanding of bat species, including Little Brown Myotis, in the state. Both WGFD and the Wyoming Natural Diversity Database (WYNDD) have conducted numerous bat inventories across the state including a statewide forest bat inventory from 2008 to 2011 [14-17, 33, 34], a statewide inventory of cliffs, caves, and rock outcroppings from 2012 to 2015 [35, 36], an inventory of bats at Devils Tower National Monument from 2010 to 2011, a bat monitoring effort in southern Wyoming from 2011 to 2013 [37-39], and bat surveys in northeastern Wyoming in 2014 and 2015 [18]. Little Brown Myotis was the most frequently captured and recorded bat species during the majority of these investigations [10, 14, 15, 18, 34-36]. While Little Brown Myotis was frequently detected during all years across southern Wyoming, it was not the most commonly documented species from either acoustic monitoring or mist-net surveys, suggesting the species may be less abundant than other bat species in arid areas across the state [37-39]. In 2011, 2013, 2014, and 2015 WYNDD conducted multi-taxa inventories, which included bat surveys, within the Ferris Mountain Wilderness Study Area (WSA), Gardner Mountain WSA, Fortification Creek WSA, and North Fork WSA. Several bat species were detected within these four WSAs including Little Brown Myotis [40-42]. Also in 2014, WYNDD, the Bureau of Land Management, the USFWS, and the BioDiversity Research Institute conducted pilot work to investigate the potential for environmental contaminant accumulation in bats that feed and obtain water from produced water evaporation pits associated with oil and natural gas extraction in northeast Wyoming. Results are pending, and it is unknown if this work will continue in the future. In 2015, WYNDD developed a bat monitoring plan and initiated survey activities at Bighorn Canyon National Recreation Area (BICA). The primary objective of this monitoring plan is to develop a baseline activity level or other index of abundance for Little Brown Myotis that can be used to detect changes in populations within BICA through time. In addition to research activities, many conservation organizations and federal and state agencies, including WGFD, have developed outreach and education materials to inform the general public of the importance bats and concerns regarding the persistence of bats in the future.

ECOLOGICAL INFORMATION NEEDS

Understanding habitat use and management practices that benefit the species are needed in the face of large population declines in parts of the species' range. Relatively few Little Brown Myotis hibernacula are known in Wyoming. These sites represent a critical habitat component for the species and a vitally important piece of information to better monitor and understand potential impacts and spread of WNS should it reach Wyoming. Robust estimates of abundance and population trends of the species in Wyoming do not exist, but would be valuable in the face of pending stressors such as WNS and wind energy development. While WNS has not been documented in Wyoming to date, continued monitoring for WNS across the state is necessary so that potential mitigation measures can be enacted in a timely manner. Current geographic and morphometric based sub-specific designations have been questioned. Application of molecular techniques would clarify taxonomic uncertainties of Little Brown Myotis [4].

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Very little is known about the wintering locations of Little Brown Myotis in Wyoming. Although WNS has not been detected in the state, the slow westward progression of the fungus necessitates the need for these data before it reaches Wyoming. Consequently, priorities will focus on locating and monitoring hibernacula as well as other roost locations (e.g., maternity roosts) to monitor populations and recommend and assist with bat-friendly closures of important caves and mines. In 2016, WGFD will begin a project in collaboration with the state of Nebraska to evaluate occurrence, abundance, and reproductive status of bats in eastern Wyoming, which represents an important zone of overlap between eastern and western bat species. Mist-net surveys will continue to implement WNS protocols and assessment in an effort to assist with early detection should the disease reach the state. Habitat assessments will be incorporated with survey efforts to better understand what influences species presence and distribution at a finer scale. In addition to inventory projects, WGFD, in collaboration with the Wyoming Bat Working Group and other state-wide partners, will implement the North American Bat Monitoring Program that will use acoustic monitoring to assist with state and region-wide assessment of bat trends. Additional priorities will include updating and revising the Conservation Plan for Bats in Wyoming and the Strategic Plan for WNS in Wyoming. Finally, outreach and collaboration with private landowners will remain a priority to ensure conservation of bats and bat habitat.

CONTRIBUTORS

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Nichole L. Bjornlie, WGFD
Douglas A. Keinath, WYNDD

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Figure 1: Adult Little Brown Myotis. (Photo courtesy of Douglas A. Keinath)

Figure 2: North American range of *Myotis lucifugus*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Forest clearing used by Little Brown Myotis in the Bear Lodge Mountains, Wyoming. The poles are supporting a mist net used to capture bats foraging over the water. (Photo courtesy of WGFD)

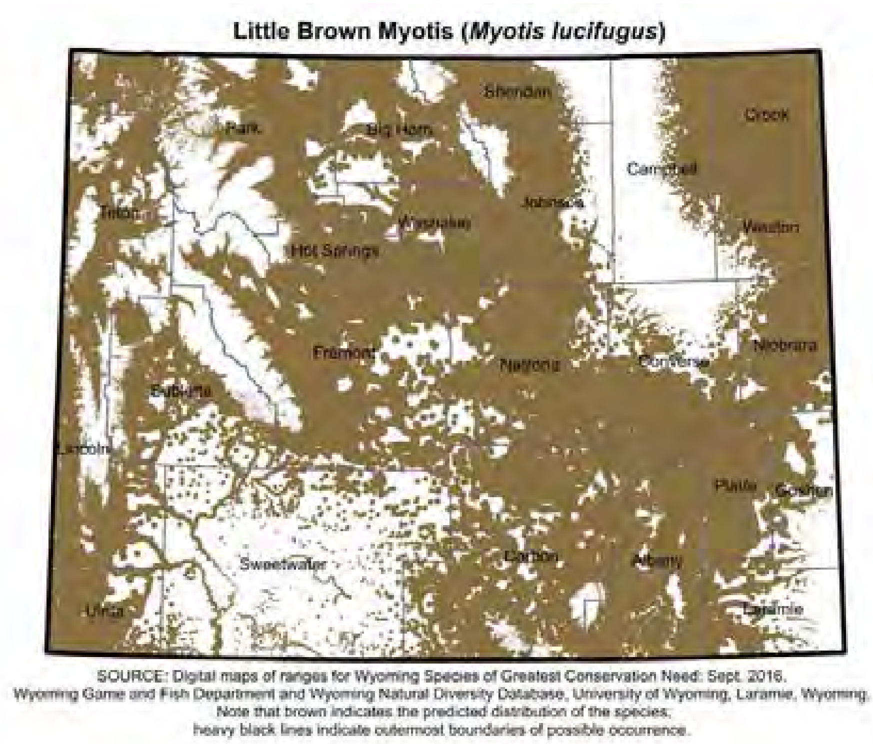

Figure 4: Range and predicted distribution of *Myotis lucifugus* in Wyoming.

Long-eared Myotis
Myotis evotis

REGULATORY STATUS
USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: Sensitive
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS4 (Cb), Tier III
WYNDD: G5, S4S5
Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS
The Wyoming Natural Diversity Database (WYNDD) has assigned Long-eared Myotis (*Myotis evotis*) a range of state conservation ranks because of uncertainty about the species' abundance in Wyoming.

NATURAL HISTORY
Taxonomy:
There is uncertainty regarding subspecific designations of Long-eared Myotis, with some researchers indicating two subspecies and others up to six [1, 2]. All subspecific classifications are based solely on morphology. Manning [2] suggested up to six subspecies, four of which are currently recognized as valid subspecies of Long-eared Myotis: *M. e. evotis, M. e. pacificus, M. e. chrysonotus,* and *M. e. jonesorum*. According to this publication, *M. e. chrysonotus* is the only subspecies that occurs in Wyoming [2]. Two additional subspecies (*M. e. micronyx* and *M. e. milleri*) were also suggested by Manning [2], but are not widely recognized [3].

Description:
Identification of Long-eared Myotis is possible in the field. Long-eared Myotis is a medium sized bat, but large among *Myotis* species. Pelage is long and pale brown to straw-colored and is generally darker dorsally than ventrally. The ears are long (21 mm) and very dark in color with a long, pointed tragus [3]. Wing and tail membranes are very dark and nearly opaque [3, 4]. Juveniles are similar in appearance to adults, but pelage may appear uniformly gray [3]. The species is similar in appearance to other *Myotis* species in the "Long-eared" group. Members of this group that occur in Wyoming include Northern Long-eared Myotis (*M. septentrionalis*) and Fringed Myotis (*M. thysanodes*) [3]. Long-eared Myotis can be differentiated from Northern Long-eared Myotis by its dark, nearly opaque ears and patagia and from the Fringed Myotis by the lack of distinct hairs protruding from the posterior edge of the uropatagium [4].

Distribution & Range:
Long-eared Myotis is widely distributed across the western United States and southwestern Canada. Wyoming is on the eastern edge of the species' range. Locally, seasonal changes in distribution may be observed as individuals move between summer range and winter hibernacula. In Wyoming, the species occurs throughout most of the state with the exception of the northern portions of the Great Divide Basin in southcentral Wyoming, the Powder River Basin in northeastern Wyoming, and portions of extreme southeastern Wyoming.

Habitat:
Across its range, Long-eared Myotis occupies a wide range of habitat types. Generally, the species is associated with forested areas but is also found in various grassland and shrubland habitats. In Wyoming, the species has been documented in various forest types including Ponderosa Pine (*Pinus ponderosa*) and spruce-fir (*Picea* spp.-*Abies* spp.) forests. In drier areas of the state, the species has been documented in areas dominated by sagebrush (*Artemisia* spp.) and juniper (*Juniperus* spp.) [3]. In summer, the species will utilize a variety of roost types depending largely upon surrounding habitat and roost availability. The species has been observed roosting in rock crevices, tree stumps, and in cavities and under the bark of live and dead trees [3, 5, 6]. In winter, Long-eared Myotis hibernates. Specifics of hibernacula, especially in Wyoming, are largely unknown, but the species has been observed swarming at a cave entrance and hibernating in an abandoned mine in other portions of its range [1, 3, 7]. It is assumed that Long-eared Myotis undergoes short migrations between summer habitats and winter hibernacula. Nothing is known about habitat use during these movements [1, 3].

Phenology:
Phenology of Long-eared Myotis is poorly understood across its range and in Wyoming in particular. Breeding phenology is inferred from similar species and anecdotal observations of Long-eared Myotis across its range. Breeding occurs in late summer (August or September). Like most bat species in North America, females store spermatozoa through the winter, and fertilization and implantation of the egg occurs in early spring. Gestation ranges from 50 to 60 days, and females bear a single, non-volant offspring in early summer [1]. Long-eared Myotis hibernates during winter. Timing of hibernation is poorly known, but Long-eared Myotis likely enters hibernation in late-fall or early-winter and emerges from hibernation in late-spring or early-summer.

Diet:
Long-eared Myotis primarily consumes small moths in the order Lepidoptera, but will also feed upon Coleoptera and Diptera [1, 3, 5].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: COMMON
There are no estimates of abundance of Long-eared Myotis in Wyoming. Range-wide, evidence suggests that the species is well represented within bat communities and may be relatively common in suitable habitat. Specifically, Long-eared Myotis comprised a large proportion of acoustic detections and mist-net captures in a number of bat inventory and monitoring studies conducted in Wyoming, indicating that the species is likely common in a variety of suitable habitats [8-16].

<u>Population Trends</u>:
Historic: UNKNOWN
Recent: UNKNOWN
Both historic and recent population trends are unknown for Long-eared Myotis in Wyoming.

<u>Intrinsic Vulnerability</u>:
MODERATE VULNERABILITY
Long-eared Myotis is moderately vulnerable to extrinsic stressors. The species has low fecundity, giving birth to a single pup each year [1]. While evidence is limited, it appears that Long-eared Myotis may have high fidelity to hibernation sites. For example, at one hibernation site in Colorado, the same individuals were documented for up to 16 years [7].

<u>Extrinsic Stressors</u>:
MODERATELY STRESSED
Long-eared Myotis may face potential population declines resulting from global climate change, as the number of pregnant or lactating Long-eared Myotis was significantly lower in years that had below average precipitation [17]. Following climate models, these precipitation patterns are predicted to become more frequent throughout the western United States, including Wyoming, and may result in population declines from decreased reproductive rates [17]. The species may also be negatively affected by wildfire. At Mesa Verde National Park in Colorado, Long-eared Myotis preferred roost locations in areas that had not experienced wildfire [6]. While true piñon-juniper woodlands are very limited in Wyoming, the species is frequently detected in areas with Rocky Mountain Juniper (*J. scopulorum*) which are subject to similar fire regimes [18, 19]. Disturbance from visitors to caves and abandoned mines used as hibernacula represents a substantial threat to cave-roosting bats and bat habitat where human visitors occur [20]. Even a small number of short duration disturbances lead to significant increases in arousal events and subsequent energy expenditures that may lead to increased mortality of hibernating bats [21, 22]. White-nose Syndrome (WNS) is a fungal disease that affects hibernating bats. WNS has killed several million bats in eastern North America [23, 24]. The pathogenic fungus *Pseudogymnoascus destructans* (formerly *Geomyces destructans*) that causes WNS has not been detected within the range of Long-eared Myotis or in Wyoming to date [25], but it is thought that the disease will continue to expand westward. It is unknown if Long-eared Myotis will be affected by WNS, but other bat species in the genus *Myotis* have experienced large population declines from the disease [23].

KEY ACTIVITIES IN WYOMING

Bats have received increasing research attention across North America and in Wyoming. To address concerns regarding potential WNS infection of bats in Wyoming, the Wyoming Game and Fish Department (WGFD) in cooperation with the Wyoming Bat Working Group authored "A strategic plan for white-nose syndrome in Wyoming" in 2011. This document presents a plan of action to minimize impacts of WNS if it is detected in states adjacent to or in Wyoming [26]. To facilitate early detection of the disease, WGFD requires researchers to evaluate all bats captured during research activities for signs of WNS infection using the Reichard Wing-Damage Index [27]. Beginning in 2012, WGFD personnel placed temperature and humidity loggers in a number of known or suspected hibernacula across Wyoming to determine if climatic conditions at those sites are favorable for growth of *P. destructans*. Personnel have also begun collecting swabs from hibernating bats and hibernacula substrates in an effort to assist with early detection of *P. destructans*. While placing loggers, surveyors also searched for hibernating bats, and 33 Long-eared Myotis were documented at one hibernation site during these surveys [28, 29]. WGFD conducts periodic surveys at known hibernacula throughout the state, resulting in 5 known hibernacula for Long-eared Myotis [30, 31]. Several studies have been completed or are underway that have increased our understanding of bat species in the state, including Long-eared Myotis. Both WGFD and the WYNDD have conducted numerous bat inventories across the state including a statewide forest bat inventory from 2008 to 2011 [8-10, 32-34], a statewide inventory of cliffs, caves, and rock outcroppings from 2012 to 2015 [13-16], an inventory of bats at Devils Tower National Monument from 2010 to 2011, a bat monitoring effort in southern Wyoming from 2011 to 2013 [18, 19, 35], and bat surveys in northeastern Wyoming in 2014 and 2015 [12]. Long-eared Myotis was captured and recorded during these investigations and in general represented a large proportion of the bat community [8-16]. In 2015, WYNDD developed a bat monitoring plan and initiated survey activities at Bighorn Canyon National Recreation Area (BICA). The primary objective of this monitoring plan is to develop a baseline activity level or other index of abundance for Little Brown Myotis (*M. lucifugus*) that can be used to detect changes in populations within BICA through time, but Long-eared Myotis was frequently recorded throughout the area [36]. In 2015 and 2016, WYNDD captured Long-eared Myotis at Devils Tower National Monument during mistnetting activities conducted during a study of day roost use of Northern Long-eared Myotis [37, 38]. In addition to research activities, many conservation organizations and federal and state agencies, including WGFD, have developed outreach and education materials to inform the general public of the importance bats and concerns regarding the persistence of bats in the future.

ECOLOGICAL INFORMATION NEEDS

Subspecific taxonomy of Long-eared Myotis is based solely on morphometric differences, and it is currently unclear which subspecies occurs in Wyoming. Application of molecular techniques to clarify taxonomy and distribution of subspecies at a continental scale is needed. Habitat associations and use of Long-eared Myotis in Wyoming are poorly understood. This is particularly true in regards to summer day roost and winter hibernacula use and selection. All aspects of phenology are poorly understood, especially for this species in Wyoming. There are no robust estimates of abundance or population trends for Long-eared Myotis, but these data would be useful in the face of potential stressors such as WNS, human recreation, and land management practices. As of 2016, WNS has not been documented in Wyoming, but continued monitoring of this disease is an essential component of minimizing potential effects of the disease on bats in Wyoming.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Little is known about the wintering locations of Long-eared Myotis in Wyoming. Although WNS has not been detected in the state, the westward progression of the fungus necessitates the need for these data before it reaches Wyoming. Consequently, priorities will focus on locating and systematically surveying hibernacula to monitor populations and recommend and assist with bat-friendly closures of important caves and mines where needed. In 2016, WGFD began a project in collaboration with the state of Nebraska to evaluate occurrence, abundance, and reproductive status of bats in eastern Wyoming, which represents an important zone of overlap between eastern and western bat species, including Long-eared Myotis. Mist-net and hibernacula surveys will continue to implement WNS protocols and assessment in an effort to assist with early detection should the fungus reach the state. Habitat assessments will be incorporated with survey efforts to better understand what influences species presence and distribution at a finer scale and to develop management and conservation recommendations. In addition to inventory projects, WGFD, in collaboration with the Wyoming Bat Working Group and other state-wide partners, will implement the North American Bat Monitoring Program that will use acoustic monitoring to assist with state and region-wide assessment of bat trends, which are currently lacking. Additional priorities will include updating and revising the Conservation Plan for Bats in Wyoming and the Strategic Plan for WNS in Wyoming. Finally, outreach and collaboration with private landowners will remain a priority to ensure conservation of bats and bat habitat.

CONTRIBUTORS

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Figure 1: A Long-eared Myotis in Grand Teton National Park, Teton County, Wyoming. (Photo courtesy of Kaylan A. Hubbard)

Figure 2: North American range of *Myotis evotis*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

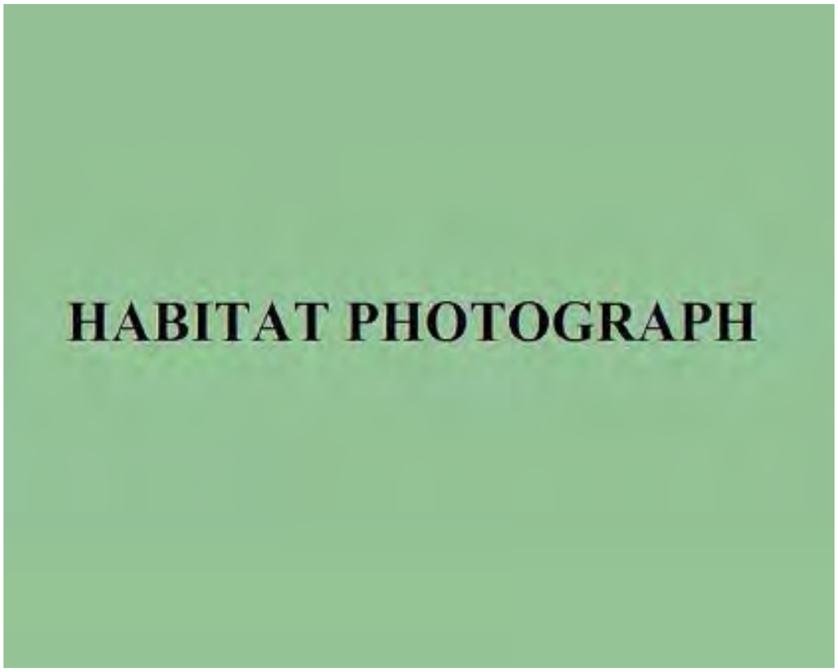

Figure 3: Photo not available.

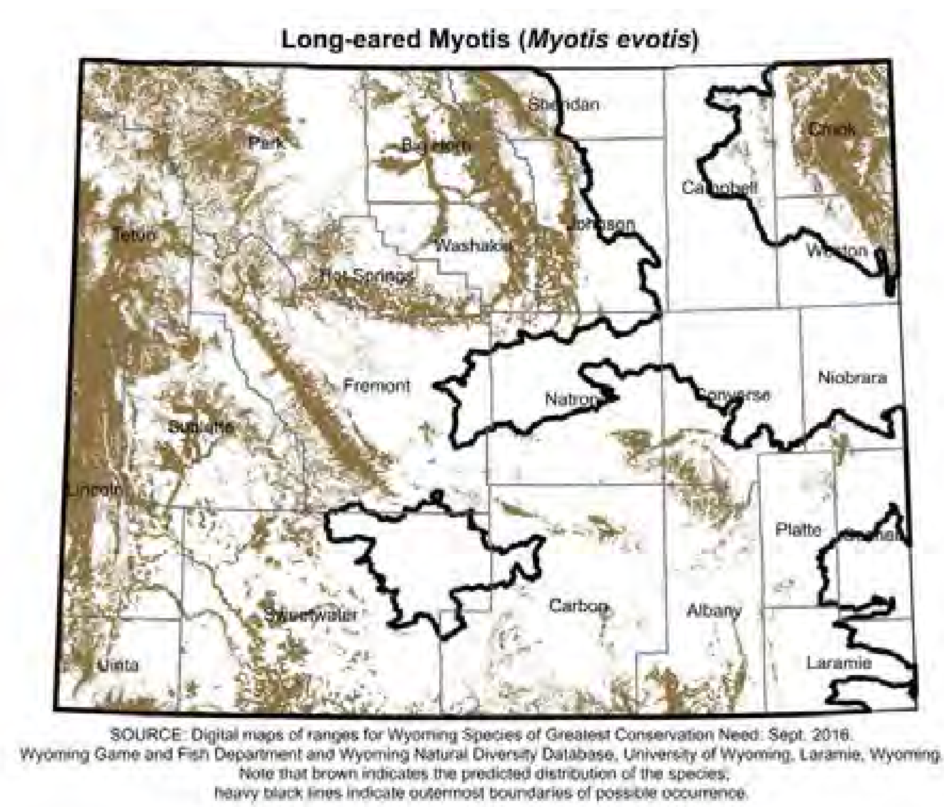

Figure 4: Range and predicted distribution of *Myotis evotis* in Wyoming.

Long-legged Myotis
Myotis volans

Regulatory Status
USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

Conservation Ranks
USFWS: No special status
WGFD: NSS4 (Cb), Tier III
WYNDD: G4G5, S5
Wyoming Contribution: LOW
IUCN: Least Concern

Status and Rank Comments
Long-legged Myotis (*Myotis volans*) has a global rank of G4G5 because of uncertainties regarding distribution and threats to the species during winter [1].

Natural History
Taxonomy:
There are four currently recognized subspecies of Long-legged Myotis: *M. v. volans*, *M. v. amotus*, *M. v. interior*, and *M. v. longicrus* [2]. Only *M. v. interior* occurs in Wyoming [3].

Description:
Long-legged Myotis is identifiable in the field. The species is a small vespertilionid bat, medium in size among bats in the genus *Myotis*. Pelage is variable in color with some populations exhibiting local color adaptations [3]. Generally, dorsal pelage ranges from ochraceous buff to dark reddish or blackish brown. Ventral pelage is lighter, ranging from pale buffy to smoky cinnamon brown [3]. The wing and tail membranes and ears are darkly pigmented, nearly black. The ears are rounded and relatively short (12–13 mm), barely reaching the nostrils when folded forward [3, 4]. The tragus is pointed and fairly long (6–8 mm) in relation to the ear [3]. Males and females are identical in appearance, but females have significantly longer forearms than males [3]. Volant juvenile individuals are identical in appearance to adults, but the growth plates in the phalanges of juveniles are visible throughout the first summer [5]. Long-legged Myotis is similar in appearance to other sympatric *Myotis* species. Within the Wyoming range of the species, these include the Little Brown Myotis (*M. lucifugus*), Fringed Myotis (*M. thysanodes*), Long-eared Myotis (*M. evotis*), Western Small-footed Myotis (*M. ciliolabrum*), and Northern Long-eared Myotis (*M. septentrionalis*). Long-legged Myotis can be distinguished from these species by the presence of a distinctly keeled calcar and well-furred underwing between the elbow and the knee [3].

Distribution & Range:
Long-legged Myotis is widely distributed across western North America from extreme northwestern Canada to north-central Mexico. Wyoming falls near the eastern edge of the species distribution. Long-legged Myotis is distributed throughout Wyoming in forested habitats and has been observed in 26 of the state's 28 latitude/longitude degree blocks [6]. In late summer and early fall, the species migrates to hibernacula. However, only one individual has been documented hibernating in Wyoming [7]. Recently, the species has been documented in northern Canada in both the Yukon and Northwest Territories [8-10]. These observations mark extensions to the currently accepted range of the species and likely resulted from a previous lack of extensive bat inventories in these areas rather than range expansions.

Habitat:
Across its range, Long-legged Myotis is primarily associated with forested habitats, especially coniferous forests. The species may also be found in other forest types such as riparian forests, juniper scrub, and mixed deciduous forests [4]. In Wyoming, the species is common in montane forests and may be found at high elevations up to, or even above, tree-line [4]. However, recent bat inventories across Wyoming have found Long-legged Myotis inhabiting sagebrush-steppe and grassland habitats with few or no trees, indicating that the species may utilize a broader range of habitat in Wyoming than previously thought [11-13]. In spring, summer, and fall, Long-legged Myotis roosts in a variety of structures during the day. These include dead and live trees, rock crevices, and human structures; but the species most frequently roosts in dead trees [3, 14, 15]. Specifically, both males and females of the species prefer to roost under the bark of moderately decayed snags that are taller than surrounding trees and that have a large diameter [16]. Males tend to roost singly and utilize a broader array of roost structures [17]. Females roost clonally in groups ranging from several individuals to several hundred individuals and almost exclusively roost in dead trees [16]. More specifically, at the stand level, female Long-legged Myotis preferred unfragmented forests with abundant snags and a relatively open overstory [14, 16, 18]. At the individual snag level, female Long-legged Myotis preferred to roost in tall, large, moderately decayed snags with a large amount of exfoliating bark [14, 18]. It is important to note that roost selection has not been evaluated in Wyoming, but, in general, roost selection patterns are similar in studies that occurred in a range of locations and forest types, suggesting that these findings are applicable to the Wyoming landscape. The species hibernates in winter, primarily in natural caves but also in abandoned mines. Little is known about what constitutes a suitable hibernation site or how the species selects microhabitat features within hibernacula.

Phenology:
The phenology of Long-legged Myotis in Wyoming is poorly understood. Across the species' range, phenology is highly variable, likely due to climatic variation [3]. Breeding occurs in fall, but the egg is not fertilized until spring when females emerge from hibernation. Females give birth to a single altricial pup between early May and early August following a 50- to 60-day gestation [19]. Pups are volant by late May to late August. The species hibernates during winter, but timing and duration of hibernation are not known [3, 16].

Diet:
Long-legged Myotis is strictly insectivorous. The species consumes a variety of insects across its range, but insects in the order Lepidoptera comprise the majority of its diet [3, 20, 21].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: COMMON
There are no robust estimates of abundance for Long-legged Myotis in Wyoming. The species is frequently documented during bat inventories across the state, often comprising a large proportion of the total number of bats detected [22-28]. This suggests that Long-legged Myotis is common in a variety of habitat types across Wyoming.

Population Trends:
Historic: UNKOWN
Recent: UNKNOWN
Both historic and recent population trends of Long-legged Myotis in Wyoming are unknown.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Long-legged Myotis has low fecundity, giving birth to one pup per year [3]. Long-legged Myotis hibernates in caves and abandoned mines during the winter, which are rare landscape features.

Extrinsic Stressors:
MODERATELY STRESSED
Long-legged Myotis hibernates in caves and abandoned mines during the winter, often in association with other bat species, including Little Brown Myotis and Northern Long-eared Myotis, which are known to be susceptible to the pathogenic fungus *Pseudogymnoascus destructans* (formerly *Geomyces destructans*) that causes White-nose Syndrome (WNS). The disease affects hibernating bats and has led to the death of millions of bats in eastern North America [29, 30]. Currently, the continental distribution of WNS does not overlap with the distribution of Long-legged Myotis [31], and it is unknown if Long-legged Myotis is susceptible to the disease. However, it is assumed that the distribution of WNS will continue to expand westward, and Long-legged Myotis could potentially experience declines in Wyoming and other portions of its range should WNS occur here. Disturbance from visitors to caves and abandoned mines used as hibernacula represents a significant threat to cave-roosting bats and bat habitat [19]. Even a small number of short duration disturbances lead to significant increases in arousal events and subsequent energy expenditures that may lead to increased mortality of Long-legged Myotis [32]. Throughout its range, Long-legged Myotis is generally associated with forest habitats. Any activities that alter forest structure may negatively impact the species. Specifically, because Long-legged Myotis roosts primarily in large dead trees in the summer, any timber management practices that reduces the number of these structures on the landscape may negatively affect local populations [15, 18, 21].

KEY ACTIVITIES IN WYOMING

Bats have received increasing research attention across North America and in Wyoming. To address concerns regarding potential WNS infection of bats in Wyoming, the Wyoming Game and Fish Department (WGFD) in cooperation with the Wyoming Bat Working Group authored "A strategic plan for white-nose syndrome in Wyoming" in 2011. This document presents a plan of action to minimize impacts of WNS if it is detected in Wyoming or adjacent states [33]. To facilitate early detection of the disease, WGFD requires researchers to evaluate all bats captured during research activities for signs of WNS infection using the Reichard Wing-Damage Index [34].

Beginning in 2012, WGFD personnel placed temperature and humidity loggers in a number of known or suspected hibernacula across Wyoming to determine if climatic conditions at these sites are favorable for growth of *P. destructans* [35, 36]. Personnel have also started collecting swabs of hibernating bats and hibernacula substrates in an effort to assist with early detection of *P. destructans*. Both WGFD and the Wyoming Natural Diversity Database (WYNDD) have conducted numerous bat inventories across the state including a statewide forest bat inventory from 2008 to 2011 [24-28, 37], a statewide inventory of cliffs, caves, and rock outcrops from 2012 to 2015 [22, 23], an inventory of bats at Devils Tower National Monument in 2010 and 2011, a bat monitoring effort in southern Wyoming from 2011 to 2013 [11, 12, 38], and bat surveys in northeastern Wyoming in 2014 and 2015 [39]. Long-legged Myotis was documented during all of these investigations [22, 23, 27, 28, 37, 40]; however, annual detections were low across southern Wyoming, likely because the majority of sample locations were not in suitable habitat. However, it is important to note that Long-legged Myotis was documented during both acoustic monitoring and mist-net surveys, indicating that the species may occur in other arid areas across the state [11, 12, 38]. In 2011, 2013, and 2015, WYNDD conducted multi-taxa inventories, which included bat surveys, within the Ferris Mountain Wilderness Study Area (WSA), Gardner Mountain WSA, and North Fork WSA. Several bat species were detected within these three WSAs including Long-legged Myotis [41, 42]. In 2015, WYNDD developed a bat monitoring plan and initiated survey activities at Bighorn Canyon National Recreation Area (BICA). The primary objective of this monitoring plan is to develop a baseline activity level or other index of abundance for Little Brown Myotis that can be used to detect changes in populations within BICA through time. During the first year of monitoring, Long-legged Myotis was documented at many sites across BICA. In addition to research, conservation organizations and federal and state agencies have developed outreach and education materials to inform the general public of the importance of bats and concerns regarding the persistence of bats in the future.

ECOLOGICAL INFORMATION NEEDS

While Long-legged Myotis is known to be associated with forested habitats, recent evidence indicates that the species occurs in other habitat types as well. A better understanding of the full breadth of habit use is needed. Phenology of the species in Wyoming is poorly understood and may be quite variable across the state depending on altitude and local climatic conditions. There is one known Long-legged Myotis hibernacula in Wyoming, and only one individual has been documented hibernating at this site, but, given the abundance and wide distribution of the species across the state, it is likely the species over-winters here in greater numbers than have been observed. Hibernacula are critical habitat components for many bat species and require systematic monitoring to better understand potential impacts and spread of WNS should it reach Wyoming. Robust estimates of abundance and population trends of the species in Wyoming do not exist, but would be valuable in the face of potential stressors such as WNS. While WNS has not been documented in Wyoming to date, continued monitoring for WNS across the state is necessary so that potential mitigation measures can be enacted in a timely manner.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Very little is known about the wintering locations of Long-legged Myotis in Wyoming. Although WNS has not been detected in the state, the slow westward progression of the fungus necessitates the need for these data before it reaches Wyoming. Consequently, priorities will focus on locating and systematically surveying hibernacula to monitor populations and recommend and assist with bat-friendly closures of important caves and mines where needed. In 2016, WGFD will begin a project in collaboration with the state of Nebraska to evaluate occurrence, abundance, and reproductive status of bats in eastern Wyoming, which represents an important zone of overlap between eastern and western bat species, including Long-legged Myotis. Mist-net surveys will continue to implement WNS protocols and assessment in an effort to assist with early detection should the fungus reach the state. Habitat assessments will be incorporated with survey efforts to better understand what influences species presence and distribution at a finer scale and to develop management and conservation recommendations. In addition to inventory projects, WGFD, in collaboration with the Wyoming Bat Working Group and other state-wide partners, will implement the North American Bat Monitoring Program that will use acoustic monitoring to assist with state and region-wide assessment of bat trends. Additional priorities will include updating and revising the Conservation Plan for Bats in Wyoming and the Strategic Plan for WNS in Wyoming. Finally, outreach and collaboration with private landowners will remain a priority to ensure conservation of bats and bat habitat.

CONTRIBUTORS

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Figure 1: Adult Long-legged Myotis. (Photo courtesy of Robert J. Luce)

Figure 2: North American range of *Myotis volans*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Mixed montane forest where Long-legged Myotis was documented in the Bighorn Mountains, Wyoming. (Photo courtesy of Ian M. Abernethy)

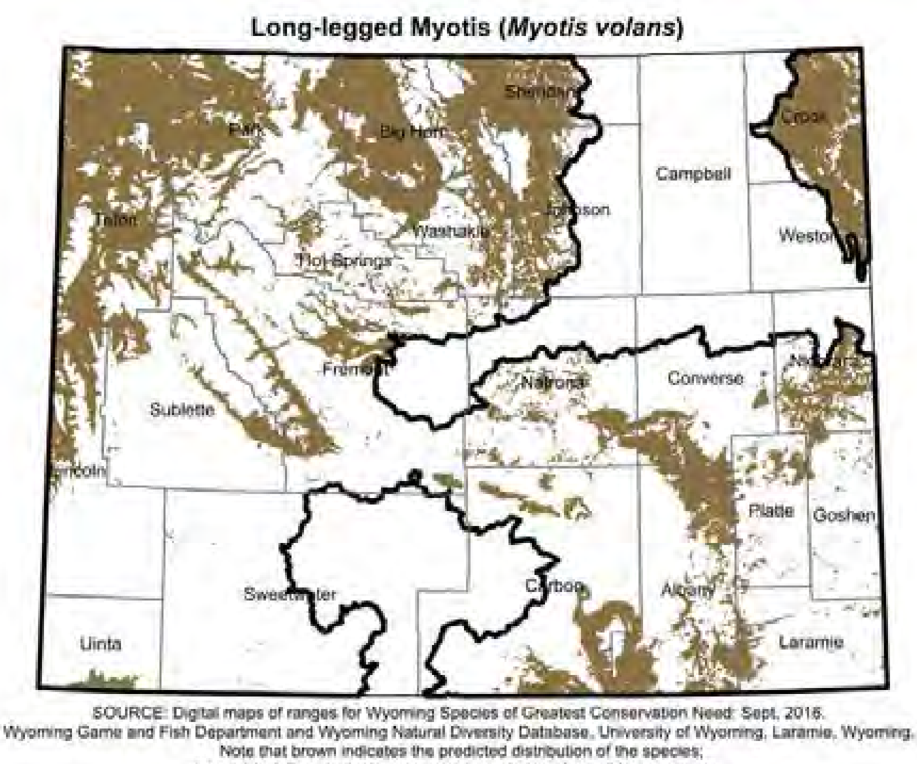

Figure 4: Range and predicted distribution of *Myotis volans* in Wyoming.

Meadow Jumping Mouse

Zapus hudsonius

REGULATORY STATUS

USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS4 (Bc), Tier III
WYNDD: G5, S3
Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS

Two subspecies of Meadow Jumping Mouse (*Zapus hudsonius*) are listed under the Endangered Species Act. Preble's Meadow Jumping Mouse (*Z. h. preblei*) is listed as Threatened throughout its range in Colorado and Wyoming [1], and the New Mexico Jumping Mouse (*Z. h. luteus*) is listed as Endangered throughout its range in Arizona, Colorado, and New Mexico [2]. However, Meadow Jumping Mouse at the species level has no additional regulatory status or conservation rank considerations beyond those listed above. Preble's Meadow Jumping Mouse is discussed in detail separately in a sub-species specific account.

NATURAL HISTORY

Taxonomy:

Twelve subspecies of Meadow Jumping Mouse are currently described, two of which occur in Wyoming – the Preble's Meadow Jumping Mouse and the Bear Lodge Meadow Jumping Mouse (*Z. h. campestris*) [3]. There has been debate among researchers regarding the merit of historic and current subspecific designations within the species [4-6]. However, the most recent review supports current sub-specific designations [7].

Description:

Meadow Jumping Mouse is distinguished by a yellow dorsum with a thick dark stripe down the back, white venter, an exceptionally long tail, and large hind feet. Males and females are identical in appearance. Adults weigh 12–22 g, depending on season, and reach a total length of 180–220 mm [3]. The tail comprises over half the total length, ranging from 115–136 mm in length, and is round, sparsely haired, and bicolored [3]. The ears are dark and edged in white. The hind feet are large (28–31 mm) and whitish-yellow. The sides have a yellow hue. Young are similar in appearance to adults but are lighter in color overall [3]. Meadow Jumping Mouse is difficult to distinguish from Western Jumping Mouse (*Z. princeps*) where they overlap in the southeastern part of the state, and genetic analyses are the only currently accepted method for identification in that area [8].

Distribution & Range:
Meadow Jumping Mouse has a fairly large continental range extending from southern Alaska throughout the southern third of Canada and into the continental United States in the Midwest, Northeast, and Southeast to Mississippi and Alabama; Wyoming represents the westernmost edge of the range in the continental United States [9]. In Wyoming, *Z. h. preblei* is found in the southeastern corner of the state and is primarily restricted to the Laramie Mountain Range, and *Z. h. campestris* is found in the Black Hills. Distributions of the two subspecies do not overlap [3, 10].

Habitat:
Meadow Jumping Mouse may be found in a variety of habitats but is most commonly found near water, including along ponds, streams, and marshes with dense vegetation [9]. For example, in the upper Midwest, more individuals were caught in willow-alder thickets and grass/sedge meadows than coniferous swamps and upland coniferous and deciduous forests [11]. During the active season, mice are typically found near the stream bed ($\leq$ 100 m), although they are known to range further [12]. Day nests are constructed of woven grass, forb, sedge, and rush, and are often associated with shrubs, trees, or decaying vegetation used to anchor the nest or provide cover [13, 14]. Typical hibernacula are underground or underneath logs in nests made of leaves or grass [9].

Phenology:
In Colorado, females are typically pregnant by the third week of June and have two reproductive pulses per summer, one in July and one in August [15]. Gestation length is around 18 days [11], and litter size ranges from 4 to 7 [9]. Males display descended testes and are capable of reproducing for nearly the entire active season [16]. Meadow Jumping Mouse is a true hibernator and hibernates for approximately 210 days per year. Most weight gain occurs in the 2 weeks prior to entering hibernation. Hibernation begins in September or October, and emergence occurs in late May or early June, with males emerging from hibernation before females [9].

Diet:
Meadow Jumping Mouse consumes a variety of foods, including invertebrates, primarily lepidopteron larvae and beetles; seeds; berries; nuts; fruits; and subterranean fungi, which may be a particularly important food item. Invertebrates are heavily used early in the season, but seeds are the primary food item overall, particularly grass seeds. The importance of food items shifts throughout the active period and tracks vegetation green-up. Meadow Jumping Mouse has not been documented caching food [9].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: UNCOMMON
There are no estimates of abundance for Meadow Jumping Mouse in Wyoming, but the species is thought to be uncommon in the state [17]. In Colorado, population estimates ranged from 22.7 ± 7.9 to 85.6 ± 30.3 individuals per stream km. Overall capture success was 3.4 individuals per 100 trap nights [15]. Capture rates tend to be lower in Wyoming (e.g., 0.3 to 0.9 individuals per 100

trap nights) [18]; however, data are currently only available from a single season in the southeastern part of the state.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends are unknown. It is assumed that the Preble's Meadow Jumping Mouse subspecies has declined in abundance throughout its range [15], but the species as a whole may be stable in Wyoming.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Meadow Jumping Mouse is a habitat specialist, requiring dense vegetation along waterways or water bodies, which makes them inherently vulnerable to threats to these habitats. The long duration of hibernation may also contribute to the species' vulnerability by limiting reproductive potential. Although survival tends to be high during the hibernation season, insufficient fat stores may lower overwinter survival; body mass when entering hibernation is the most useful predictor of overwinter survival [15, 19].

Extrinsic Stressors:
MODERATELY STRESSED
Meadow Jumping Mouse is most common around riparian and other moist environments, but these environments represent only a small part of the landscape overall and are exposed to a variety of threats [20, 21]. Because emigration and immigration events might be critical for maintaining local populations, fragmentation of riparian habitats might reduce or eliminate the frequency of these events, making persistence of populations less likely [22]. Additional habitat modifications, both natural and anthropogenic, might lead to habitat degradation and destruction in Wyoming, such as overgrazing, drought, fires, and floods.

KEY ACTIVITIES IN WYOMING

Nearly all work to date in Wyoming has focused on the federally threatened Preble's Meadow Jumping Mouse, with little to no efforts directed toward the Bear Lodge Jumping Mouse subspecies or the Meadow Jumping Mouse species as a whole. Since initial listing, the Wyoming Natural Diversity Database has conducted extensive research on Preble's Meadow Jumping Mouse, and the Wyoming Game and Fish Department began funding annual surveys to determine presence and delineate range boundaries of the subspecies in 2009 (see the Preble's Meadow Jumping Mouse species account for more details).

ECOLOGICAL INFORMATION NEEDS

Meadow Jumping Mice in Wyoming represent the western geographical range of the species. A better understanding of distribution and ecological boundaries for this species is needed, particularly in the Black Hills. Additionally, many unknowns exist regarding the impacts of landscape-level habitat changes such as fire, drought, and flood. Finally, basic demographic and life history information regarding survival, reproduction, dispersal, density, abundance, and population trends are lacking. Because population size and presence can vary drastically, long-term monitoring is likely needed to acquire robust population estimates.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Implementing the Recovery Plan for Preble's Meadow Jumping Mouse will continue to be a priority in Wyoming. However, little is known about Meadow Jumping Mice statewide. Consequently, additional priorities will focus on addressing data deficiencies, including presence, trends, and distribution throughout northeastern Wyoming, as well as evaluating the impact of threats on population persistence and demographics statewide.

CONTRIBUTORS

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Figure 1: A live-captured jumping mouse (*Zapus* spp.). (Photo courtesy of WYNDD)

Figure 2: North American range of *Zapus hudsonius*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Heavily vegetated riparian corridor with woody overstory along Friend Creek, Albany County, Wyoming. (Photo courtesy of WGFD)

Figure 4: Range and predicted distribution of *Zapus hudsonius* in Wyoming.

Moose
Alces americanus

REGULATORY STATUS
USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Big Game Animal (see regulations)

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS4 (Bc), Tier II
WYNDD: G5, S4
Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS
Moose (*Alces americanus*) is classified as a big game animal in Wyoming by W.S. § 23-1-101 [1]. Harvest is regulated by Chapter 8 of Wyoming Game and Fish Commission Regulations [2].

NATURAL HISTORY
Taxonomy:
Bradley et al. (2014), following Boyeskorov (1999), has recognized North American/Siberian Moose as *A. americanus*, separate from European Moose (*A. alces*) based on chromosome differences [3, 4]. Bowyer et al. (2000) cautions against using chromosome numbers to designate speciation in large mammals [5]. Molecular [6] and morphological [7] evidence supports a single species. The International Union for Conservation of Nature recognizes two separate species but acknowledges this is not a settled matter [8]. George Shiras III first described this unique mountain race of Moose during his explorations in Yellowstone National Park, from 1908 to 1910 [9]. In honor of Shiras, Dr. Edward W. Nelson named the Yellowstone or Wyoming Moose *A. alces shirasi* [10]. That original subspecies designation is now recognized as *A. americanus shirasi*, Shiras Moose, which is the only recognized subspecies of Moose in Wyoming and surrounding states. Three other recognized subspecies occur in distant portions of North America, with an additional 4 subspecies in Eurasia [6, 11].

Description:
Moose is the largest big game animal in Wyoming and the largest member of the cervid family. Shiras Moose is the smallest of the four subspecies of Moose found in North America. It is the least social ungulate in Wyoming and is often observed alone or in small groups [12]. Moose is easily identifiable by its large size, dark brown color, long legs, large ears, long bulbous muzzle and bell shape dewlap under the throat. Male Moose weigh up to approximately 816 lbs (370 kg) and generally grow palmicorn antlers each year [13]. Some males, particularly young animals, may grow antlers that are more cervicorn shaped or similar to Elk (*Cervus canadensis*) antlers. Adult

males without antlers can be identified by pedicel scars. Adult female Moose weigh up to 750 lbs (340 kg) [13]. Female Moose can generally be identified from bulls due to the absence of antlers and the presence of a vulva patch or area of light colored hair around the genital area. Calf Moose typically remain close to the cow and body size is the most useful criteria for distinguishing calves from cows. However, head features can also be used to identify larger calves. Calves typically have small ears and a short pointed nose compared to older animals [12].

Distribution & Range:
Shiras Moose occurs in portions of Wyoming, Idaho, Utah, Colorado, Montana, Washington, and southern Alberta and southeastern British Columbia. Moose is believed to have entered Wyoming through Yellowstone National Park and along the Teton Range from southeast Idaho during the 1800s. There is no archaeological evidence of Moose populations in Wyoming prior to the 1800s [14]. By the 1930s Moose began to occupy portions of the Wind River Range. In addition to natural colonization of western Wyoming, Moose was translocated from northwest Wyoming to the Bighorns (1948, 1950, 1974, and 1987), and Colorado (1979, 1987) [15]. Moose colonized the Snowy Range and Sierra Madre Mountains from Colorado. Moose currently occupies the mountain ranges of northwestern and western Wyoming, as well as the Bighorn Mountains in north central Wyoming and the Snowy Range and Sierra Madre Mountains in southeastern Wyoming. Individuals are occasionally observed far from mountain population centers.

Habitat:
Wyoming Moose occupies lacustrine and palustrine habitats associated with Engelmann Spruce (*Picea engelmannii*), Douglas (*Pseudotsuga menziesii*) and Subalpine Fir (*Abies lasiocarpa*), and Lodgepole Pine (*Pinus contorta*) forests. In western Wyoming, Moose moves to higher elevations during summer and selects for areas close to aspens (*Populus tremuloidies*) and conifers [16]. The selection of summer range appears to be highly influenced by landscape features that provide high quality forage and also limit thermal stress. During winter, Moose generally selects low elevation riparian/deciduous shrub vegetation dominated by willow (*Salix* spp.). In areas where riparian habitats are limited or during more severe winters, Moose selects for mature conifer forests that provide abundant cover and forage. Some Wyoming Moose move up in elevation during the winter [17]. In the Bighorn Mountains, Moose rarely exhibits elevational movements seasonally. It usually shifts from willow riparian habitats to conifer habitats during the winter months.

Phenology:
Moose is a year round resident in Wyoming with most individuals in a population moving between distinct summer and winter ranges. Movement from summer range to winter range typically involves descending to lower elevations where snow depths are shallower and animal mobility is greater. Radio collared Moose exhibited a high degree of variability in the onset of spring and fall migrations in western Wyoming ($N = 118$). Unlike other cervids, Moose generally does not collect harems or associate in large groups during the breeding season [18, 19]. Breeding occurs during late September – early October and males usually travel extensively during the rut to locate and breed receptive females. Because of the short breeding season, males likely breed only a few females each year. The gestation length is approximately 231 days, although the literature reports some variability [18]. Moose parturition peaks across much of North America around May 25 [20]. In the Sublette and Jackson herds parturition occurred from May 10 to June 19, with a mean date of May 25 ($N = 129$) [21]. In other Moose populations, twinning is common

when habitats are in good shape although it is unclear if Shiras Moose exhibit this trait. Ritchie (1978) reported 12% twinning rate in Idaho and Houston (1968) reported 5% twinning rate in the Jackson area [22, 23]. While twinning rates may not be a good indicator of habitat condition for Shiras Moose, pregnancy rates may be. In the Sublette herd unit, Oates et al. (In prep.) observed an average pregnancy rate of only 63% from 2001–2014, with one set of twins in 2014.

Diet:
Willow is an important forage, constituting approximately 60% of the winter diet [17] and approximately 90% of the summer diet [24-26]. Moose also takes advantage of other available high quality forage including Bitterbrush (*Purshia tridentata*), Serviceberry (*Amelanchier alnifolia*) and other mountain shrubs. During winter, Subalpine Fir was the second most important winter forage for Moose in the Snowy Range [17], and Yellowstone National Park [27].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: UNCOMMON
In 2014, local Wyoming Game and Fish Department (WGFD) managers estimated the statewide Moose population at 4,050 animals [28].

Population Trends:
Historic: INCREASE
Recent: STABLE
Currently Moose herds across the state are exhibiting a wide range of population performance [29]. Local populations in Teton County have exhibited a large decline over the last two decades, the Sublette County herd has remained relatively stable while other areas of the state have increased during that time [16, 21, 29]. These trends are similar to Moose populations in the northern mid-west states. Populations in what were considered historic Moose range in Wyoming have declined significantly, while Moose populations in newer habitats (e.g., southeastern Wyoming) have fared much better.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Moose is strongly adapted to cool climates, and may be physiologically stressed by high temperatures. In the southern reaches of the species' range, such as Wyoming, temperature is the most critical factor determining distribution. During winter Moose may become stressed by temperatures greater than 23° F (5° C). In summer Moose may become stressed when temperatures exceed 57° F (14° C) [30]. Moose may be affected by climate change and the regional variation in habitat quality that will occur as temperatures rise and preferred foraging areas become drier [31]. Moose are susceptible to diseases and parasites, although the effects of such on Moose populations are still being elucidated. Chronic wasting disease, a fatal neurological prion disease, was discovered in a free-ranging Moose in western Wyoming in 2008. Subsequent surveillance has not found additional positive animals. Statewide monitoring of hunter-harvested Moose and other Moose mortalities for Carotid Arterial Worm (*Elaeophora schneideri*) was conducted in 2010. Approximately 50% of the Moose sampled had arterial worms present [32]. Winter tick loads vary considerably year-to-year, and may affect overwinter survival when tick loads are high [33]. Very little is known about the implications of these and other diseases (e.g., West Nile virus, keratoconjuctivitis) on Moose population performance.

Extrinsic Stressors:
SLIGHTLY STRESSED
Threats to Moose populations in Wyoming and range wide are primarily from degradation, fragmentation, and loss of habitats through urban development, mineral exploration, human disturbance, winter recreation, expanding large predator populations (see Becker 2008, Jesmer et al. 2014) and motor vehicle collisions. In addition, large scale wild fires may reduce habitat quality [34], and could increase in frequency and severity as the climate warms.

KEY ACTIVITIES IN WYOMING

The WGFD and the University of Wyoming Cooperative Fish and Wildlife Research Unit have implemented research projects on Moose in an effort to evaluate population performance in relation to habitat condition and to collect baseline demography and movement data. In Teton County, habitat quality was likely influencing Moose demography although the impacts of predation could not be ruled out. Research also determined that wildfire on summer ranges may be partially responsible for observed population declines [16, 34]. In Sublette County, baseline information was collected on the Sublette Moose herd in response to potential energy development and to develop a comprehensive data set to help managers understand the influence of nutrition on population demography. Adult female Moose exhibited low survival and low pregnancy rates suggesting that habitat quality may be limiting this Moose population. High neonate survival likely allows the population to remain stable [21]. In southeast Wyoming the seasonal habitat requirements and the distribution of Moose in the Medicine Bow Mountains were studied. Global positioning collars confirmed the importance of riparian shrub, deciduous forest and mixed forest cover types for Moose. A habitat suitability index model was developed for this population [17]. In addition, regional habitat-performance research evaluating linkages between habitat, nutritional condition and population performance is underway [29]. In 2007, the Conservation Research Center of Teton Science School initiated a habitat evaluation starting with the northwest Wyoming [35].

ECOLOGICAL INFORMATION NEEDS

Specific herd unit knowledge of Moose demographics linked to habitat and nutrition is lacking. More refined estimates of population trend would be useful, since some populations have experienced declines while other herds have been relatively stable or increasing. Current trend data usually isn't sensitive enough to detect population changes until they are well underway. More effort is needed to identify cause specific mortality to further evaluate the effects of predation. Further assessments of Moose response to habitat modifications from large scale wild fire, energy development and climate change are needed.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Doug Brimeyer and Tim Thomas. Moose is classified as a Species of Greatest Conservation Need in Wyoming [36]. Moose populations in Wyoming are delineated into 10 distinct herd units that are further divided into 38 hunt areas. Seven hunt areas are currently closed to Moose hunting [2]. All Moose herds are designated in the "Special" management category. Each herd unit is managed towards an objective based on population trend data and or harvest indices (e.g., animal age, hunter effort). A median age of harvested bulls > 4.5 yr and a male to female ratio of 50–70 males/100 females is desired [37]. After each hunting season all moose license holders are surveyed by mail and phone, and data are used to estimate total harvest, harvest composition, and to develop harvest statistics including hunter success, hunter effort (days hunted per moose harvested) and total recreation days. Age data and antler width measurements are collected from harvested moose and non-hunting mortalities. Age is determined through cementum analysis of the primary incisor (I1) [37]. Moose poses unique challenges for managers trying to census populations because they occur in small groups, tend to segregate according to sex and age, and are found in diverse vegetation cover types. Ground or aerial surveys are conducted during the pre-hunting season or post hunting season period on Moose herds in Wyoming. Composition data are expressed as the number of bulls and calves per 100 cows and used to estimate recruitment of calves into the population and to evaluate the presence of bulls.

CONTRIBUTORS

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Figure 1: Adult male Moose in Seedskadee National Wildlife Refuge, Sweetwater County, Wyoming. (Photo courtesy of Tom Koerner, USFWS)

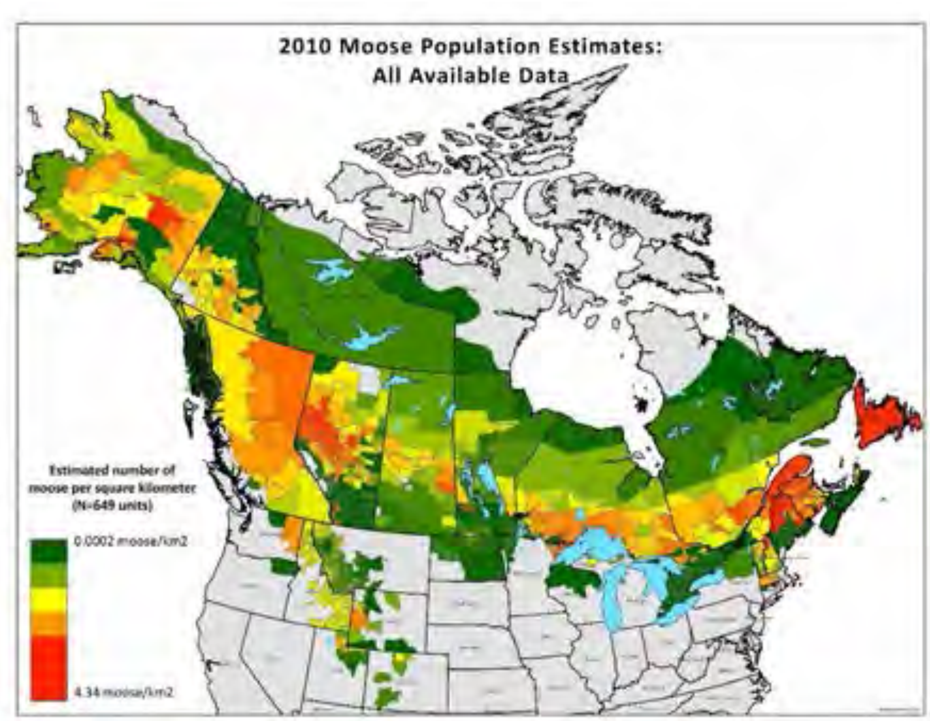

Figure 2: North American range of *Alces americanus* as of 2010 (Map from: Jensen, W. F., et al. (In Prep.) Mapping continental range distribution of moose over time using geographic information systems technology.)

Figure 3: Willow wetland Moose habitat in Albany County, Wyoming. (Photo courtesy of Kaylan A. Hubbard)

Figure 4: Range and predicted distribution of *Alces americanus* in Wyoming.

Figure 5: Adult female Moose with calf in Seedskadee National Wildlife Refuge, Sweetwater County, Wyoming. (Photo courtesy of Tom Koerner, USFWS)

Northern Flying Squirrel

Glaucomys sabrinus

REGULATORY STATUS

USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS4 (Cb), Tier II
WYNDD: G5, S3S4
    Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS

The Wyoming Natural Diversity Database (WYNDD) has assigned Northern Flying Squirrel (*Glaucomys sabrinus*) a state conservation rank ranging from S3 (Vulnerable) to S4 (Apparently Secure) because of uncertainties in the species' abundance, the amount of occupied habitat, and population trends in Wyoming. An isolated population of Northern Flying Squirrel is found in the Black Hills of Wyoming and South Dakota. WYNDD assigns this population a state conservation rank of S1 (Critically Imperiled) and a Wyoming contribution of VERY HIGH.

NATURAL HISTORY

Taxonomy:

Recent genetic analyses suggest Northern Flying Squirrel could be comprised of more than one species [1, 2]; however, only one species is currently recognized [3]. There are approximately 25 subspecies of Northern Flying Squirrel. Currently, *G. s. bangsi* is the only one known to occur in Wyoming; however, *G. s. lucifugus* occurs in northeastern Utah and may occur in southwestern Wyoming [4, 5]. Additional research suggests the disjunct population in the Black Hills of Wyoming and South Dakota is genetically isolated and should be considered a separate subspecies [6, 7], but this taxonomic revision is not yet widely accepted.

Description:

Identification of Northern Flying Squirrel is possible in the field. Northern Flying Squirrel is a small tree squirrel ranging from 29–32 cm in length, including the tail, and weighing 105–170 g. Dorsal pelage is typically soft gray to beige and the underside is white. Eyes are notably large and dark. The species is distinguished from other sympatric tree squirrels by a layer of loose skin attached to the fore- and hind-limbs, which assists with gliding [8].

Distribution & Range:

Northern Flying Squirrel is broadly distributed across Canada and Alaska, and its range extends south along the east and west coasts of the United States and along the Rocky Mountains into

Utah. Disjunct populations also exist on the southern periphery of the species range. In Wyoming, the species is found in the northwestern mountains and the Black Hills in the northeast. The species is also known to occur in the Uinta Mountains in northeastern Utah but has not been confirmed from the portions of this mountain range in southwestern Wyoming [5, 8].

Habitat:
Northern Flying Squirrel is found in mature and old-growth coniferous, deciduous, mixed, and riparian forests throughout its range [9, 10]. The species tends to be more abundant and occur at higher densities in old-growth and mature forest stands than in secondary growth type forests, though both types of forests are used [9, 11, 12]. In conifer-dominated forests in Ontario, density of Northern Flying Squirrel was strongly related to the density of large spruce (*Picea* spp.) and hardwood trees and snags [13]. In Wyoming, the species is primarily found in coniferous forests, particularly those with tall, large diameter trees, moist conditions, and abundant standing and downed snags and decaying logs [5, 8, 10, 14, 15]. Northern Flying Squirrel requires tall trees to provide launch points for gliding, cavities for nesting/denning, and moist decaying materials that support growth of fungi, its primary food. The species also prefers forests with open understories that allow for longer unobstructed glides but avoids clear-cuts [5, 12]. Habitat use does not change seasonally [10].

Phenology:
Northern Flying Squirrel is active throughout the year and does not hibernate. In Wyoming, the species breeds from late March to May. Gestation lasts 37–42 days and litter size ranges from 2–6 young. Young are weaned at about two months and are sexually mature in 6–12 months. The species has been known to breed more than once a year in some parts of its range, but it is unknown if this occurs in Wyoming [8, 10, 16].

Diet:
Fungi, particularly mycorrhizal fungi, and lichens comprise the majority of the diet of Northern Flying Squirrel, and these appear to be a critical component of the species' diet throughout its range. However, the species will also eat insects, nuts, buds, seeds, and fruit, and occasionally bird eggs and nestlings [5, 8-12].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: UNCOMMON
There are no robust estimates of Northern Flying Squirrel abundance in Wyoming; however, the probability of occupancy for survey grids in the Wyoming Range was high (0.80) [14], as was the probability of occupancy in the Black Hills (0.87) [15]. Elsewhere in the species' range, densities in good habitat range from 0.1 to 4.0 individuals per ha [9, 17]. The statewide abundance rank of UNCOMMON is based on state occupancy estimates and the quantity and quality of potential available habitat in Wyoming.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends for Northern Flying Squirrel in Wyoming are unknown, although protocols are in place to evaluate trends in occupancy of Northern Flying Squirrel in

portions of its range in Wyoming [15]. Across northern North America, populations are thought to be stable [10, 11]. In the southern portions of the species' range, including Wyoming, loss of preferred habitat may currently be causing a decline in populations [11].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Northern Flying Squirrel is moderately vulnerable to extrinsic stressors due to the species' reliance on mesic old-growth and mature forests, specialized diet, and relatively low fecundity for its body size. Northern Flying Squirrel's dependence on tall trees in forests with relatively open understory for gliding and its avoidance of open areas limit the species' dispersal ability. Because Northern Flying Squirrel is a secondary cavity nester, density of suitable nest cavities is known to limit population densities in some areas [12, 18].

Extrinsic Stressors:
SLIGHTLY to MODERATELY STRESSED
Factors that decrease old-growth and mature conifer forests and snag density will likely affect Northern Flying Squirrel populations in Wyoming. Forest management practices such as clearcutting and thinning reduce and fragment mature and old-growth forest habitat. Fragmentation of populations through these disturbances may lead to local extirpations. Although the species will use secondary forest types, abundance, density, and productivity are lower in these habitats [9, 11, 12]. A meta-analysis of 14 studies confirmed the association of Northern Flying Squirrel with mature uncut forest [19]. Although some studies of the effects of thinning on Northern Flying Squirrel suggest that impacts can be minimized by maintaining a heterogeneous forest that allows the species to shift distribution to neighboring suitable patches [20], other studies suggest landscape configuration does little to offset habitat loss [21]. Wildfires and the recent Mountain Pine Beetle (*Dendroctonus ponderosae*) epidemic potentially have resulted in the loss of Northern Flying Squirrel habitat in Wyoming.

KEY ACTIVITIES IN WYOMING

In the fall of 2011, the Wyoming Game and Fish Department evaluated several survey techniques for Northern Flying Squirrel in the Wind River Range in the Shoshone National Forest [22]. The combination of bait stations and remote cameras proved most effective, and subsequent studies further improved the efficiency and utility of the technique [23]. This survey method was used in 2012 and 2013 in the Wyoming Range and in 2014 in Teton County and the Black Hills to assess Northern Flying Squirrel occupancy and habitat use [14, 15, 24]. Baseline occupancy estimates from this study will be used to assess population trends in the future.

ECOLOGICAL INFORMATION NEEDS

Northern Flying Squirrel would benefit from continued research to determine its abundance and population trends in Wyoming. The taxonomy of Northern Flying Squirrel needs to be resolved following genetic research suggesting it should be split into multiple species. In Wyoming, genetic research has been limited to the isolated Black Hills population, and additional research is needed to determine subspecies and/or species designations across the state [1, 2].

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Recent activities for Northern Flying Squirrel have included developing and evaluating monitoring protocols, assessing baseline occupancy and distribution, and evaluating habitat use. Moving forward, management priorities include continuing and expanding occupancy surveys in order to monitor population trends throughout the range the species in Wyoming. Surveys will continue to include habitat assessment in order to better understand what influences presence and distribution at a finer scale, including the availability of food resources. Evaluating changes in presence and occupancy in the face of potential stressors, such as natural and anthropogenic habitat loss, is of particular importance. Results from these efforts will be ultimately be used to develop management and conservation recommendations.

CONTRIBUTORS

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Figure 1: A radio-collared adult Northern Flying Squirrel in the Black Hills, South Dakota. (Photo courtesy of Melissa Hough)

Figure 2: North American range of *Glaucomys sabrinus*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Northern Flying Squirrel habitat in the Black Hills, South Dakota. (Photo courtesy of Melissa Hough)

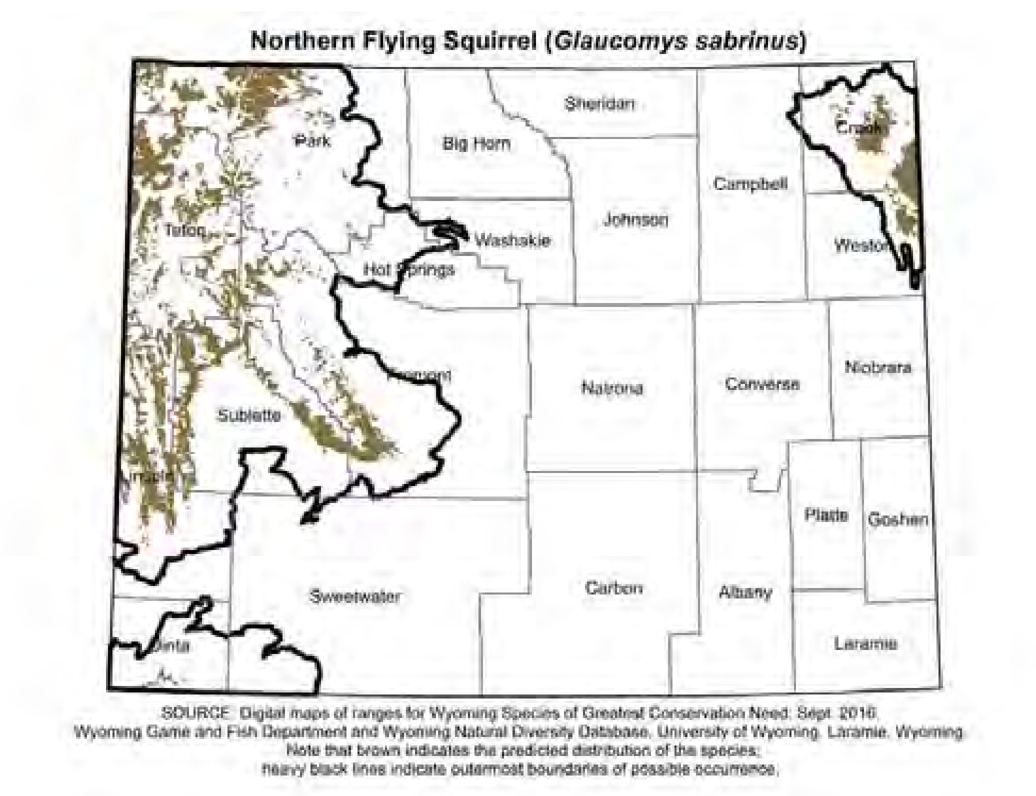

Figure 4: Range and predicted distribution of *Glaucomys sabrinus* in Wyoming.

Northern Long-eared Myotis
Myotis septentrionalis

Regulatory Status
USFWS: Threatened
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

Conservation Ranks
USFWS: No special status
WGFD: NSS2 (Ba), Tier II
WYNDD: G1G2, S1
Wyoming Contribution: LOW
IUCN: Least Concern

Status and Rank Comments
Northern Long-eared Myotis (*Myotis septentrionalis*) was listed as threatened under the Endangered Species Act in 2015 [1]. In Wyoming, the species is covered by a 4(d) rule [2]. The species has been assigned a global range rank of G1G2 because of uncertainties of the effects of White-nose Syndrome (WNS) on the persistence of the species [3]. The rank of G1G2 indicates that across the species range, it is at very high or high risk of extinction [3].

Natural History

Taxonomy:
There are no recognized subspecies of Northern Long-eared Myotis [4]. Historically, Northern Long-eared Myotis was classified as a subspecies of Keen's Myotis (*M. keenii*). Literature referencing Keen's Myotis outside of the Pacific Northwest refers to *M. septentrionalis* [5].

Description:
Northern Long-eared Myotis is identifiable in the field. The species is a small vespertilionid bat but is medium in size among *Myotis* species. Dorsal pelage is dull yellow-brown while ventral pelage is pale gray. The calcar often has a slight keel. The ears and wing and tail membranes are translucent and light brown [6]. Northern Long-eared Myotis has relatively long ears (17–19 mm) with a long, pointed tragus [5], although individuals in Wyoming typically have shorter ears than average (14–16 mm), which may complicate identification [7]. Volant juvenile individuals are identical in appearance to adults, but the growth plates in the phalanges of juveniles are visible throughout the first summer [5, 8]. Northern Long-eared Myotis is similar in appearance to other sympatric *Myotis* species. Within the Wyoming range of the species, these include the Little Brown Myotis (*M. lucifugus*), Fringed Myotis (*M. thysanodes*), Long-eared Myotis (*M. evotis*), Western Small-footed Myotis (*M. ciliolabrum*), and Long-legged Myotis (*M. volans*). Northern Long-eared Myotis can be distinguished by its translucent, light brown ears and wing and tail membranes and its long, pointed tragus.

Distribution & Range:
Northern Long-eared Myotis is widely distributed across Canada and the Midwestern and eastern United States. It is generally considered an eastern species and is quite rare in the western portions of its distribution. Wyoming is on the extreme western edge of the species' range. In Wyoming, the species has only been documented in the northeastern corner of the state in the vicinity of the Bear Lodge Mountains and Black Hills. Across its range, local distributions change seasonally as the species moves between summer ranges and winter hibernacula [5]. While no shifts in distribution have been documented, large declines and local extinctions resulting from WNS infection have been observed across the species range where the disease currently occurs [9-11].

Habitat:
Basic knowledge of habitat use and associations of Northern Long-eared Myotis in Wyoming is limited. Across its range, Northern Long-eared Myotis is strongly associated with forests and is considered a forest obligate by some researchers. In summer, the species frequents a wide variety of day and night roosts. Trees are most frequently used as roosts. Specifically, tall, large-diameter trees are preferred across the species range. In the Black Hills of South Dakota, female Northern Long-eared Myotis roosted in highly decayed, large-diameter Ponderosa Pine (*Pinus ponderosa*) snags [12]. Maternity colonies may also include roosts such as human-made structures and buildings [5]. In Wyoming, the species is only known from the Black Hills region in areas dominated by contiguous Ponderosa Pine forest [13, 14]. At Devils Tower National Monument, male Northern Long-eared Myotis roosted in a variety of structures including standing dead and live Ponderosa Pine, fallen Ponderosa Pine trees, small Bur Oak (*Quercus macrocarpa*) snags, and a rock crevice [15]. It is likely that roost selection of both male and female Northern Long-eared Myotis across their range in Wyoming is similar to the findings presented above. During winter, Northern Long-eared Myotis hibernates. Across the species range, including in the Black Hills of South Dakota, caves and abandoned mines are used as hibernacula [5, 16]. Currently, there are no known Northern Long-eared Myotis hibernacula in Wyoming. However, evidence suggests that summer habitat is generally close to winter hibernacula (< 56 km), making it likely that the species overwinters in the state [5]. Within hibernacula, Northern Long-eared Myotis often clusters in deep crevices.

Phenology:
Phenology of Northern Long-eared Myotis in Wyoming largely unknown but is assumed to be similar to other portions of its range. Northern Long-eared Myotis breeds from July to September. Females store sperm over winter, and a single egg is fertilized in spring when they emerge from hibernation [5]. In northern portions of its range, parturition likely occurs mid-July. Offspring are volant by early August [5]. Northern Long-eared Myotis begins visiting hibernacula from late July to early September. Northern Long-eared Myotis typically enter hibernation from September to November and leave the hibernacula from March to May. Length of hibernation varies with latitude and local environmental conditions [5].

Diet:
Northern Long-eared Myotis consumes a wide variety of small insects. Small moths (Lepidoptera) comprise a large proportion of the species' diet [17].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
There are no estimates of abundance of Northern Long-eared Myotis in Wyoming. The species occupies a small portion of northeastern Wyoming and typically comprises a relatively small proportion of mist-net captures and acoustic detections [18, 19]. However, surveys conducted within contiguous forested habitat in the Bear Lodge Mountains and Black Hills found the species to be among the most common bat captured during mist-net surveys, suggesting the species may be locally common [13, 14].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
There are no estimates of historic or recent population trends of Northern Long-eared Myotis in Wyoming. In the eastern United States, the species has undergone large declines where it is affected by WNS [9, 20]. As of 2015, WNS has not been documented in Wyoming [21], and declines of Northern Long-eared Myotis resulting from the disease have not occurred in the state.

Intrinsic Vulnerability:
HIGH VULNERABILITY
Multiple factors make Northern Long-eared Myotis highly vulnerable to extrinsic stressors. Foremost of these is the species susceptibility to WNS. Northern Long-eared Myotis has low fecundity, giving birth to only one pup per year [5]. As a result, the species may have a difficult time recovering from population declines. Northern Long-eared Myotis also has specific requirements for roosting and hibernacula habitat. The species prefers to roost in tall, large diameter trees [5]. During winter, the species hibernates in caves and abandoned mines. Both roost trees and hibernacula are often limited landscape features.

Extrinsic Stressors:
MODERATLY STRESSED
The most important stressor to Northern Long-eared Myotis outside Wyoming is WNS. The pathogenic fungus *Pseudogymnoascus destructans* (formerly *Geomyces destructans*) that causes WNS was unintentionally introduced to North America in 2006 [22]. Multiple lines of evidence suggest large declines of several bat species, including Northern Long-eared Myotis, in eastern North America have resulted from WNS. Annual declines of 30 to 99% have been documented at hibernacula known to have WNS infected bats, with local extinctions of Northern Long-eared Myotis at 69% of monitored hibernation sites in the northeastern United States [11, 22]. Similarly, large declines in acoustic detections during the summer have been documented in many areas of eastern North America [9, 20]. As of 2015, WNS has not been documented in Wyoming [21]. It is assumed that WNS will eventually occur in Wyoming, but it is unknown if WNS will affect bats to the same degree in Wyoming as in other areas of North America. Northern Long-eared Myotis is also negatively affected by some commonly applied timber harvest and forest management practices and minimally or unaffected by others [23]. Because the species is restricted to forest habitats, practices that reduce or fragment forest habitat are likely to negatively affect Northern Long-eared Myotis. In other parts of its range, Northern Long-eared Myotis was generally not detected passing through or foraging in clear-cuts [24], suitable habitat for the species decreased following an increase in forest openings and proportion of edge habitat [25], and occupancy

decreased with increasing amount of edge in the landscape [26]. In a highly fragmented landscape, Northern Long-eared Myotis was entirely constrained to forest fragments and the probability of forest fragment occupancy was positively related to fragment area [27 28]. Conversely, selective harvest techniques such as diameter-limit or single tree removal that maintain contiguous forest cover or generate only small openings may minimally affect or even benefit the species [23, 29]. While the effects of forest fragmentation have not been evaluated in Wyoming, patterns seem to be consistent across a variety of forest types where the species occurs, making it likely that effects would be similar in Wyoming. Finally, natural or anthropogenic disturbance events that reduce the number of suitable roost trees are likely to negatively affect Northern Long-eared Myotis. The species may tolerate removal of some roost trees, but the level of removal tolerated before the species abandons an area is likely dependent on local forest conditions [30]. Disturbance from visitors to caves and abandoned mines used as hibernacula represents a substantial threat to cave-roosting bats and bat habitat where human visitors occur [31]. Even a small number of short duration disturbances lead to significant increases in arousal events and subsequent energy expenditures that may lead to increased mortality of hibernating bats [32, 33].

Key Activities in Wyoming

State and federal wildlife and land management agencies have taken several actions to protect Northern Long-eared Myotis and other bat species from WNS. Specifically, the Black Hills National Forest implemented an adaptive management strategy for caves and abandoned mines to limit the potential for introduction and spread of WNS [34, 35]. The Wyoming Game and Fish Department (WGFD) along with the Wyoming Bat Working Group developed "A strategic plan for white-nose syndrome in Wyoming" in 2011 [36]. This plan is intended to minimize the impacts of WNS once it is detected in adjacent states or within Wyoming. To facilitate early detection of the disease, WGFD requires researchers to use the Reichard Wing-Damage Index [37] to evaluate all bats captured during research activities for signs of WNS infection as well as to implement WNS decontamination protocols when handling bats or conducting hibernacula surveys. Beginning in 2012, WGFD personnel placed temperature and humidity loggers in a number of known or suspected hibernacula across Wyoming to determine if climatic conditions at these sites are favorable for growth of *P. destructans*. Preliminary results suggest that temperature and relatively humidity in known hibernacula could facilitate the growth of the fungus [38, 39]. Personnel have also begun collecting swabs of hibernating bats and hibernacula substrates in an effort to assist with early detection of *P. destructans*. Collectively, WGFD and the Wyoming Natural Diversity Database (WYNDD) have conducted statewide systematic and project-specific surveys for bats since 2008, with numerous, smaller scale projects occurring prior to this time. In 2010, the WGFD conducted an inventory of forest bats in northeastern Wyoming. During these surveys, 27 Northern Long-eared Myotis were captured at seven sites [19]. In 2010 and 2011, WYNDD conducted an inventory of bats at Devils Tower National Monument. During this inventory, four Northern Long-eared Myotis were captured at two sites, and > 100 acoustic detections from 16 sites were recorded [18]. In 2014, WYNDD initiated a study to evaluate occupancy and habitat associations for Northern Long-eared Myotis in Wyoming. Preliminary analyses indicate that across the species currently accepted range in northeastern Wyoming, the probability of a site being occupied by the species was approximately 50%. During mist-net surveys associated with this work in 2014 and 2015, Northern Long-eared Myotis was generally among the most commonly captured bat species, suggesting it may be relatively abundant in suitable habitat in the Black Hills and Bear Lodge Mountains [13, 14]. In 2015, WYNDD initiated a study to identify and characterize day roosts at Devils Tower National Monument. Eight Northern Long-eared Myotis were captured and fitted with radio transmitters and tracked back to 10 day roosts [15].

ECOLOGICAL INFORMATION NEEDS

Habitat use and associations of Northern Long-eared Myotis are poorly understood in Wyoming. While the species is known to occur in Wyoming in the spring, summer, and fall, there are no known Northern Long-eared Myotis hibernacula in Wyoming. Summer day roost use is largely unknown in Wyoming. Both hibernacula and summer day roosts represent critical habitat components for persistence of the species in Wyoming. Estimates of abundance and population trends of Northern Long-eared Myotis in Wyoming are not available. However, these data would be useful in the face of potential stressors such as WNS or forestry management practices. As of 2015, WNS has not been documented in Wyoming, but continued monitoring for the disease is essential so that appropriate measures can be put in place to potentially minimize the effect of the disease in Wyoming.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Very little is known about the wintering locations of Northern Long-eared Myotis in Wyoming. Although WNS has not been detected in the state, the slow westward progression of the fungus necessitates the need for these data before it reaches Wyoming. Consequently, priorities will focus on locating and monitoring hibernacula as well as other roost locations (e.g., maternity roosts) to monitor populations and recommend and assist with bat-friendly closures of important caves and mines. Additional priorities will focus on further defining the distribution of the species in the state to help direct future management and conservation efforts. Mist-net surveys will continue to implement WNS protocols and assessment in an effort to assist with early detection should the disease reach the state. Habitat assessments will be incorporated with survey efforts to better understand what influences species presence and distribution at a finer scale. In addition to inventory projects, WGFD, in collaboration with the Wyoming Bat Working Group and other state-wide partners, will implement the North American Bat Monitoring Program that will use acoustic monitoring to assess state and region-wide bat trends. Additional priorities will include updating and revising the Conservation Plan for Bats in Wyoming and the Strategic Plan for WNS in Wyoming. Finally, outreach and collaboration with private landowners will remain a priority to ensure conservation of bats and bat habitat.

CONTRIBUTORS

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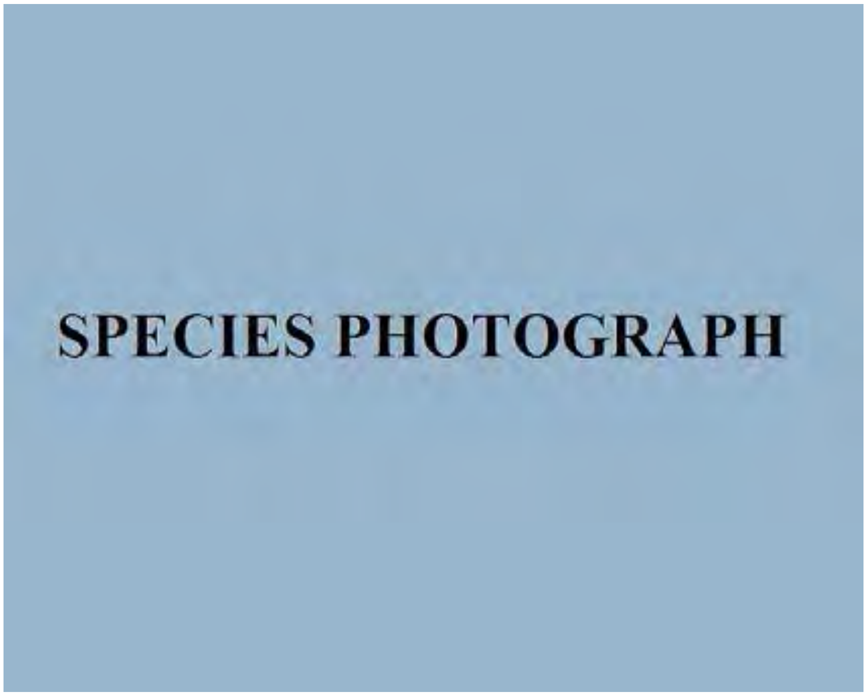

Figure 1: Photo not available.

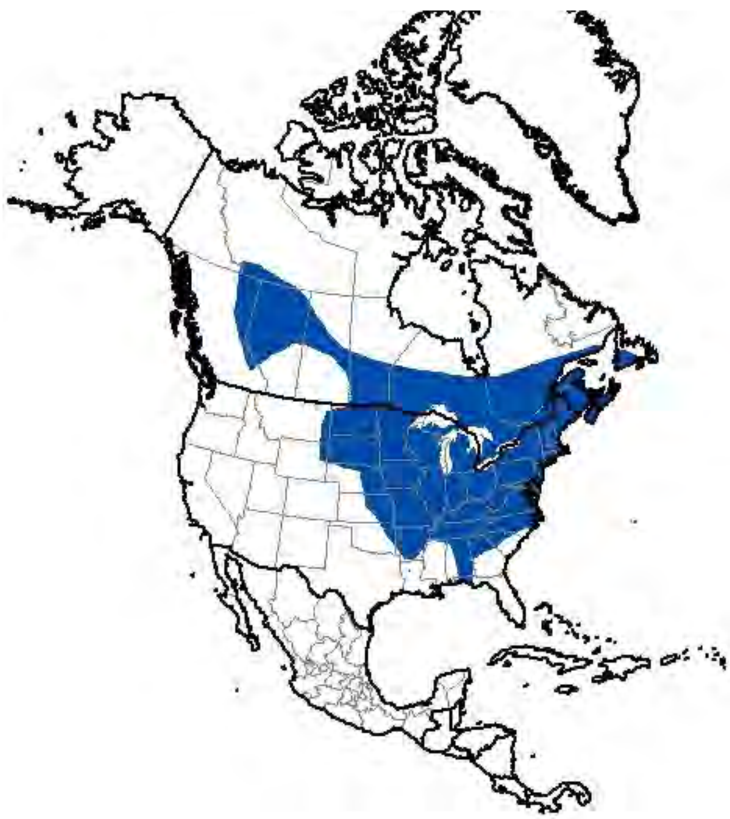

Figure 2: North American range of *Myotis septentrionalis*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Northern Long-eared Myotis habitat near Devils Tower National Monument in Crook County, Wyoming. (Photo courtesy of WYNDD)

Figure 4: Map not available.

ꕤ Wyoming Species Account ꕤ

Northern River Otter

Lontra canadensis

REGULATORY STATUS

USFWS: No special status
USFS R2: Sensitive
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Animal

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G5, S3S4
    Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS

The Wyoming Natural Diversity Database has assigned Northern River Otter (*Lontra canadensis*) a state conservation rank ranging from S3 (Vulnerable) to S4 (Apparently Secure) because of uncertainty about the state range and proportion of range occupied for this species in Wyoming.

NATURAL HISTORY

Taxonomy:

Historically, 7–19 subspecies of Northern River Otter were recognized. However, reintroduction programs have occurred across North America, facilitating breeding among subspecies, and recent genetic analysis of Northern River Otter populations suggests that subspecies designations are no longer valid [1, 2].

Description:

Identification of Northern River Otter is possible in the field. Northern River Otter is a large, stocky, yet streamlined member of the weasel family. The species is characterized by short legs, webbed feet, a long tapered tail that makes up a third of the body length, and a small blunt head. The fur is short and dense, ranging in color from pale chestnut to nearly black on the back and light brown to silver gray on the belly. Adult length ranges from 91–134 cm. Weight ranges from 5–14 kg. Young otters are similar in appearance to adults [2, 3]. In Wyoming, Northern River Otter is most similar to Mink (*Mustela vison*), Muskrat (*Ondatra zibethicus*), and American Beaver (*Castor Canadensis*) but can be distinguished from these species by its long, thick, tapered tail and ventral fur that is noticeably paler than the dorsal fur [4].

Distribution & Range:

Historically, Northern River Otter was distributed across most major river drainages in the United States and Canada, including much of Wyoming. The species was largely extirpated across its range due to fur trapping, pollution, and habitat degradation [2, 5]. Outside of Grand

Teton and Yellowstone National Parks, the species had been extirpated from Wyoming by the mid-1900s. Protection of Northern River Otter in Wyoming outside of the national parks began in 1953. The species is now more widespread in Wyoming, having expanded south and east from Yellowstone and Grand Teton National Parks and north from reintroductions in Colorado [2, 4]. However, its exact distribution in the state is still unclear. Confirmed or suspected breeding has been documented in 12 of Wyoming's 28 latitude/longitude degree blocks, primarily in the western half of the state [6].

Habitat:
Across the species' range, Northern River Otter uses many types of aquatic habitat, including rivers, streams, marshes, lakes, and reservoirs. The species requires aquatic habitats with relatively high water quality, riparian vegetation for cover, permanent open water for foraging, and ample food sources [2]. Northern River Otter prefers vegetated shorelines with stable banks for denning and cover and avoids waterbodies with gently sloping sandy or gravel shorelines. The species also requires structural complexity in the form of riparian vegetation, logjams, beaver or muskrat lodges, or rock piles for cover [2, 5]. Habitat needs are similar year-round. In winter, the species is restricted to areas with open water [2].

Phenology:
Northern River Otter females may breed every 1–2 years. Mating occurs from late winter through early spring; however, females delay implantation for 8 months or more. Gestation is 61–63 days, and litters of 1–3 young are born between February and April. Young begin to eat solid food at 9–10 weeks of age and are weaned by 12 weeks but remain with the mother until they are 37–38 weeks old. Dispersal of young from the natal territory occurs in April and May, at age 12–13 months [2, 5].

Diet:
Northern River Otter primarily feeds on fish from a wide variety of families, but will also readily eat crustaceans (especially crayfish) and amphibians. Other prey items include mollusks, insects, birds, and mammals. Diet composition is usually a reflection of the relative abundance of available prey items [2, 4].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
There are no robust estimates of abundance for Northern River Otter in Wyoming. The species has an estimated statewide abundance rank of VERY RARE and appears to be uncommon even within suitable environments in the occupied area [6]. In Wyoming, Northern River Otter is believed to be most common in the Yellowstone, Green, and Snake River drainages [2, 7]. In 2008, the Northern River Otter population in Yellowstone Lake and nearby tributaries was estimated to range from 1 otter per 10.1–20.4 km of shoreline (approximately 14–28 individuals) [8]. Population estimates for 3 study reaches along the Green and New Fork Rivers (106 km of river) ranged from 35–44 individuals in 2010 [9].

Population Trends:
Historic: LARGE DECLINE
Recent: INCREASE

Historically, Northern River Otter suffered large population declines range-wide and was extirpated from much of Wyoming as a result of fur trapping, pollution, and habitat degradation [2, 5]. Reintroduction and management efforts in a number of states have allowed populations to rebound, and Northern River Otter populations are likely stable or increasing in most western states [2, 10]. Although reintroductions have not occurred in Wyoming, Northern River Otter populations are believed to be increasing in the state, partly due to dispersal from reintroduced populations in neighboring states [2, 4].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Northern River Otter has moderate intrinsic vulnerability to extrinsic stressors in Wyoming due to its limited habitat requirements, low fecundity, and large home range size. Suitable habitat for Northern River Otter in Wyoming may be limited. Although the species will use several types of aquatic habitats, high altitude montane ponds and streams are typically unsuitable due to lack of open water in the winter, low food availability, and/or steep terrain [2]. The species' need for high quality productive waterways with structurally complex riparian vegetation and limited human disturbance also limits available habitat at lower elevations. Furthermore, Northern River Otter territories can be large, limiting the number of otters a single waterway can support [2]. Although the species will often live in family groups, individual male and female territories can range from 50–80 km and 31–58 km of river, respectively [2].

Extrinsic Stressors:
SLIGHTLY STRESSED
Northern River Otter is slightly stressed by alteration and degradation of aquatic habitats in Wyoming. Because the species is dependent upon higher quality productive aquatic systems with structurally diverse riparian vegetation, threats to the health of these aquatic habitats could negatively impact the species. Negative impacts on aquatic habitats can result from alteration of natural flow regimes due to dams and reservoirs, siltation of streams and rivers from logging operations, pollution from agricultural chemicals and oil and gas development, and both habitat degradation and anthropogenic disturbance resulting from human development along waterways [2, 11, 12]. Research suggests that Northern River Otter abundance in Wyoming's Green River drainage is negatively impacted by anthropogenic disturbance (i.e., oil and natural gas development, infrastructure development) and possibly pollution [9]. Northern River Otter is high on the aquatic food chain, making it susceptible to reduced prey abundance and bioaccumulation of heavy metals and toxic compounds resulting from water pollution [2, 5, 8, 13].

KEY ACTIVITIES IN WYOMING

Surveys for Northern River Otter were conducted along the Green River in southwestern Wyoming in 2010 and 2011 to assess the influence of oil and gas development on species abundance [9]. Results suggest that Northern River Otter tended to avoid areas with energy development; however, it is unclear whether avoidance resulted from increased disturbance or from water contamination. Researchers also studied the demographic and behavioral response of Northern River Otter to declining native Yellowstone Cutthroat Trout (*Oncorhynchus clarkii bouvieri*) populations in Yellowstone Lake and surrounding tributaries from 2002–2008 [8]. Results suggest that Northern River Otter distribution and diet appear to have changed as a result of the decline in native cutthroat trout, once a major food source for otters in that drainage. Both survival and abundance of Northern River Otter might also be negatively impacted by the decline in native trout, although further monitoring is necessary to elucidate population trends [8].

ECOLOGICAL INFORMATION NEEDS

Information on the current distribution, abundance, and population status of Northern River Otter is needed for Wyoming. Factors limiting recolonization and occupancy of different drainages in Wyoming are not understood. Further information is needed to clarify the effects of energy development on otter abundance, particularly the relative impacts of industrial disturbance and water contamination [9]. Northern River Otter would also benefit from continued monitoring of the impacts of declining native cutthroat trout on survival and abundance in the Yellowstone Lake area, once a population stronghold for otters in Wyoming.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Recent management activities for Northern River Otter in Wyoming have included funding research projects to improve understanding of limiting factors, particularly energy and other anthropogenic development. Moving forward, management priorities will continue to address the impacts of limiting factors as well as focusing on developing a better understanding of distribution throughout the state and identifying potential barriers and corridors to dispersal and colonization. Additional priorities include developing and implementing a robust protocol to detect Northern River Otter and monitor population trends, all of which will ultimately be used to develop management and conservation recommendations.

CONTRIBUTORS

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Figure 1: Adult Northern River Otter in Yellowstone National Park, Wyoming. (Photo courtesy of Nate Bowersock)

Figure 2: North American range of *Lontra canadensis*. Due to range expansions, the species may now be found outside the mapped range. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Northern River Otter habitat on Yellowstone Lake in Yellowstone National Park, Wyoming. (Photo courtesy of Jamie R. Crait)

Figure 4: Range and predicted distribution of *Lontra canadensis* in Wyoming.

Olive-backed Pocket Mouse

Perognathus fasciatus

REGULATORY STATUS

USFWS: No special status
USFS R2: No special status
UWFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS4 (Cb), Tier III
WYNDD: G5, S3S5
    Wyoming contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS

Olive-backed Pocket Mouse (*Perognathus fasciatus*) is assigned a range of state conservation ranks by the Wyoming Natural Diversity Database (WYNDD) due to uncertainty concerning the abundance, population trends, amount of occupied habitat, and extent of extrinsic stressors in Wyoming.

NATURAL HISTORY

Taxonomy:

Olive-backed Pocket Mouse is a member of the family Heteromyidae, which includes the pocket mice and kangaroo rats [1]. There are two recognized subspecies of *P. fasciatus*, both of which are found in Wyoming: *P. f. callistus* occupies southwestern Wyoming, while *P. f. fasciatus* is found in the eastern two-thirds of the state [2, 3]. There is no apparent barrier between the distributions of these two subspecies, suggesting the potential for introgression. A recent genetic analysis confirms that *P. fasciatus* is distinct from other, geographically proximate *Perognathus* species, but does not further resolve subspecific designations [4].

Description:

Olive-backed Pocket Mouse, like other pocket mice, is a small-bodied rodent with a relatively long tail and visible, external, fur-lined cheek pouches. Dorsal pelage of Olive-backed Pocket Mouse is generally olivaceous, being darker in the northeast portion of its range (i.e., *P. f. fasciatus*) and more buffy in the southwest (i.e., *P. f. callistus*) [3]. Olive-backed Pocket Mouse typically has whitish ventral pelage, usually with a bright yellowish lateral line separating dorsum and venter [5, 6]. It can be identified in the field, but positive identification can be difficult as it is similar in appearance to other, sympatric congeners. It is most similar to Plains Pocket Mouse (*P. flavescens*) and Silky Pocket Mouse (*P. flavus*), which both have generally lighter (i.e., yellow, buff, or creamy) dorsal pelage rather than olivaceous. In addition to lacking olivaceous coloring, Great Basin Pocket Mouse (*P. parvus*) has a tail that is penciled (i.e., having a tuft of longer hair at the end) and longer in proportion to its body, while Hispid Pocket Mouse (*P. hispidus*) is generally larger [5-7].

Distribution & Range:
Wyoming is on the southwestern edge of Olive-backed Pocket Mouse range. It is Wyoming's most widely distributed pocket mouse and is presumed to occur throughout the grassland and shrubland basins of the state, although this is based on only about 30 records of documented occurrence [8]. There have apparently been no major recent range expansions or contractions, either in Wyoming or elsewhere in its range, although data are lacking.

Habitat:
The Olive-backed Pocket Mouse is found in a variety of arid and semiarid upland habitats, generally with a large grass component, sparse vegetation, and loose sandy to clayey soils that accommodate tunnel construction [3]. Although commonly associated with relatively open grasslands, it can also occupy farmland, grassy rock outcroppings, arid shrublands, and semi-wooded habitat [3, 9]. In a survey of rodents in eastern Wyoming, Olive-backed Pocket Mouse only occurred in a grassland site dominated by blue grama (*Bouteloua gracilis*) and needle and thread grass (*Stipa comata*), on loamy-sand soil, and having less than 40% bare ground [10]. Habitat associations in other portions of Wyoming are poorly understood. Olive-backed Pocket Mouse lives in burrows year round, becoming almost entirely fossorial during winter [3].

Phenology:
Olive-backed Pocket Mouse can breed from April to August, with duration of the breeding season and number of litters produced per year varying with location and inter-annual weather patterns [3]. Litters of roughly 4 to 6 young are born after a one-month gestation period. Olive-backed Pocket Mouse becomes almost entirely fossorial during winter, but there is some confusion regarding over-winter habits. Some sources suggest hibernation [9], while others report continued activity [3, 6]. Alternating periods of winter torpor and activity is perhaps most likely, with mice feeding on food cached in their burrow complexes during periods of arousal.

Diet:
Olive-backed Pocket Mouse is largely granivorous, feeding on wide variety of small seeds [6], although it may also consume green vegetation and invertebrates [11]. Seeds are gathered in cheek pockets and cached within the burrow complex [3].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: UNCOMMON
Although a fairly widespread species of the Great Plains and Rocky Mountain front, densities of the Olive-backed Pocket Mouse are generally low throughout its range, with studies reporting from 0.62 to 4.00 individuals per ha [3]. In Wyoming, Olive-backed Pocket Mouse abundance is largely unknown. There are reported occurrences from many of Wyoming's basins, but no systematic surveys have been conducted for the species across its purported range in the state. Local small mammal surveys in Wyoming have generally reported very low capture rates of Olive-backed Pocket Mouse, suggesting it is relatively rare [6, 10, 12], although it is not clear if this reflects true rarity or could be the result of low capture probability. A recent study using occurrence of small mammal remains in owl pellets suggests that Olive-backed Pocket Mouse

was the 5th most abundant small mammal in a study in the Canadian Great Plains, but still only represented 2–5% of specimens identified [13]. Based on accumulated opportunistic data, Olive-backed Pocket Mouse is assumed to be relatively widely distributed in Wyoming and to occur at relatively low densities.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
No information is available regarding population trends of Olive-backed Pocket Mouse anywhere within its range.

Intrinsic Vulnerability:
LOW VULNERABILITY
Olive-backed Pocket Mouse has slightly lower fecundity compared to other small mammal species, producing one or two litters of 4–6 young per year [3, 9]. Although occurring in a variety of lowland habitat types, evidence from the literature suggests that Olive-backed Pocket Mouse may be sparsely distributed and occur at low densities. It is thought that the distributions of several species of pocket mouse, including Olive-backed Pocket Mouse, are limited by interspecific competition [3].

Extrinsic Stressors:
MODERATELY STRESSED
Threats to Olive-backed Pocket Mouse in Wyoming are largely speculative. It may be impacted by invasive species, as suggested by studies of other pocket mice that occurred at lower abundance at sites that had undergone invasions of nonnative plants [14]. Grasslands across the world, including Wyoming, have undergone similar invasions of nonnative plants. Habitats within Olive-backed Pocket Mouse range in Wyoming continue to be affected by traditional and renewable energy development, but it is unknown how these activities affect the species.

KEY ACTIVITIES IN WYOMING

The Wyoming Game and Fish Department (WGFD) has recently funded three studies relating (directly or indirectly) to Olive-backed Pocket Mouse in Wyoming. First, the Wyoming Cooperative Fish and Wildlife Research Unit completed a study of small mammals in sagebrush steppe habitats in southwestern Wyoming in 2011. This study captured a single Olive-backed Pocket Mouse near Pinedale, slightly outside the previously known Wyoming distribution [15]. Second, from 2013–2015 the Wyoming Cooperative Fish and Wildlife Research Unit evaluated the impact of Cheatgrass (*Bromus tectorum*) on small mammal communities in Thunder Basin National Grassland [16]. Third, the WYNDD initiated a study in 2015 to refine the distribution of several rare small mammals in the state, including Olive-backed Pocket Mouse. The goals of this project are to develop pocket mouse survey protocols, determine occupancy, and evaluate habitat, distribution, and threats from energy development to pocket mice. It has an expected completion date in 2017 [17, 18].

ECOLOGICAL INFORMATION NEEDS

Assessment of Olive-backed Pocket Mouse status in Wyoming is hampered by limited information regarding distribution, habitat use, abundance, and population trends. Improved distribution and habitat information are necessary to develop refined estimates of potential impact from development activities across Wyoming's basins. Estimates of abundance and occupancy rates are important to establish an accurate conservation rank and as a baseline for eventual population monitoring that can be used to assess trends over time.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Although the Olive-backed Pocket Mouse is likely widespread throughout Wyoming, very little is known regarding trends, density, and limiting factors. Consequently, priorities in Wyoming in the short-term will focus on addressing these data deficiencies. Of particular importance are data on habitat requirements, distribution, population status, and limiting factors, which will ultimately be used to develop management and conservation recommendations.

CONTRIBUTORS

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Figure 1: Olive-backed Pocket Mouse in Natrona County, Wyoming. (Photo courtesy of Kristina M. Harkins)

Figure 2: North American range of *Perognathus fasciatus*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Olive-backed Pocket Mouse habitat in Campbell County, Wyoming. (Photo courtesy of Kristina M. Harkins)

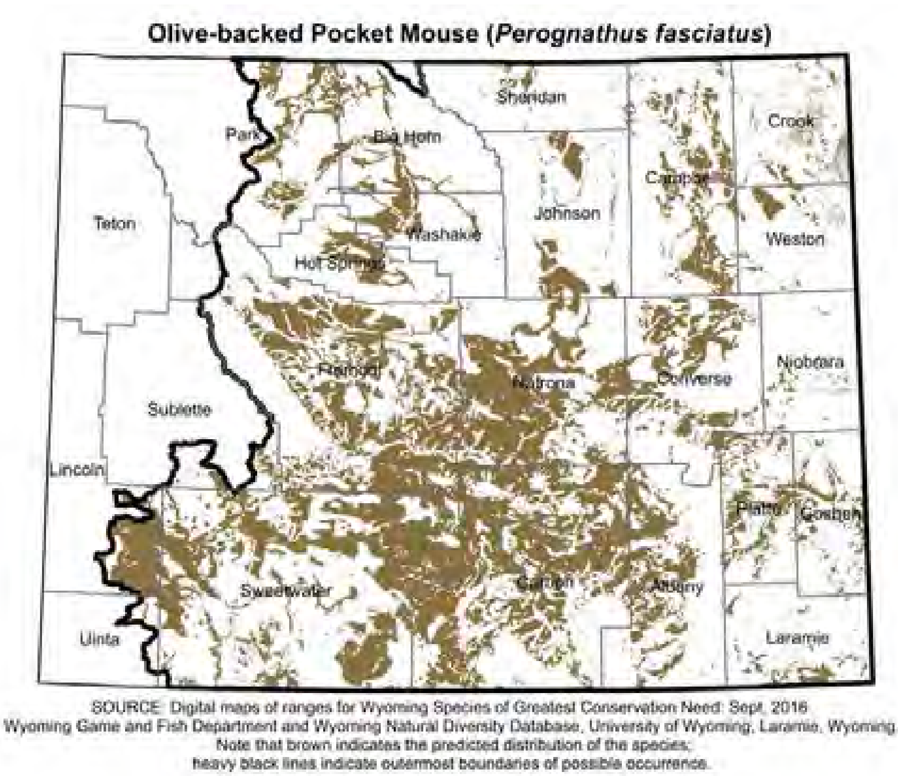

Figure 4: Range and predicted distribution of *Perognathus fasciatus* in Wyoming.

Figure 5: Range of *Perognathus fasciatus* subspecies; *P. f. fasciatus* in red and *P. f. callistus* in blue. (Overall range from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia. Sub-specific boundaries adapted from: Manning, R. W., and Jones Jr., J. K. (1988) *Perognathus fasciatus*, *Mammalian Species 303*, 1-4.)

Pallid Bat

Antrozous pallidus

REGULATORY STATUS

USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G4, S2S3
    Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS

The Wyoming Natural Diversity Database (WYNDD) has assigned Pallid Bat (*Antrozous pallidus*) a state conservation rank ranging from S2 (Imperiled) to S3 (Vulnerable) because of uncertainty about the species' abundance and population trends in Wyoming.

NATURAL HISTORY

Taxonomy:

Many authors recognize six or seven subspecies of Pallid Bat based on morphological variation across their range [1, 2]. Following these subspecific designations, only *A. p. pallidus* occurs in Wyoming [3]. Recent molecular analyses suggest that Pallid Bat falls into three genetically differentiated groups across the specie's range. However, taxonomy has not been modified based on these findings [4, 5].

Description:

Pallid Bat is identifiable in the field and is large among bats in Wyoming. Dorsal pelage is light brown to pale yellow with hairs lighter at the base than at the tip. Ventral pelage is lighter and may be nearly white [2]. Wing and tail membranes are pinkish-brown. The ears are long (25–33 mm), translucent light pink in color, and completely separate at the base [2, 3, 6]. The tragus is long and pointed, extending at least half the length of the ear [2]. The snout is blunt with the pararhinal gland forming two, low-profile lumps on the top. Females may be slightly larger than males but are otherwise identical in appearance [2]. Pallid Bat is easily differentiated from other long-eared bats that occur in Wyoming; Townsend's Big-eared Bat (*Corynorhinus townsendii*) has longer ears that meet at the base, and Spotted Bat (*Euderma maculatum*) has black dorsal pelage with three white spots.

Distribution & Range:

Pallid Bat is widely distributed across arid habitats in southwestern and western North America, from central Mexico north to far southern British Columbia. An isolated subspecies is endemic to Cuba [2]. Wyoming is on the far northwestern edge of the species' distribution, but Pallid Bat is found across most of the basins in the state with the exception of the Powder River Basin in northeastern Wyoming [6]. Confirmed breeding has been documented in just 1 of the 28 latitude/longitude degree blocks in the state in northcentral Wyoming [7].

Habitat:
Pallid Bat is typically associated with arid deserts, grasslands, and shrublands [2, 8]. The species has also been documented in low abundances within coniferous forests [2]. Within these habitats, Pallid Bat is generally found in the vicinity of rocky outcrops or cliffs. In summer, these rocky features are used as day roosts, where Pallid Bat congregates in small colonies in cracks and crevices. Use of other roost structures have been noted, including caves, mines, tree cavities, and human structures [2]. Roosts or hibernation sites used in winter are largely unknown [8].

Phenology:
The phenology of Pallid Bat is poorly understood in general, but is likely variable across its range depending upon elevation and latitude. Copulation likely occurs in late fall or early winter (i.e., October to December) [2]. Fertilization of the egg is delayed until spring. One or two altricial pups are born about nine weeks following fertilization. Young are volant around 40 days after birth. The species is assumed to hibernate in winter across its range, but timing and duration of hibernation are entirely unknown [2].

Diet:
Pallid Bat is a dietary generalist, feeding by gleaning prey items from the ground and vegetation. The majority of the diet is comprised of large arthropods such as scorpions, crickets, and beetles [2]. Vertebrate prey including small lizards and small mammals comprise approximately 25% of the diet [2]. Pallid Bat has also been documented opportunistically feeding on nectar pooled in flowers of Cardon Cactus (*Pachycereus pringlei*) [9].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: UNCOMMON
There are no estimates of abundance for Pallid Bat in Wyoming.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
There are no population trend estimates available for Pallid Bat in Wyoming. Local extirpations have been noted at a number of sites in central Arizona, but it is unknown if similar patterns have occurred in other portions of Pallid Bat range, including Wyoming [10].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Pallid Bat is moderately vulnerable to extrinsic stressors in Wyoming. Habitat use tends to be broad, although the availability of cliffs and rocky outcrops are limited landscape features. Pallid Bat is a gregarious species, frequently congregating in large groups of up to 100 individuals at day roosts [2, 11]. Females and juveniles congregate in maternity colonies and, unlike most bat species, males also roost together. Because Pallid Bat congregates in large numbers at hibernacula and other roost sites, regional populations are vulnerable to single catastrophic

events at these sites. The species has low fecundity, with females giving birth to one or two pups per year [2, 12].

Extrinsic Stressors:
MODERATELY STRESSED
Pallid Bat is sensitive to disturbance by human visitors at summer day roosts and hibernacula, and displacement from these structures has been documented [10]. This is exacerbated by the species' gregarious nature, leading to the potential displacement of a large number of individuals. All hibernating bats are sensitive to disturbance from visitors to caves and abandoned mines used as hibernacula [13]. Even a small number of short duration disturbances lead to significant increases in arousal events and subsequent energy expenditures that may lead to increased mortality of hibernating bats [14, 15]. Because Pallid Bat hibernates, it is potentially susceptible to the pathogenic fungus *Pseudogymnoascus destructans* (formerly *Geomyces destructans*) that causes White-Nose Syndrome (WNS) that was first documented in North America in 2006 [16]. Large declines of several bat species in eastern North America have resulted from WNS. Annual declines of 30 to 99% have been documented at hibernacula known to have WNS infected bats, with local extinctions of some bat species [16, 17]. As of 2016, WNS has not been documented in Wyoming [18]. It is assumed that WNS will eventually occur in in the state, but it is unknown if WNS will affect bats, including Pallid Bat, to the same degree in Wyoming as in other areas of North America.

KEY ACTIVITIES IN WYOMING

State and federal wildlife and land management agencies have taken several actions to protect bat species from WNS. The Wyoming Game and Fish Department (WGFD), along with the Wyoming Bat Working Group, developed "A strategic plan for white-nose syndrome in Wyoming" in 2011 [19]. This plan is intended to minimize the impacts of WNS once it is detected in Wyoming or adjacent states. To facilitate early detection of the disease, WGFD requires researchers to evaluate all bats captured during research activities for signs of WNS infection using the Reichard Wing-Damage Index [20], and to implement WNS decontamination protocols when handling bats or conducting hibernacula surveys. Beginning in 2012, WGFD personnel placed temperature and humidity loggers in a number of known or suspected hibernacula across Wyoming to determine if climatic conditions at these sites are favorable for growth of *P. destructans*. Preliminary results suggest that temperature and relatively humidity in known hibernacula could facilitate the growth of the fungus [21, 22]. Personnel have also begun collecting swabs of hibernating bats and hibernacula substrates in an effort to assist with early detection of *P. destructans*. Collectively, WGFD and WYNDD have conducted statewide systematic and project-specific surveys for bats since 2008, with numerous, smaller scale projects occurring prior to this time. Acoustic surveys in southeastern Wyoming resulted in 71 detections of Pallid Bats [23]. Beginning in 2012, WGFD conducted a bat inventory of cliff and canyon habitats across Wyoming. A total of 41 captures and 154 acoustic recordings of Pallid Bat were made from 2012-2015 [24-27]. In 2012 and 2013, WYNDD conducted bat surveys across southern Wyoming and captured 7 Pallid Bats and made 39 recordings across these two years [28, 29].

ECOLOGICAL INFORMATION NEEDS

Pallid Bat in the wild remains one of the least studied bat species, especially in the northern portions of its range, which includes Wyoming [30]. Current subspecific taxonomy is based largely on morphological variation and does not align with recent genetic evidence [4-6]. Habitat associations and use are poorly understood in general but especially in Wyoming. This is particularly true for use and selection of summer day roosts and winter hibernacula. Similarly, phenology is very poorly understood. Estimates of abundance and population trends are unknown in Wyoming but important in evaluating the status of the species in the face of intrinsic and extrinsic factors specific to Pallid Bat.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Very little is known about population trends and roosting locations of Pallid Bat in Wyoming. Although WNS has not been detected in the state, the westward progression of the fungus and recent confirmation of WNS in Washington necessitates the need for these data before it reaches Wyoming. Consequently, priorities will focus on locating and monitoring hibernacula as well as other roost locations (e.g., maternity roosts) to monitor populations and recommend and assist with bat-friendly closures of important roosts. In 2016, WGFD began a project in collaboration with the state of Nebraska to evaluate occurrence, abundance, and reproductive status of bats in eastern Wyoming, which represents an important zone of overlap between eastern and western bat species, including Pallid Bat. Mist-net surveys will continue to implement WNS protocols and assessment in an effort to assist with early detection should the disease reach the state. Habitat assessments will be incorporated with survey efforts to better understand what influences species presence and distribution at a finer scale. In addition to inventory projects, WGFD, in collaboration with the Wyoming Bat Working Group and other state-wide partners, will implement the North American Bat Monitoring Program that will use acoustic monitoring to assist with state and region-wide assessment of bat trends. Additional priorities will include updating and revising the Conservation Plan for Bats in Wyoming and the Strategic Plan for WNS in Wyoming. Finally, outreach and collaboration with private landowners will remain a priority to ensure conservation of bats and bat habitat.

CONTRIBUTORS

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Figure 1: Adult Pallid Bat in flight. (Photo courtesy of Robert J. Luce)

Figure 2: North American range of *Antrozous pallidus*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Arid shrubland in extreme southern Sweetwater County, Wyoming in the vicinity of rock outcroppings typical of habitat occupied by Pallid Bat. (Photo courtesy of Ian M. Abernethy)

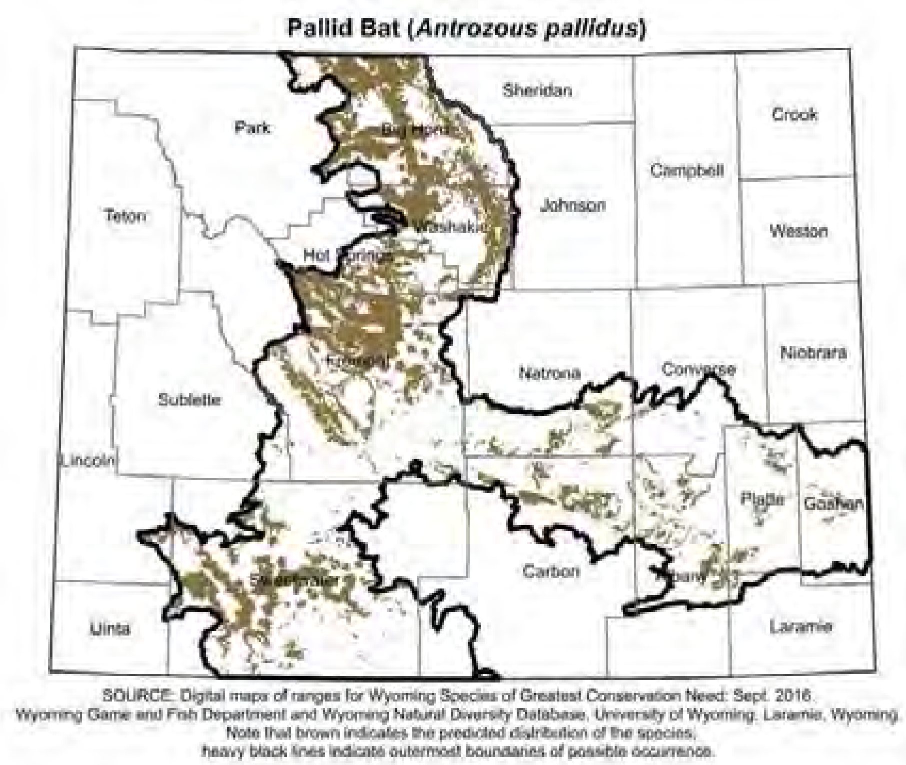

Figure 4: Range and predicted distribution of *Antrozous pallidus* in Wyoming.

Figure 5: Ventral view of a female Pallid Bat captured in Wyoming. (Photo courtesy of Becky Abel, WGFD)

Piñon Deermouse

Peromyscus truei

REGULATORY STATUS

USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G5, S1
Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS

Piñon Deermouse (*Peromyscus truei*) has no additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:

There are between 11 and 15 recognized subspecies of Piñon Deermouse, but only *P. t. truei* is found in Wyoming [1-4].

Description:

Identification of Piñon Deermouse is possible in the field. Piñon Deermouse is a medium-sized *Peromyscus* with long, silky hair; large, naked ears; white feet; and a bi-colored, hair-covered tail with longer hairs at the end [2-5]. Ear size, tail length, and pelage color vary geographically, but in Wyoming Piñon Deermouse has large ears, a tail that is slightly longer than the head and body combined, and grayish-brown dorsal hair [2, 4, 6]. The underbelly hairs are white with gray at the base [4, 5]. Males and females are comparable in size [3, 4]. Adults weigh between 25–28 g and can reach total lengths of 171–190 mm. Tail, hind foot, and ear length ranges from 80–120 mm, 22–25 mm, and 20–26 mm, respectively [4]. Three other species of *Peromyscus* are found in Wyoming, but only Canyon Deermouse (*P. crinitus*) and North American Deermouse (*P. maniculatus*) have distributions that overlap with Piñon Deermouse in the state [4]. Piñon Deermouse can be distinguished from both Canyon Deermouse and North American Deermouse by its larger, hairless ears, and from North American Deermouse by its longer tail [4].

Distribution & Range:

The distribution of Piñon Deermouse extends from north-central Oregon south along the Pacific Coast to the northern Baja Peninsula, central mainland Mexico as far south as Oaxaca, and as far east as western Kansas [2, 7]. Piñon Deermouse is a peripheral resident in Wyoming and is limited to the far southwestern part of the state [4, 8]. Most of the existing habitat for this species in

Wyoming is likely found near Flaming Gorge Reservoir in Sweetwater County [4]. Confirmed breeding has been documented in just 1 of 28 latitude/longitude degree blocks in the state [8].

Habitat:
Piñon Deermouse is most commonly associated with arid and semi-arid, rocky, piñon-juniper woodlands and shrublands, but can also be found in a variety of other habitat types across its continental distribution [2, 3, 5, 9-13]. In Wyoming, Piñon Deermouse is found in rocky slope and cliff habitat in woodlands dominated by Utah Juniper (*Juniperus osteosperma*) [4, 14, 15]. Areas with high canopy cover and low shrub cover away from woodland edges provide important habitat [14]. Most nests are formed from shredded juniper bark and grass in the hollow cavity of a juniper tree, although rock crevices may occasionally be used [4].

Phenology:
Piñon Deermouse is nocturnal and active all year [3, 5]. Females are seasonally polyestrous, typically producing 2–9 litters per year starting in the spring [4, 5]. Litter size can range from 2–6 with litters of 3 or 4 being most common, and gestation lasts 25–27 days [3, 4, 16]. Females nurse young for up to 30 days, and female offspring are able to reproduce at the age of 2 months [4, 5].

Diet:
Piñon Deermouse is omnivorous and consumes a variety of food items depending on availability, including juniper seeds and berries; seeds from other trees, shrubs, cacti, grasses, and forbs; mushrooms; vegetation; and insects [3, 4, 13]. This species is known to scatter-hoard seeds and cache seeds in burrow larders [17, 18]. Piñon Deermouse obtains most water needed for survival from food [4].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
There are no robust estimates of abundance available for Piñon Deermouse in Wyoming. The species has a statewide abundance rank of VERY RARE and appears to be rare even within suitable environments in the occupied area [8]. Piñon Deermouse lost historic habitat in Wyoming to flooding when the Green River was dammed to create Flaming Gorge Reservoir in 1962 [4, 14]. Research conducted in 1998 and 1999 recorded just 19 individuals across 5 of 14 rocky slope and cliff habitat sites sampled in juniper woodlands east of Flaming Gorge Reservoir for an overall capture rate of 0.008 captures per trap night throughout suitable habitat [14, 19]. Abundance in Wyoming seems to be much lower than nearby populations in northeastern Utah [19].

Population Trends:
Historic: MODERATE DECLINE
Recent: UNKNOWN
Because of its restricted distribution in Wyoming, Piñon Deermouse likely experienced historic moderate population declines due to the aforementioned habitat loss following the creation of Flaming Gorge Reservoir half a century ago. However, recent population trends for this species in Wyoming are unknown.

Intrinsic Vulnerability:
HIGH VULNERABILITY
Piñon Deermouse has high intrinsic vulnerability in Wyoming due to very low abundance, a narrow range of habitat requirements within a very restricted distribution, and limited dispersal ability. This species has high fecundity but is likely to be affected by any natural or anthropogenic disturbances to occupied habitat within its already restricted distribution. The environment of Flaming Gorge is unique in Wyoming, and supports wildlife species, including Piñon Deermouse, that are not found anywhere else in the state. Therefore, this species has little opportunity for range expansion within the state, and would likely have an increased risk of extirpation should disturbance or loss of existing habitat occur.

Extrinsic Stressors:
MODERATELY STRESSED
Loss and degradation of existing habitat as well as disturbance, both natural and anthropogenic, could negatively impact Piñon Deermouse in Wyoming. Rocky habitats in southwestern Wyoming are threatened by potential oil shale and other energy development, as well as exposure to anthropogenic disturbance from recreational activities [15, 20]. Furthermore, juniper woodlands are potentially vulnerable to changes in fire regime; invasive species such as Cheatgrass (*Bromus tectorum*); drought and climate change; habitat fragmentation; and human disturbance, including juniper removal and thinning programs [15]. However, recent expansion of juniper woodlands into shrub-grasslands might provide additional habitat that could offset some of these threats. Piñon Deermouse may be exposed to some anthropogenic disturbance within its Wyoming distribution, and the species has been shown to avoid habitats with high grass cover including those dominated by Cheatgrass [21, 22]. Despite being adapted to arid environments, Piñon Deermouse can experience abbreviated breeding seasons and lower breeding rates during severe drought conditions, which may lead to decreased population densities in drought-affected areas [16, 23]. The species has experienced geographic and elevational range shifts in parts of its distribution, which may be attributed to climate change and increased temperatures [24-26]. Currently, it is not known how these potential extrinsic stressors could be impacting Piñon Deermouse in Wyoming.

KEY ACTIVITIES IN WYOMING

Piñon Deermouse is classified as a Species of Greatest Conservation Need by the Wyoming Game and Fish Department (WGFD). In 1998 and 1999, the WGFD funded a University of Wyoming graduate research project that examined habitat use for three rare, small mammal species in southwestern Wyoming, including Piñon Deermouse [14]. In 2016, the WGFD will begin a two-year project designed to collect crucial data on the distribution, relative abundance, and habitat use of piñon-juniper obligate species, including Piñon Deermouse, in the woodlands of southwestern Wyoming.

ECOLOGICAL INFORMATION NEEDS

Little is known about the current status of Piñon Deermouse in Wyoming. This species would benefit from research to determine its actual distribution, current abundance, habitat use, reproductive rates, and basic life history in Wyoming. Additionally, the distribution of juniper forests in Wyoming is far vaster than the distribution of Piñon Deermouse, and a better understanding of habitat use and requirements at this northernmost range boundary is needed, including a better understanding of the current range boundary for both the species as well as the juniper habitat on which it depends. Perhaps most importantly, potential extrinsic stressors should be identified within the species' limited distribution to ensure the persistence of available habitat for this species in Wyoming.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Little is known about Piñon Deermouse in Wyoming. Consequently, management priorities for the species in the short-term will focus on addressing these data deficiencies. Of particular importance are data on presence, distribution, population status and trends, and the impact of extrinsic threats. Upcoming projects will address these needs, including evaluating habitat requirements and potential changes in presence and distribution in response to juniper removal and juniper expansion. These results will be used to develop management and conservation recommendations as well as develop monitoring protocols to establish trends.

CONTRIBUTORS

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Figure 1: A recently released, adult Piñon Deermouse (with ear tag) that was captured in Flaming Gorge, Sweetwater County, Wyoming (Photo courtesy of Jessica Grant, WGFD)

Figure 2: North American range of *Peromyscus truei*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Rocky juniper woodland habitat east of Flaming Gorge Reservoir in Sweetwater County, Wyoming. (Photo courtesy of Kaylan A. Hubbard)

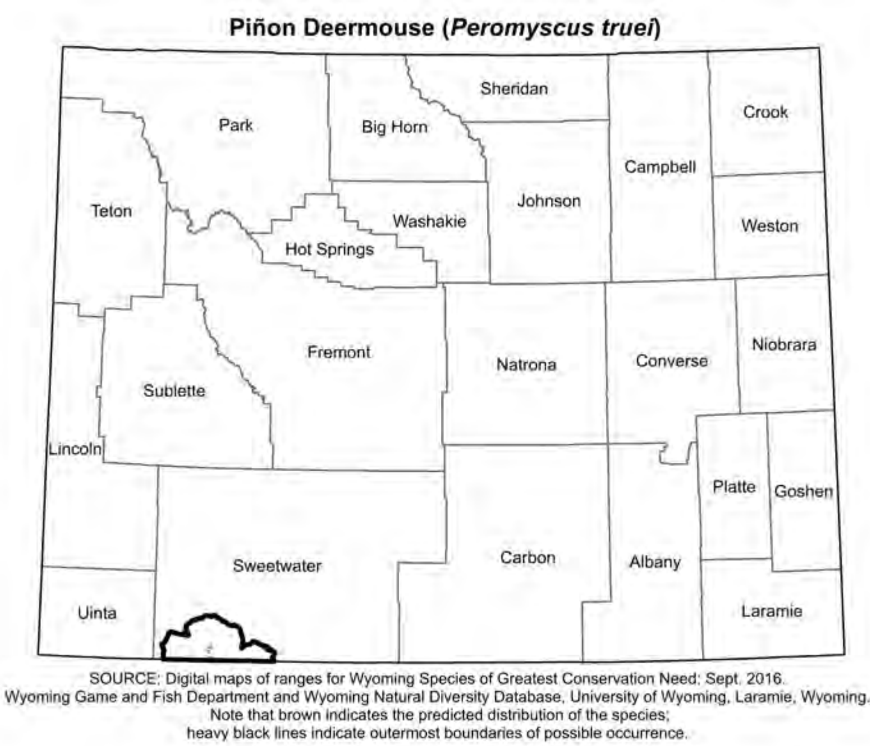

Figure 4: Range and predicted distribution of *Peromyscus truei* in Wyoming.

Plains Harvest Mouse

Reithrodontomys montanus

Regulatory Status

USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

Conservation Ranks

USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G5, S3S5
Wyoming Contribution: LOW
IUCN: Least Concern

Status and Rank Comments

The Wyoming Natural Diversity Database has assigned Plains Harvest Mouse (*Reithrodontomys montanus*) a state conservation rank ranging from S3 (Vulnerable) to S5 (Secure) because of uncertainty about the abundance, proportion of range occupied, and population trends for this species in Wyoming.

Natural History

Taxonomy:

There are three recognized subspecies of Plains Harvest Mouse, but only *R. m. albescens* is found in Wyoming [1-4].

Description:

It is difficult to accurately identify Plains Harvest Mouse in the field where it is sympatric with Western Harvest Mouse (*R. megalotis*) [1-3]. Dorsally, Plains Harvest Mouse is grayish-brown and has an indistinct mid-dorsal stripe of darker hair. The venter is whitish. The tail has a dark dorsal stripe and is typically shorter (48–55 mm) than the combined length of the head and body [2-4]. The sexes are similar in size and appearance [3, 4]; adults weigh between 10–13 g and have a total length of 105–143 mm [2]. Hind foot and ear length ranges from 14–20 mm and 12–13 mm, respectively [2]. Although numerous metrics have been suggested for distinguishing Plains Harvest Mouse from Western Harvest Mouse (e.g., body size, dorsal pelage color, tail color, tail length, skull measurements, molar characteristics), considerable uncertainty remains about the ability of these metrics to accurately differentiate the two species [1, 3, 5, 6]. Multiple authors suggest that tail length differs between the two species, with Western Harvest Mouse generally having a longer tail (56–73 mm) that is at least as long as the head and body [2-4]. Plains Harvest Mouse and other *Reithrodontomys* spp. can be distinguished from *Peromyscus* spp. by their upper incisors, which each have one anterior longitudinal grove [1-4].

Distribution & Range:
A majority of the continental distribution of Plains Harvest Mouse is restricted to the Great Plains of the central United States, extending as far south as northern Mexico [7]. Wyoming is on the northwestern periphery of the core distribution of this species, where Plains Harvest Mouse is found in grasslands in the eastern third of the state. Confirmed or suspected breeding has been documented in 5 of 28 latitude/longitude degree blocks, all in far eastern Wyoming [8].

Habitat:
Plains Harvest Mouse is found in a variety of natural, disturbed, managed, fragmented, and reclaimed grassland environments throughout its range [3, 4, 9-24]. In Wyoming, this species inhabits short-grass, mixed-grass, and sagebrush (*Artemisia* spp.) grassland habitats [2, 3]. Vegetation structure and soil type may be more important characteristics of Plains Harvest Mouse habitat than dominant grass species [3, 4]. Plains Harvest Mouse is most abundant in short-grass environments (2.5–25 cm), with a high percentage of grass cover (> 60%), and loamy sand soil [1-4]. Nests are small, woven spheres of grass with a single opening, which are constructed in dense vegetation, under logs, in rock crevices or discarded man-made objects, or below ground in burrows [2-4].

Phenology:
The breeding habits and life history of Plains Harvest Mouse in Wyoming are not well known. This nocturnal, polyestrous species does not hibernate and may produce multiple litters a year beginning in the late winter [2, 3]. Litters of 3–7 young are born after a 21-day gestation period. Young are altricial at birth but mature quickly; they are weaned after 2 weeks, ready to leave the nest after 3–4 weeks, and are sexually mature by the age of 2 months [2, 3].

Diet:
Plains Harvest Mouse primarily consumes a variety of seeds, as well as flowers, fruits, berries, green plant material, and insects [1-4]. This species is known to cache food [2].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: UNCOMMON
Despite having a widespread continental distribution, capture studies often report relatively few detections of Plains Harvest Mouse compared to other sympatric small mammal species across a variety of natural and anthropogenic grassland habitats [10, 15-20, 23, 24]. For example, only 2% of all small mammal captures in a recent study conducted in Thunder Basin National Grassland were harvest mice; Plains and Western Harvest Mouse were pooled because of low detections and difficulty with species differentiation [25]. Likewise, *Reithrodontomys* spp. accounted for 6% of captures in statewide survey for small mammals in Wyoming's basins in 2015 [26, 27]. There are no robust estimates of abundance available for Plains Harvest Mouse in Wyoming. The species has a statewide abundance rank of UNCOMMON and appears to be rare within suitable environments in the occupied area [8].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends for Plains Harvest Mouse in Wyoming are unknown.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Plains Harvest Mouse has moderate intrinsic vulnerability in Wyoming due to low density within a narrow range of habitat types in the state. However, this species has the potential for high fecundity and a demonstrated ability to inhabit a variety of disturbed and fragmented habitats in other parts of its range, which may reduce its vulnerability to potential extrinsic stressors in Wyoming.

Extrinsic Stressors:
SLIGHLTY STRESSED
Primary potential extrinsic stressors to Plains Harvest Mouse in Wyoming are loss or degradation of habitat from natural or anthropogenic disturbances. Grassland environments in the state are vulnerable to development for energy, infrastructure, and agriculture; invasive plant species such as Cheatgrass (*Bromus tectorum*) and Canada Thistle (*Cirsium arvense*); anthropogenic disturbance from off-road recreational activities; altered fire and grazing regimes; and drought and climate change [8]. Harvest mouse occupancy was positively correlated with Cheatgrass cover in Thunder Basin National Grassland, potentially due to their omnivorous diet and preference for closed habitats [25]. In other parts of its continental distribution Plains Harvest Mouse has been detected in or adjacent to environments altered or fragmented by various types of agriculture [9, 10, 15-18, 20, 21], prescribed burning [11, 19], mining [12, 23], energy development [24], and roads [13, 14, 21]. Although this species appears to tolerate some habitat disturbance, it is not currently known how potential extrinsic stressors could impact Plains Harvest Mouse in Wyoming.

KEY ACTIVITIES IN WYOMING

Plains Harvest Mouse is classified as a Species of Greatest Conservation Need by the Wyoming Game and Fish Department (WGFD). A number of projects have recently been funded to evaluate the impact of extrinsic stressors on small mammals, including Plains Harvest Mouse. From 2013–2015, the WGFD funded a project at the Wyoming Cooperative Fish and Wildlife Research Unit to evaluate the impact of Cheatgrass on small mammal communities in Thunder Basin National Grassland [25]. In 2015, the University of Wyoming initiated a two-year graduate research project to better understand the distribution, occupancy, habitat, and diet partitioning of small mammals in the state, including Plains Harvest Mouse, through statewide surveys of pocket mice and other small mammals. Plains Harvest Mouse was detected at a number of sites during the first season of trapping in 2015, and this project is already providing valuable information on the distribution and habitat associations of this species in Wyoming [26, 27].

ECOLOGICAL INFORMATION NEEDS

Little is known about the natural history or reproductive habits of Plains Harvest Mouse in Wyoming. This species will benefit from current ongoing research to determine its abundance and distribution in the state. Further research is needed to evaluate how this species may respond to natural and anthropogenic disturbances in Wyoming.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Recent management activities have focused on funding research projects to improve understanding of distribution, habitat, and impact of extrinsic stressors on small mammals, including Plains Harvest Mouse, and on-going projects will continue to investigate these management questions. Of particular importance are data on distribution, presence and abundance, population status and trends, and the impact of potential threats, including the degree and impact of loss and degradation of habitat, all of which will ultimately be used to develop management and conservation recommendations.

CONTRIBUTORS

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Figure 1: A harvest mouse (*Reithrodontomys* spp.) captured in Goshen County, Wyoming. (Photo courtesy of Maddy Pfaff)

Figure 2: North American range of *Reithrodontomys montanus*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Plains Harvest Mouse habitat in Campbell County, Wyoming. (Photo courtesy of Kristina M. Harkins)

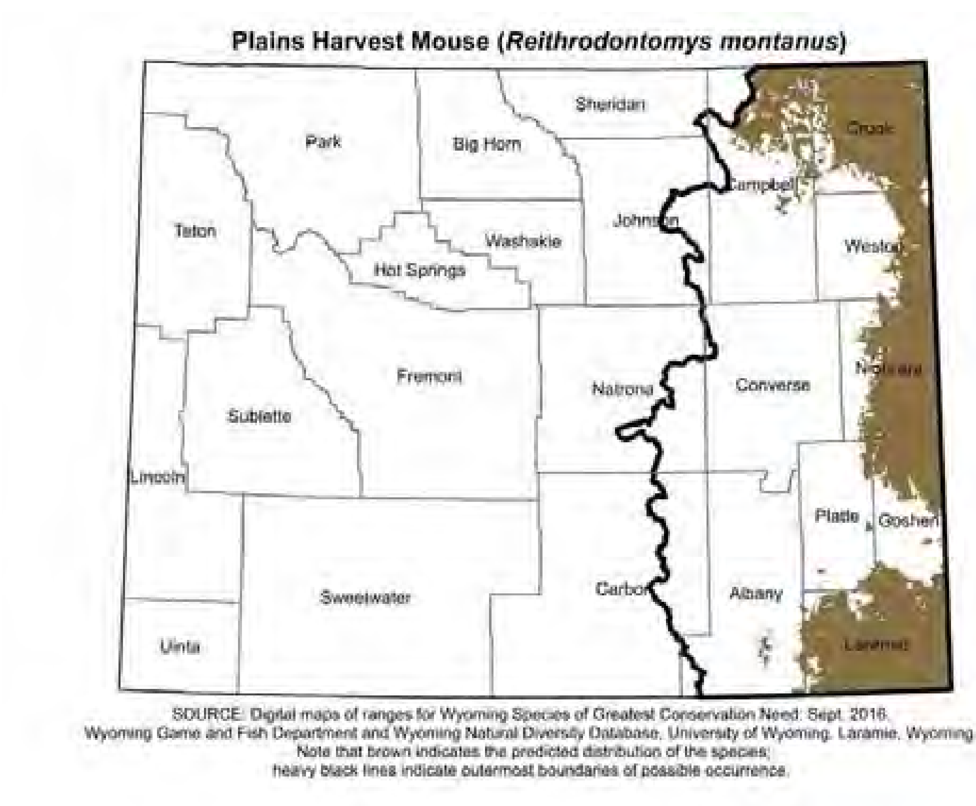

Figure 4: Range and predicted distribution of *Reithrodontomys montanus* in Wyoming.

Plains Pocket Mouse
Perognathus flavescens

REGULATORY STATUS
USFWS: No special status
USFS R2: No special status
UWFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS
USFWS: No special status
WGFD: NSSU (U), Tier III
WYNDD: G5, S2S3
Wyoming contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS
Plains Pocket Mouse (*Perognathus flavescens*) is assigned a range of state conservation ranks by the Wyoming Natural Diversity Database (WYNDD) due to uncertainty concerning the abundance, population trends, amount of occupied habitat, and extent of extrinsic stressors in Wyoming.

NATURAL HISTORY

Taxonomy:
Plains Pocket Mouse is a member of the family Heteromyidae, which includes the pocket mice and kangaroo rats [1]. There are 8 recognized subspecies of *P. flavescens*, but only *P. f. flavescens* occurs in Wyoming [2, 3]. One of the subspecies from the southwestern United States (*P. f. apache)* is sometimes viewed as a full species (*P. apache*) [4], but most authors now consider it a subspecies of *P. flavescens,* based in part on molecular phylogeny suggesting that *P. flavescens* and *P. apache* form a clade relative to *P. fasciatus* [5, 6].

Description:
Plains Pocket Mouse (like other pocket mice) is a small-bodied rodent with a relatively long tail and visible, external, fur-lined cheek pouches. It can be identified in the field, but positive identification can be difficult as it is similar in appearance to other sympatric congeners. Pelage color varies substantially across *P. flavescens* range, potentially driven by environmental characteristics such as soil color (e.g., those on black volcanic sands in Arizona have very dark fir) [5]. The tail is relatively short for a pocket mouse (i.e., 86–97% of the length of the head and body) [7] and is nonpenicillate (i.e., does not end in a tuft of hair) [2]. Plains Pocket Mouse is similar to Olive-Backed Pocket Mouse (*P. fasciatus*), which generally has darker, olivaceous dorsal pelage, and Silky Pocket Mouse (*P. flavus*), which has more conspicuous post-auricular patches [2].

Distribution & Range:
Wyoming is on the northwestern periphery of Plains Pocket Mouse range and represents < 5% of the species global range. It is thought to occur mainly in the southeastern portion of the state, but there are a few records from as far north as the southern Powder River Basin. There has been no apparent shift in the species range in Wyoming or globally, although there is limited formal survey data with which to confirm this. However, small mammal surveys across Wyoming's basins during 2015 recorded *P. flavescens* at only one of 14 sites within the species' purported range in Wyoming [8].

Habitat:
Plains Pocket Mouse is generally confined to areas of sandy or sandy-loam soils, whereas *P. flavus* and *P. fasciatus* can be found in drier and harder soils [2, 9]. It typically associates with either grassland or shrubland habitats, although it may also occur in agricultural fields [10]. In Wyoming, it seems to inhabit sand dunes, sagebrush-grassland, yucca-grassland, and grama grassland and generally occurs in areas with sandy or sandy-loam soil, sparse vegetation, and where the height of the dominant vegetation > 50 cm [11]. Plains Pocket Mouse burrows contain separate nesting and food storage areas. Burrows are generally plugged, and may have small entrance mounds (~ 10 cm diameter) that lead to tunnels < 2 cm diameter [2]. Activity is often restricted to areas near burrows, which contributes to small home ranges (0.02–0.05 ha) [2].

Phenology:
Plains Pocket Mouse is active from early April through late October over much of its range. It is considered a facultative hibernator, being torpid much of the winter and awakening periodically to feed on food cached in the burrow [2]. Breeding occurs from April to September, depending on location, and females often bear 2 litters of 2–7 young (usually 4–5) per year after a gestation of 21–25 days [2, 12]. Plains Pocket Mouse is largely nocturnal, only being active above ground at night, with activity being curtailed by moonlight [2].

Diet:
Plains Pocket Mouse is considered a granivore and, like other pocket mice, seeds are gathered in cheek pouches and cached within burrows [2]. Seeds of grasses seem to be important food sources, although seeds from a variety of forbs are also collected. Insects may be consumed when they are abundant or when seeds are scarce [5].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD BUT PATCHY
Wyoming: UNCOMMON
There are no quantitative estimates of abundance for Plains Pocket Mouse in Wyoming or elsewhere. Relatively low capture rates on sites were they occur suggests that they may be fairly uncommon within their range in Wyoming [8]. Range-wide, the International Union for Conservation of Nature (IUCN) considers Plains Pocket Mouse to be patchily distributed [10], which is supported by some local studies [9]. Heritage Programs consider the species secure in much of the core range, but vulnerable or imperiled in the periphery of its range, including Wyoming, due primarily to restricted distribution and relatively low population sizes. Home ranges are small (0.02–0.3 ha) and generally contain one adult per burrow [2, 13], suggesting neither the potential for unusually high or low densities.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
There are no estimates of historic or recent population trends for Plains Pocket Mouse in Wyoming, or elsewhere. Range-wide, the IUCN classifies populations of Plains Pocket Mouse as stable [10]. Although not directly applicable to Wyoming, recent surveys in Nebraska found Plains Pocket Mouse to occur in localized, disjunct populations associated with suitable soil types throughout its historic range [9].

Intrinsic Vulnerability:
LOW VULNERABILITY
Plains Pocket Mouse does not apparently exhibit reproductive restrictions that would make it vulnerable, as they produce roughly 5 offspring per litter and can produce 2 or 3 litters per year in suitable climates [2]. Although moderately specialized to sandy grasslands, thus resulting in a relatively patchy distribution, habitat choice does not appear to be so restrictive as to make Plains Pocket Mouse particularly vulnerable. Given that it is a small mammal with a relatively small home range, dispersal ability may be limited, but there is no evidence that this is biologically restrictive.

Extrinsic Stressors:
MODERATELY STRESSED
Threats to Plains Pocket Mouse in Wyoming are largely speculative. It may be impacted by invasive species, as suggested by studies of other pocket mice that occurred at lower abundance at sites that had undergone invasions of nonnative plants [14]. Grasslands across the world, including Wyoming, have undergone similar invasions of nonnative plants. Habitats within Plains Pocket Mouse range in Wyoming are affected by agriculture, including cattle grazing and conversion to cropland, but it is unknown how these activities affect the species.

KEY ACTIVITIES IN WYOMING

The Wyoming Game and Fish Department has recently funded two studies relating (directly or indirectly) to Plains Pocket Mouse in Wyoming. First, from 2013–2015 the Wyoming Cooperative Fish and Wildlife Research Unit evaluated the impact of Cheatgrass (*Bromus tectorum*) on small mammal communities in Thunder Basin National Grassland [15]. Second, WYNDD initiated a study in 2015 to refine distributions, estimate occupancy rates, and assess habitat selection for several pocket mice species in the state [8, 16]. This project has an expected completion in 2017.

ECOLOGICAL INFORMATION NEEDS

Assessment of Plains Pocket Mouse status in Wyoming is hampered by limited information regarding distribution, habitat use, abundance, and population trends. Improved distribution and habitat information are necessary to develop refined estimates of potential impacts from development activities across Wyoming's basins. Better information on how Plains Pocket Mouse responds to events that reduce grass production and seed set in shrub-grasslands, including management practices and invasive plants, would be helpful. Estimates of abundance (and/or occupancy rates) are important to establish an accurate conservation rank and as a baseline for eventual population monitoring that can be used to assess trends over time.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Plains Pocket Mouse is assigned an NSSU rank because survey data that would provide for an assessment of population status are lacking. Consequently, priorities in Wyoming in the short-term will focus on addressing these data deficiencies. Of particular importance are data on population status and trends and a more refined understanding of distribution within the state. Because of the low density and patchy distribution of Plains Pocket Mice on the landscape, acquiring these data will likely require targeted survey efforts. Additional priorities will focus on assessing limiting factors and habitat requirements, including the impact of invasive species, which will ultimately be used to develop management and conservation recommendations.

CONTRIBUTORS

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Figure 1: A Plains Pocket Mouse in Goshen County, Wyoming. (Photo courtesy of Kristina M. Harkins)

Figure 2: North American range of *Perognathus flavescens*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Plains Pocket Mouse habitat in Goshen County, Wyoming. (Photo courtesy of Kristina M. Harkins)

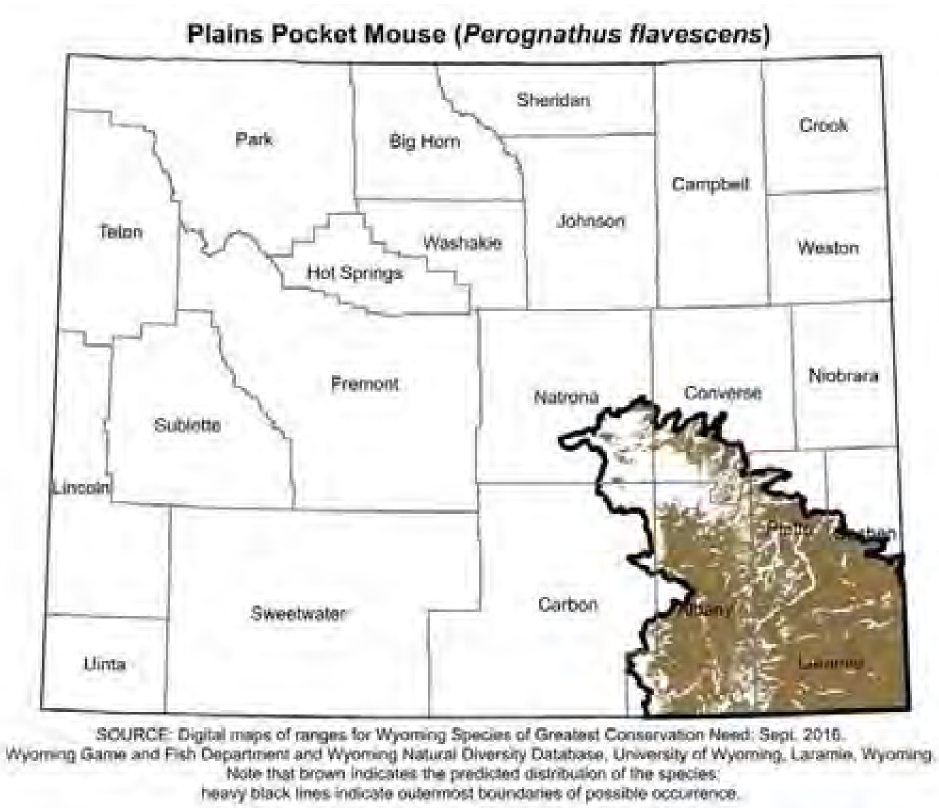

Figure 4: Range and predicted distribution of *Perognathus flavescens* in Wyoming.

Preble's Meadow Jumping Mouse

Zapus hudsonius preblei

REGULATORY STATUS

USFWS: Threatened
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: Sensitive
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G5T2, S1
    Wyoming Contribution: VERY HIGH
IUCN: Not evaluated

STATUS AND RANK COMMENTS

Preble's Meadow Jumping Mouse (*Zapus hudsonius preblei*; hereafter, Preble's) was first listed as Threatened under the Endangered Species Act (ESA) in 1998 [1]. In 2008, ESA protections were removed from populations in Wyoming, because it was determined that the subspecies was not Threatened with endangerment throughout all of its range, but Threatened status remained for populations in Colorado, which were recognized as a significant portion of the Preble's range [2]. Threatened status was reinstated for populations of Preble's in Wyoming in 2011 [3].

NATURAL HISTORY

Taxonomy:

Preble's is one of 12 subspecies of Meadow Jumping Mouse; Bear Lodge Meadow Jumping Mouse (*Z. h. campestris*) also occurs in Wyoming. There has been debate among researchers regarding the merit of historic and current subspecific designations within the species [4-6]. However, recent research supports current subspecific designations [7].

Description:

Preble's cannot be reliably distinguished from other subspecies of Meadow Jumping Mouse or from Western Jumping Mouse (*Z. princeps*) in the field. Consequently, genetic analyses are the only currently accepted method for identification [8]. In general, Meadow Jumping Mouse is a medium-sized rodent distinguished by a yellow dorsum with a thick dark stripe down the back, white venter, an exceptionally long tail, and large hind feet. Males and females are identical in appearance. Adults weigh 12–22 g, depending on season, and reach a total length of 180–220 mm. The tail comprises over half of the total length, ranging from 115–135 mm in length, and is round, sparsely haired, and bicolored. The ears are dark but edged in white. The hind feet are large (28–31 mm) and whitish-yellow. The sides have a yellow hue. Young are similar in appearance to adults but are lighter in color overall [9].

Distribution & Range:
Preble's is restricted to northeastern Colorado and southeastern Wyoming from the vicinity of the city of Colorado Springs on the east side of the Front Range of Colorado north along the Laramie Range to the vicinity of the North Platte River near Douglas, Wyoming. The subspecies is typically found at elevations between 1,420 and 2,300 m. In Wyoming, Preble's predicted range includes all or portions of 4 counties, although thus far the subspecies has only been found east of the crest of the Laramie Range [1, 8, 10]. Southeast Wyoming constitutes approximately the northern third of Preble's range.

Habitat:
Preble's is typically associated with prairie and foothill riparian habitats in areas with very dense vegetation. Specifically, shrub, grass, and woody debris cover are important microhabitat variables [11]. A dense woody overstory may also be required for high abundances of the subspecies. During the active season, Preble's are typically found near the stream bed (≤ 100 m), although they are known to range further. Upland areas adjacent to stream corridors and associated riparian vegetation are used to varying degrees based upon vegetation structure and other habitat characteristics [12, 13]. Preble's also occupies montane areas along riparian corridors in the Laramie Range [13].
Day nests are constructed of woven grass, forb, sedge, and rush, and are often associated with shrubs, trees, or decaying vegetation used to anchor the nest or provide cover [14, 15]. Typical hibernacula are underneath logs or in underground chambers in flood-safe areas of riparian zones, often at the base of woody vegetation [13]. Both subterranean maternity nests and hibernacula are typically lined with grass and leaf litter and require friable soils, as Preble's dig their own burrows [15].

Phenology:
Phenology of Preble's is assumed to be similar to that of Meadow Jumping Mouse elsewhere. In Colorado, females are typically pregnant by the third week of June and have two reproductive pulses per summer, one in July and one in August [16]. Gestation length is around 18 days [17]. Preble's are true hibernators and hibernate for approximately 210 days per year. Hibernation begins in September or October, and emergence occurs in late May or early June, with males emerging from hibernation before females [11-13, 16].

Diet:
Preble's is a dietary generalist that consumes a wide variety of invertebrates, primarily lepidopteron larvae and beetles, seeds, leaves, buds, fruits, and subterranean fungi, which may be a particularly important food item [13]. Overall, the importance of food items shifts throughout the active period and tracks vegetation green-up [18, 19].

CONSERVATION CONCERNS

Abundance:
Continental: LOCAL ENDEMIC
Wyoming: RARE
There are no estimates of abundance for Preble's range-wide or for Wyoming. The subspecies is thought to be rare in the state. In Colorado, population estimates range from 22.7 ± 7.9 to 85.6 ± 30.3 individuals per stream km. Overall capture success is 3.4 individuals per 100 trap nights [16]. In Wyoming, capture success is often lower (e.g., 0.3 to 0.9 individuals per 100 trap nights) [20], suggesting abundances may be lower as well. However, presence and abundance can vary

substantially among trapping sessions [16], and capture rates reported for Wyoming are thus far based on a single survey season.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends are unknown. It is assumed that the subspecies has declined in abundance throughout its range [16], and current ESA protections are in part based on observations of local extirpations from sites where the subspecies was previously documented [1]. The only long-term trend evaluation of Preble's occurred in the southern part of the Preble's range in Colorado. Monument Creek has one of the largest documented populations of Preble's; however, populations at this site declined at a rate of 13% per year during the study, likely as a result of decreased recruitment and immigration [21].

Intrinsic Vulnerability:
HIGH VULNERABILITY
Multiple factors make Preble's highly vulnerable to extrinsic stressors. Foremost of these, Preble's is a habitat specialist, reliant upon well-developed riparian ecosystems within relatively low-elevation prairie and foothill areas [8]. The long duration of hibernation may also contribute to the subspecies' vulnerability by limiting reproductive potential [13]. Although survival tends to be high during the hibernation season, insufficient fat stores may lower overwinter survival; body mass when entering hibernation is the most useful predictor of overwinter survival [16, 22]. Finally, substantial natural variability in abundance and presence [16], limited dispersal distances, and the inherent instability of small population sizes in general might intensify the impact of these threats [10].

Extrinsic Stressors:
HIGHLY STRESSED
The primary conservation concern for Preble's is loss and degradation of riparian habitat. Urban, suburban, and agricultural development have led to a decline in the extent and quality of habitat, particularly along the Front Range in the vicinity of Denver and Colorado Springs [11]. However, this threat may be somewhat reduced in Wyoming, especially outside of Cheyenne because of a lower human population size and overall population density [10]. Because emigration and immigration events may be critical for maintaining local populations of Preble's, fragmentation of riparian habitats may reduce or eliminate the frequency of these events, making persistence of Preble's populations less likely [21]. Furthermore, because Preble's are largely confined to relatively narrow riparian habitats, populations are often described as being distributed in linear networks, which are easily fragmented by discrete disturbances. Additional habitat modifications, both natural and anthropogenic, may lead to habitat degradation and destruction in Wyoming. Overgrazing, drought, fires, and floods can destroy habitat, and the effects of these threats may be exacerbated by global warming [10]. Other potential threats may include increased rates of predation by human-associated predators such as Striped Skunk (*Mephitis mephitis*), Raccoon (*Procyon lotor*), and feral and Domestic Cat (*Felis silvestris*) [13] as well as competition with non-native House Mice (*Mus musculus*) and sympatric Deer Mice (*Peromyscus maniculatus*) that may lead to local extirpation or decreased survival [10, 21]. Finally, the impacts of exotic and noxious weeds and competition with the closely related Western Jumping Mouse are in need of further evaluation [10].

Key Activities in Wyoming

Since ESA protections were first established, considerable research and monitoring efforts have been directed towards Preble's in Wyoming and Colorado. Surveys to determine presence of Preble's are required by the U.S. Fish and Wildlife Service (USFWS) for all projects where a federal nexus exists and there is a potential effect on Preble's or Preble's habitat [23]. Since initial listing, the Wyoming Natural Diversity Database (WYNDD) has conducted extensive research on the subspecies, and, in 2012, completed an assessment of *Zapus* in Wyoming that clarified the state of knowledge of Wyoming *Zapus*, including a detailed analysis of previous captures and museum specimens [8]. The Wyoming Game and Fish Department (WGFD) began funding annual surveys to determine presence and delineate range boundaries of the subspecies in 2009. Since that time, WGFD and WYNDD have continued to refine the known distribution of the subspecies, increase records of known occurrence, and evaluate site-specific threats to persistence [20, 24-26]. In 2013, the USFWS published a 12-month finding for Preble's that reiterated the need for Threatened classification due to the continued impact of extrinsic stressors on the subspecies. The draft recovery plan was published in 2016 [27], and the final recovery plan is expected in 2017.

Ecological Information Needs

The current distribution of Preble's in Wyoming has been evaluated but is still incomplete and requires more discrete delineation of ecological and elevational boundaries. In particular, the northern and western range limits of Preble's in Wyoming remain poorly defined. Additionally, many unknowns exist regarding the impact of fire, drought, flood, and potential competition with the sympatric Western Jumping Mouse, including the potential for species-level hybridization in the northern limits of the subspecies range. Finally, basic demographic and life history information regarding survival, reproduction, dispersal, density, abundance, and population trends are lacking for the subspecies [28] and are central to more precise evaluations of the status of Preble's in Wyoming. Because population size and presence can vary drastically, long-term monitoring is likely needed to acquire robust population estimates.

Management in Wyoming

This section authored solely by WGFD; Nichole L. Bjornlie. Most work to date on Preble's in Wyoming has focused on refining the distribution in order to prioritize areas in need of management and conservation effort. Moving forward, management priorities will focus on implementing the Recovery Plan, collaborating with landowners to conserve habitat, and monitoring populations to ensure recovery objectives are being met. Additional projects will continue to evaluate the impact of threats on population persistence and demographics.

Contributors

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Figure 1: A live-captured jumping mouse (*Zapus* spp.). (Photo courtesy of WYNDD)

Figure 2: North American range of *Zapus hudsonius*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)


Figure 3: Heavily vegetated riparian corridor with woody overstory along Friend Creek, Albany County, Wyoming. (Photo courtesy of WGFD)

Figure 4: Map not available.

Preble's Shrew
Sorex preblei

REGULATORY STATUS
USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS
USFWS: No special status
WGFD: NSSU (U), Tier III
WYNDD: G4, S2S3
Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS
The Wyoming Natural Diversity Database has assigned Preble's Shrew (*Sorex preblei*) a state conservation rank ranging from S2 (Imperiled) to S3 (Vulnerable) because of uncertainty about population trends and extrinsic stressors for this species in Wyoming.

NATURAL HISTORY
Taxonomy:
There are no recognized subspecies of Preble's Shrew [1]. However, recent genetic analyses suggest the currently recognized *S. preblei* may be composed of > 1 cryptic species, with further analysis needed to confirm that possibility [2].

Description:
Preble's Shrew is an extremely small mammal, and is very similar in appearance to other Wyoming shrew species. Adult dimensions include body length 85–95 mm, tail length 35–36 mm, and weight 3–5 g. Like other *Sorex* species, Preble's Shrew has a relatively long and flexible snout, bicolored tail, proportionally small eyes, uniformly brownish or grayish fur on the back, and silvery-whitish fur below. Identification to species requires a combination of body measurements, skull measurements, and, especially, dental characteristics [1], which typically requires the individual shrew to be sacrificed. Figure 5 illustrates important differences in shrew dentition, and a technical key such as in Clark and Stromberg (1987) is an important aid in identifying Wyoming shrews to species [3].

Distribution & Range:
Preble's Shrew occurs from southwestern Canada across the western United States, extending from southern British Columbia and Saskatchewan south to Colorado and New Mexico [1, 4-6]. The species is known from the northwestern and southwestern corners of Wyoming. One specimen from southwestern Wyoming was first identified by experts as Masked Shrew (*S. cinereus*) and was amended to *S. preblei* only upon later re-examination [7]. Current understanding of the

species' entire distribution is based on rather few confirmed observations, and recent field surveys have broadened the known distribution substantially [8-10]. Of special note are the relatively recent confirmations of the species in New Mexico and Colorado [5, 6]. Given the relatively low sampling effort for shrews in Wyoming, the species may occupy more of the state than is currently documented.

Habitat:
Habitat associations of Preble's Shrew have not been extensively studied and are not well known. Captures of the species since 1992, including captures in Wyoming, have generally been in arid to semi-arid habitats such as sagebrush (*Artemisia* spp.) shrublands, subalpine shrublands characterized by manzanita (*Arctostaphylos* spp.), and grasslands [9, 11-13]. Historical records place the species in an array of habitats including marshes; riparian areas; openings in coniferous forests; and Lodgepole Pine (*Pinus contorta*), fir (*Abies* spp.) and Quaking Aspen (*Populus tremuloides*) forests [1]. Due to the difficulty of properly identifying *Sorex* shrews, some of these historical records may be misidentifications of species other than Preble's Shrew. In general, shrews are assumed to seek out certain microhabitats (e.g., specific litter depths, debris densities, or soil textures) that may not align well with traditional categories of wildlife habitat based on dominant overstory plants [14, 15].

Phenology:
Preble's Shrew is active year round. Breeding phenology is not well known but limited data suggest that females raise up to two litters per year which are likely born around June or July [16]. Based on information from other *Sorex* shrews, young may disperse at around 4 weeks of age.

Diet:
Preble's Shrew diet is likely similar to that of other *Sorex* shrews, with small invertebrates forming the bulk of consumed items [3]. Analysis of bite mechanics suggests Preble's Shrew may prefer soft-bodied over hard-bodied prey [1], but specific preferences and seasonal diet shifts are unknown.

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: UNCOMMON
There are no population estimates of Preble's Shrew at continental, national, or state scales. The UNCOMMON abundance in Wyoming is inferred from the small portion of the state known to be occupied and an apparent rarity within that range [17]. However, sampling effort for shrews in the state has been so low that the species may actually extend beyond the currently-assumed range and may be common in some localities.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends of Preble's Shrew are unknown. It is generally accepted that the recent expansion in confirmed captures and range extent are functions of increased sampling effort instead of actual population expansion.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Though little is known about Preble's Shrew, the general breeding biology of *Sorex* shrews makes them moderately vulnerable. Many *Sorex* have a life expectancy of one year, and under some conditions may produce only one litter per year. Also, limited mobility restricts shrew's ability to re-colonize suitable habitats and expand populations [3]. These characteristics may predispose *Sorex* populations to fragmentation and local extirpation if breeding is disrupted for even a single season [15]. Preble's Shrew populations may be somewhat insulated from such effects because they occupy a relatively broad range of habitats.

Extrinsic Stressors:
UNKNOWN
So little is known about Preble's Shrew in Wyoming that any outline of extrinsic threats is somewhat speculative. The species' relatively broad habitat use may protect populations from disturbances in any single habitat type. Additionally, shrews may rely on certain microhabitats that remain relatively unaffected by some large-scale disturbances, allowing populations to persist in otherwise disturbed areas.

KEY ACTIVITIES IN WYOMING
Preble's Shrew is classified as a Species of Greatest Conservation Need by the Wyoming Game and Fish Department (WGFD). Currently, there is no research being conducted on Preble's Shrew in Wyoming. In 2014 the WGFD funded and conducted an evaluation of the potential to use guard hairs to identify shrews to species, thus allowing for identification without the need to sacrifice individuals. However, only Western Water Shrew (*S. navigator*) was identifiable by guard hair, which is also the only shrew in Wyoming that is identifiable in hand [18].

ECOLOGICAL INFORMATION NEEDS
Very little is known about Preble's Shrew anywhere in the species' range. There are so few records of the species in Wyoming that basic distribution, habitat preferences, dietary needs, breeding phenology, and potential threats are poorly understood. A better estimate of actual distribution in the state may be the top priority information need at this time and could be efficiently generated as part of a larger field survey effort targeting multiple *Sorex* species simultaneously. In this context, it is important to note the recent documentation of the species in Colorado and New Mexico, ca. 400 miles distant from its previously assumed range boundary [5, 6].

MANAGEMENT IN WYOMING
This section authored solely by WGFD; Nichole L. Bjornlie. Preble's Shrew is assigned an NSSU rank because survey data that would provide for an assessment of population status are lacking. Consequently, management priorities for the species in the short-term will focus on addressing these data deficiencies. Of particular importance are data on presence, distribution, population status and trends, habitat needs, and the impact of potential threats. Because shrews are rarely trapped as part of other small mammal projects, addressing these needs will require systematic surveys designed to target shrews (i.e., pitfall traps). However, these species would also benefit from the development of new capture and identification techniques that would not require sacrificing individuals. Results from these efforts will ultimately be used to update status and develop management and conservation recommendations.

CONTRIBUTORS

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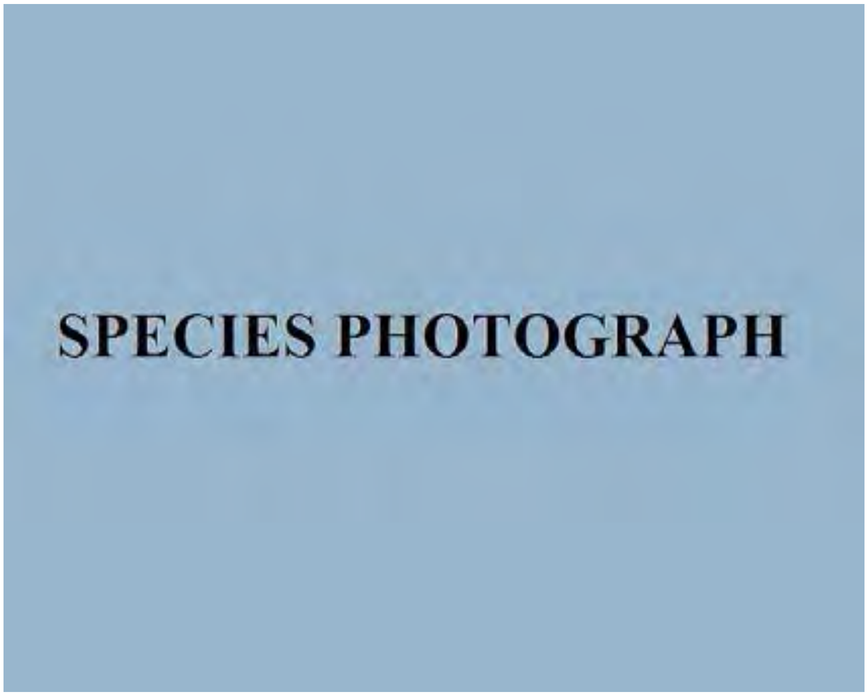

Figure 1: Photo not available.

Figure 2: North American range of *Sorex preblei* (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.). This map does not show relatively recent confirmation of the species in New Mexico (Kirkland and Findley 1996) and Colorado (Long and Hoffmann 1992).

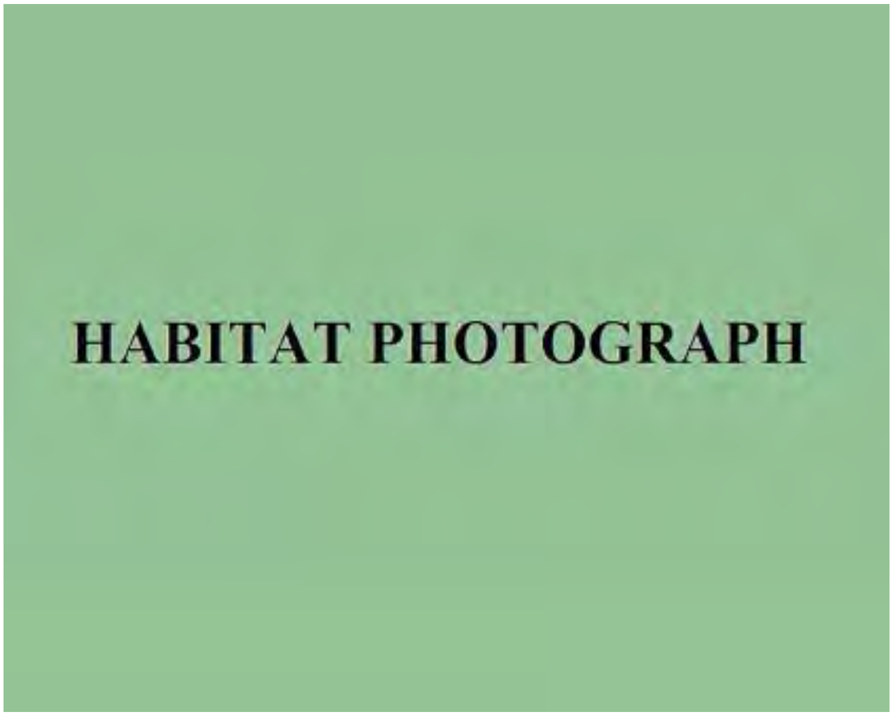

Figure 3: Photo not available.

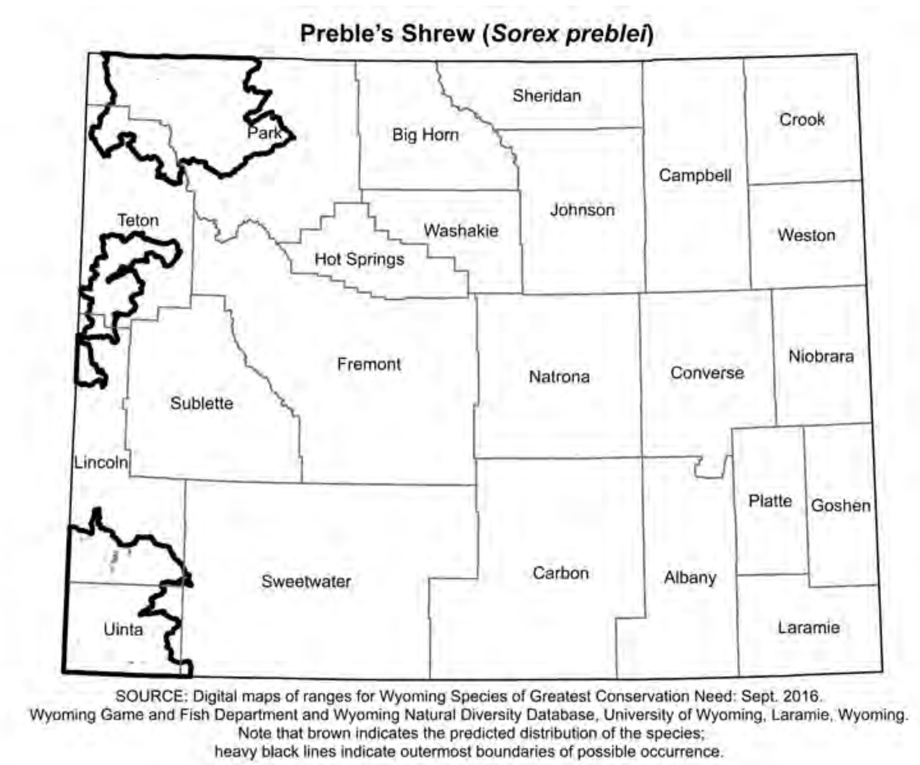

Figure 4: Range and predicted distribution of *Sorex preblei* in Wyoming.

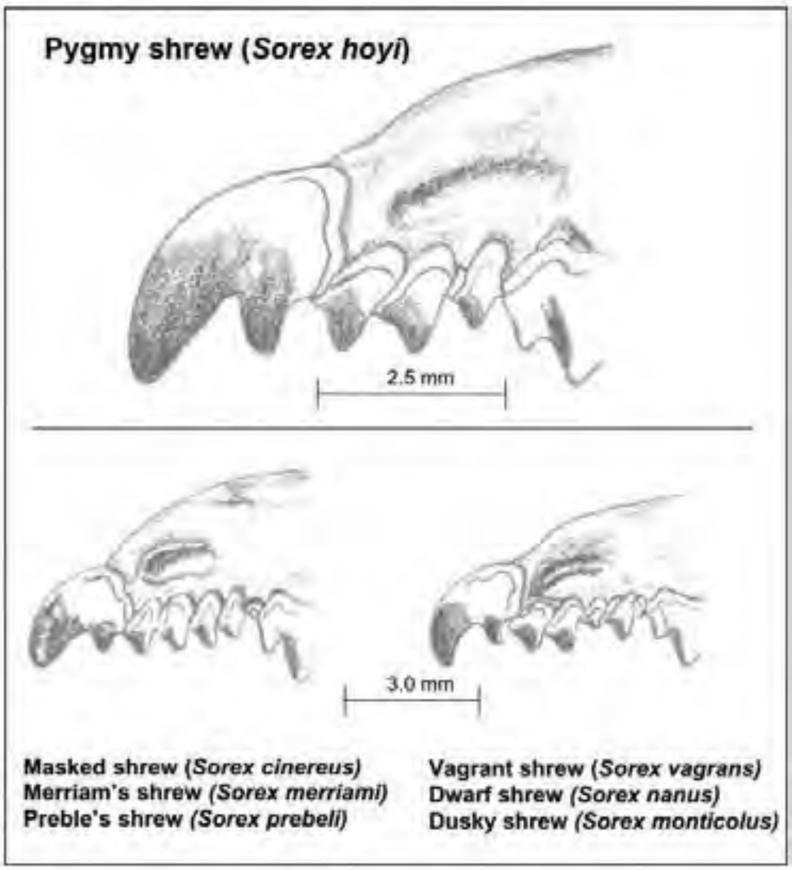

Figure 5: Lateral view of upper tooth rows of some *Sorex* spp. of shrew; Preble's Shrew shown on lower left. Top and bottom panels are not drawn to same scale – note scale bars. (Figure from: Beauvais, G. P., and McCumber, J. (2006) Pygmy Shrew (*Sorex hoyi*): a technical conservation assessment, p 34, USDA Forest Service, Rocky Mountain Region.)

Pygmy Rabbit

Brachylagus idahoensis

REGULATORY STATUS

USFWS: Listing Not Warranted
USFS R2: No special status
USFS R4: Sensitive
Wyoming BLM: Sensitive
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G4, S2
 Wyoming Contribution: MEDIUM
IUCN: Least Concern

STATUS AND RANK COMMENTS

Pygmy Rabbit (*Brachylagus idahoensis*) was petitioned for listing as an Endangered or Threatened species under the Federal Endangered Species Act in 2003. In 2010, listing was denied when the United States Fish and Wildlife Service deemed the species was not in danger of extinction or extirpation in all or a significant portion of its range [1]. However, the Distinct Population Segment (DPS) of Pygmy Rabbit in Washington's Columbia Basin is listed as a Federal Endangered Species [2].

NATURAL HISTORY

Taxonomy:

Although previously placed in the genus *Sylvilagus*, Pygmy Rabbit is now in the monotypic genus *Brachylagus* due to pronounced morphological and ecological differences [3]. No subspecies have been designated; however, Pygmy Rabbits in the Columbia Basin are considered a DPS due to genetic, geographic, and ecological differences [2].

Description:

Pygmy Rabbit is identifiable in the field but is often confused with cottontail rabbits (*Sylvilagus* spp.). Pygmy Rabbit is the smallest rabbit in North America [3, 4]. Females tend to be larger than males. Pelage is similar across sexes and age classes and is buff gray to silver gray and can be tipped with brown. Abdomen is typically pale buff colored and legs and nape are rufous brown [3, 4]. Pygmy Rabbit has notably short, round ears, the interior of which are thickly furred and tan or gray. The tail is short, inconspicuous, and buff to tan on the underside [3-5]. Unlike Pygmy Rabbit, sympatric cottontail species have longer ears that are sparsely furred and pink on the interior and a clearly visible tail that is white on the underside.

Distribution & Range:

Pygmy Rabbit occurs in the Great Basin and parts of adjacent intermountain areas in the western United States [3-5]. The disjunct Columbia Basin population in Washington was believed extirpated from the wild in 2004, but reintroduction efforts are ongoing [2]. Wyoming represents the eastern-most extent of the range of Pygmy Rabbit, and the species is patchily distributed throughout the southwest portion of the state. Confirmed and suspected breeding has been document in 7 of Wyoming's 28 latitude/longitude degree blocks [6]. Pygmy Rabbit recently has been confirmed in one area in northwest Colorado [7].

Habitat:
Pygmy Rabbit is a sagebrush obligate that occurs in areas with tall, dense sagebrush and deep soils capable of supporting burrows [3-5]. Pygmy Rabbit typically is found in Big Sagebrush (*Artemisia tridentata*) with a high density of shrub cover, but will use landscapes containing multiple small patches of tall, dense sagebrush in a matrix of shorter shrubs [8]. Sagebrush provides both food and cover to Pygmy Rabbit. Unlike most North American rabbits, Pygmy Rabbit is semi-fossorial and relies on burrows for year-round cover. Burrow entrances typically are located at the base of sagebrush shrubs. Separate single–entrance natal burrows are used for reproduction [9].

Phenology:
Pygmy Rabbit typically breeds from late winter through early summer. Females produce up to 3 litters each year and kits are typically born from April thru July [3-5]. Natal dispersal typically occurs at 6–12 weeks of age [10], and juveniles do not breed their first summer [3]. Pygmy Rabbit is active year-round and does not migrate; however, home ranges can be smaller in winter [11].

Diet:
Sagebrush comprises up to 99% of Pygmy Rabbit diet in winter and over 50% in summer [3, 4]. The species also eats a variety of grasses and forbs in summer.

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD BUT PATCHY
Wyoming: UNCOMMON
Pygmy Rabbit is patchily distributed, and abundance can vary with the size and quality of habitat patches [4]. Pygmy Rabbit can be locally abundant in parts of southwestern Wyoming [12, 13] but likely decreases in abundance near the periphery of the its range in southcentral Wyoming [12]. Despite several studies estimating occupancy of Pygmy Rabbit in parts of Wyoming [12, 14, 15], robust estimates of abundance are not available for the state.

Population Trends:
Historic: MODERATE DECLINE
Recent: UNKNOWN
Historic population declines likely resulted from loss, fragmentation, and degradation of sagebrush habitat [4]. Assessing trends is difficult because Pygmy Rabbit populations may shift across the landscape over time [16], and techniques for monitoring populations are still being developed [17, 18]. Trends in Pygmy Rabbit occupancy have been studied in only one area in Wyoming and suggest that occupancy has been slowly increasing from 2011–2014 in the study area; however, the rate of increase in occupancy appears to be decreasing [15]. Recent declines have been documented in Washington [2] and Oregon [19, 20], and anecdotal evidence suggests declines in populations elsewhere in the species' range [4].

Intrinsic Vulnerability:

HIGH VULNERABILITY
Pygmy Rabbit has high intrinsic vulnerability in Wyoming because of the species' narrow habitat requirements and limited reproductive and movement abilities. Pygmy Rabbit is restricted to areas with tall, dense sagebrush and deep soils. The species also has low fecundity relative to other rabbit species. Individuals do not breed until their second year and typically have 1–3 litters per year (avg. 6 kits/litter) [4]. Although Pygmy Rabbit can disperse up to 12 km, average natal dispersal is just 1–3 km [10]. The species may be reluctant to cross open spaces, which could potentially limit recolonization of isolated populations [4, 5, 14].

<u>Extrinsic Stressors</u>:
MODERATELY STRESSED
Pygmy Rabbit annual survival rates vary considerably with site, year, sex, age, etc., but generally are low (0.3–45%), with predation typically the main source of mortality [21-23]. Loss and fragmentation of sagebrush habitat due to fire, invasive plant species (e.g., Cheatgrass (*Bromus tectorum*)), and anthropogenic modification/conversion practices also threaten Pygmy Rabbit [4]. In Wyoming, use of remaining sagebrush patches by Pygmy Rabbit was inhibited following prescribed burns [14], and probability of occupancy was lower in survey grid cells containing either disturbed habitat or predators [12]. In Utah, the proportion of active burrows and relative abundance of Pygmy Rabbit was reduced near habitat edges [24]. Pygmy Rabbit also tended to avoid entering areas treated by crushing sagebrush (i.e., aerator treatment) [25]. These results suggest that fragmentation, manipulation, and loss of sagebrush habitat in Wyoming could negatively impact this species. Fragmentation and loss of sagebrush habitat due to energy development currently is occurring throughout the species' range in Wyoming. Furthermore, exposure of Pygmy Rabbit to energy development in Wyoming is predicted to increase 105% by 2030 based on models of current species distribution [26] and projected energy development [27]. Pygmy Rabbit also may be negatively impacted by climate change because sagebrush is predicted to decline with increasing temperature in some climate change models [28].

KEY ACTIVITIES IN WYOMING

Graduate students at the University of Wyoming have recently investigated Pygmy Rabbit in Wyoming. Research in 2004 and 2005 examined the distribution of Pygmy Rabbit in the state and extended the species' known range north of Jeffrey City and east to Rawlins [29]. A genetic study found that Pygmy Rabbit in Wyoming appears to be relatively well-connected through gene flow, maintaining moderate levels of genetic diversity [14]. However, this same study found that Pygmy Rabbit tended not to use burned areas even where remaining patches of sagebrush were of sufficient size to support the species [14, 30]. Current ongoing research has found that 48% of the predicted distribution of Pygmy Rabbit in Wyoming falls in core areas identified and managed for Greater Sage-Grouse (*Centrocercus urophasianus*) conservation [31, 32]. A recent study by the Wyoming Game and Fish Department found that occupancy of Pygmy Rabbit within its predicted distribution in Wyoming was 48% based on a survey of 50 grid cells randomly selected from within the species' distribution [12]. This study also reported that occupancy was lower on grid cells containing predators and habitat disturbance [12]. Ongoing monitoring of Pygmy Rabbit occupancy in Sublette County has occurred since 2010 [15]. Occupancy is lower in the Pinedale Anticline oil and gas exploration and development area than a nearby reference area; however, occupancy has been slowly increasing in both areas since 2011 [15]. A recent study tested the accuracy of 2 predictive distribution models for Pygmy Rabbit in Wyoming and found that although both models performed moderately well in undeveloped areas, the ability of both models to predict habitat for Pygmy Rabbit declined sharply with increasing road density associated with oil and gas development [33].

ECOLOGICAL INFORMATION NEEDS

The current distribution of Pygmy Rabbit in Wyoming is still unclear, and eastern and northern range limits of the species need further investigation [29]. Abundance estimates for Pygmy Rabbit in Wyoming are lacking and population trend data are restricted to one study in Sublette County. Currently, very little data exist to evaluate effects of different types of habitat alteration on Pygmy Rabbit survival, movement, and recruitment.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Current management priorities for Pygmy Rabbit include continuing and expanding occupancy surveys in order to monitor population trends throughout the range of the species in Wyoming. Because sagebrush habitat in Wyoming is far vaster than the distribution of Pygmy Rabbit in the state, incorporating habitat metrics into survey efforts will help elucidate variables that may be important to presence and distribution. Finally, survey efforts will continue to evaluate the impacts of energy development and habitat alteration, all of which will be used to develop management and conservation recommendations.

CONTRIBUTORS

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Figure 1: Adult Pygmy Rabbit. (Photo courtesy of J. Witham)

Figure 2: North American range of *Brachylagus idahoensis* in blue. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Sagebrush habitat used by the Pygmy Rabbit in Custer County, Idaho. (Photo courtesy of Wendy A. Estes-Zumpf)

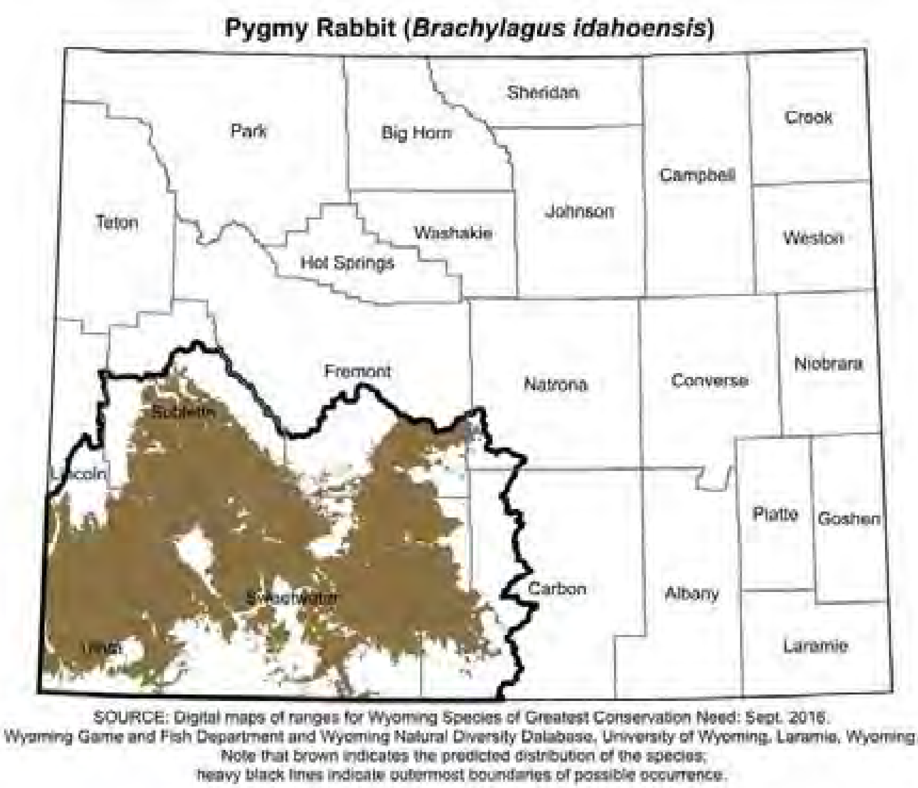

Figure 4: Range and predicted distribution of *Brachylagus idahoensis* in Wyoming.

Ringtail
Bassariscus astutus

REGULATORY STATUS
USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS
USFWS: No special status
WGFD: NSSU (U), Tier III
WYNDD: G5, S1S2
Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS
The Wyoming Natural Diversity Database has assigned Ringtail (*Bassariscus astutus*) a state conservation rank ranging from S1 (Critically Imperiled) to S2 (Imperiled), indicating uncertainty regarding its status in Wyoming. This uncertainty stems from a paucity of information on population trends and extrinsic stressors in the state.

NATURAL HISTORY
Taxonomy:
Evolutionarily, Ringtail is the most primitive Procyonid [1, 2]. The genus has been researched heavily to elucidate the deep evolution of the Procyonidae, the sister Family Mustelidae, and Order Carnivora. As many as 14 subspecies of *B. astutus* have been recognized in the past [1], but there is substantial confusion and debate over their legitimacy. After an exhaustive comparison of skulls from across the species' range, Kortlucke [3] recognized only 3 subspecies. Other researchers recommend recognizing only the species-level taxon [4]. Wyoming likely supports only the alleged subspecies *B. a. arizonensis*, with the distant possibility of *B. a. nevadensis* and *B. a. flavus* in the southwestern and southeastern corners of the state, respectively. However, these 3 purported subspecies are in broad contact with one another and with other subspecies to the south [5] and are unlikely to represent discrete biological units.

Description:
The general appearance of Ringtail is that of a large weasel with a foxlike head and face. It is similar in size and form to the Pacific Marten (*Martes caurina*) but with noticeably lighter pelage (gray to light tan), dark eyes surrounded by white providing a "masked" appearance, and a large and well-furred tail strikingly annulated with black and white rings. Total length 618–811 mm; tail 310–438 mm; adult weight 870–1100 g [1]. Ringtail is unlikely to be confused with any other Wyoming mammal under adequate viewing conditions. If viewed only briefly, the annulated tail

may convey an impression of the more common (but much larger) Northern Raccoon (*Procyon lotor*).

Distribution & Range:
Ringtail occurs from southern Mexico north to Kansas, southern Wyoming, and Oregon. The range is often mapped eastward to Louisiana and Arkansas, but eastern records may be of translocated animals. The species has a well-known history of deliberate and inadvertent human translocations. It commonly lives in close association with people, can be semi-domesticated, and has even been known to travel long distances on rail cars before escaping. Ringtail can persist in non-standard habitats following translocation [1, 4, 6]. The species has been documented only a few times in extreme southern Wyoming [7]. Wyoming animals are assumed to derive from natural populations instead of human-mediated translocations. Precise distribution and frequency of occurrence of Ringtail in Wyoming are poorly known. In 2012, Lonsinger [8] failed to document Ringtail at an Idaho site where a carcass was documented in 2003 – this apparently tenuous occupation may apply all along the species' northern range boundary, including southern Wyoming.

Habitat:
Ringtail is a habitat generalist at elevations below the lower montane zone. Although habitat use in Wyoming has not been studied, information from the core of the species' range suggests it is unlikely to occupy landscapes at mid-montane and higher elevations [1, 9]. In most of its United States range, Ringtail typically occupies dry, rocky, canyon-type settings covered with mixed woodland and shrubland. It may prefer to forage in well-developed riparian zones, and is often captured in riparian settings. However, the species can exist independent of free water, meeting its water needs solely through animal prey and succulent vegetation – Ringtail kidneys are strongly adapted for water conservation [1, 10]. Rock crevices, small caves, hollow trees, fallen logs, and similar structures are important as cover and den sites, and Ringtail is unlikely to be found in habitats lacking such features [1, 10, 11]. Ringtail is often found in human-dominated landscapes, including agricultural and suburban settings, where slash piles, buildings, and other human structures (even wooden nest boxes) are readily used [12]. Ringtail is extremely agile and able to traverse through heavy vegetation, rock cliffs, and rubble with ease – the species is arboreal and even fossorial as necessary [4].

Phenology:
Ringtail is active year-round. In core range to the south of Wyoming, breeding generally occurs February-May [1]. At northern sites such as Wyoming, breeding may occur during the latter part of this period. Pregnancy lasts 51–54 days. Newborns are altricial, become full-furred at 6 weeks, are weaned at 10–12 weeks, and achieve full size at 30 weeks. Ringtail can breed as young-of-year, but typically do not until they are 2 years old. The species is strongly nocturnal [1, 10].

Diet:
The diet of Ringtail is diverse and varies with availability at any given location and season. There is some indication of a preference for animal prey over vegetation, but in general the species is an opportunistic and generalist omnivore. Principal food items for wild Ringtail include small mammals (up to *Lepus* in size), lizards, snakes, large arthropods, conifer leaves and cones, and fruits of all types. Carrion is occasionally eaten, as are birds. Nest predation has not been documented but is a strong possibility. Frogs and even fish have been noted in some diet studies [1, 10, 13].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
There are no population estimates of Ringtail in Wyoming or adjacent regions. The VERY RARE abundance in the state is inferred from the small portion of the state suspected to be occupied, and the apparent infrequency with which animals are documented. Ringtail appears to be rare within suitable habitat in the occupied area [14].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends of Ringtail in Wyoming are unknown.

Intrinsic Vulnerability:
LOW VULNERABILITY
Although Ringtail appears to occur at rather low densities in Wyoming, it is a diet and habitat generalist that is likely robust to some disturbances. Southern Wyoming forms the species' northern range boundary, suggesting that population segments here may be operating at the limits of climatic tolerance (with winter conditions assumed to be most limiting). The species is known to be susceptible to several diseases and parasites, and can be subject to high rates of predation [1, 10]. Mortality from pathogens and predators may impact vital rates more in tenuously-suitable regions like Wyoming than in more favorable sites. If future investigations bear this out, intrinsic vulnerability may need to be re-assessed as Moderate.

Extrinsic Stressors:
UNKNOWN
So little is known about Ringtail in Wyoming that any outline of extrinsic threats is somewhat speculative. The species is occasionally trapped as a furbearer in the core of its range to the south [1, 10]. However, as a nongame species, Ringtail are not trapped in Wyoming. Almost 90% of commercial Ringtail fur now comes from farmed animals [4]. Wildfire may degrade habitat quality, especially when it removes important denning substrate such as woody vegetation and debris [4]. However, the species is assumed to be a habitat generalist, which could insulate population segments from disturbances to particular environments. A general susceptibility to pathogens and predators is mentioned above. Without more information on Ringtail habitat use and life history it is difficult to discuss threats and threat mitigation with any certainty [15].

KEY ACTIVITIES IN WYOMING

Currently, there is no research being conducted on Ringtail in Wyoming. The increasing use of camera traps to inventory other carnivores – e.g., ongoing research on spotted skunk (*Spilogale* spp.) by the Wyoming Game and Fish Department (WGFD) – may document Ringtail if such devices are placed in appropriate habitat in the state. An upcoming project by the WGFD to evaluate trends and habitat of piñon-juniper (*Pinus edulis – Juniperus* spp.) obligate species in southwestern Wyoming may also include the use of remote camera traps to assess presence and distribution of nocturnal meso-carnivores, including Ringtail, but this effort is still in the preliminary planning stages.

ECOLOGICAL INFORMATION NEEDS

Very little is known about Ringtail in Wyoming. There are so few records of the species in the state that basic distribution, habitat preferences, diet, breeding phenology, and potential threats are poorly understood. A better estimate of actual distribution in the state may be the top priority information need at this time.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Ringtail is assigned an NSSU rank because survey data that would provide for an assessment of population status are lacking. Consequently, priorities in Wyoming in the short-term will focus on addressing these data deficiencies. Of particular importance are data on population status and trends and a more refined understanding of distribution within the state. Because of the low density and limited distribution of Ringtail on the landscape, acquiring these data will likely require targeted survey efforts. Additional priorities will focus on assessing limiting factors and habitat requirements for this northern range boundary, which will ultimately be used to develop management and conservation recommendations.

CONTRIBUTORS

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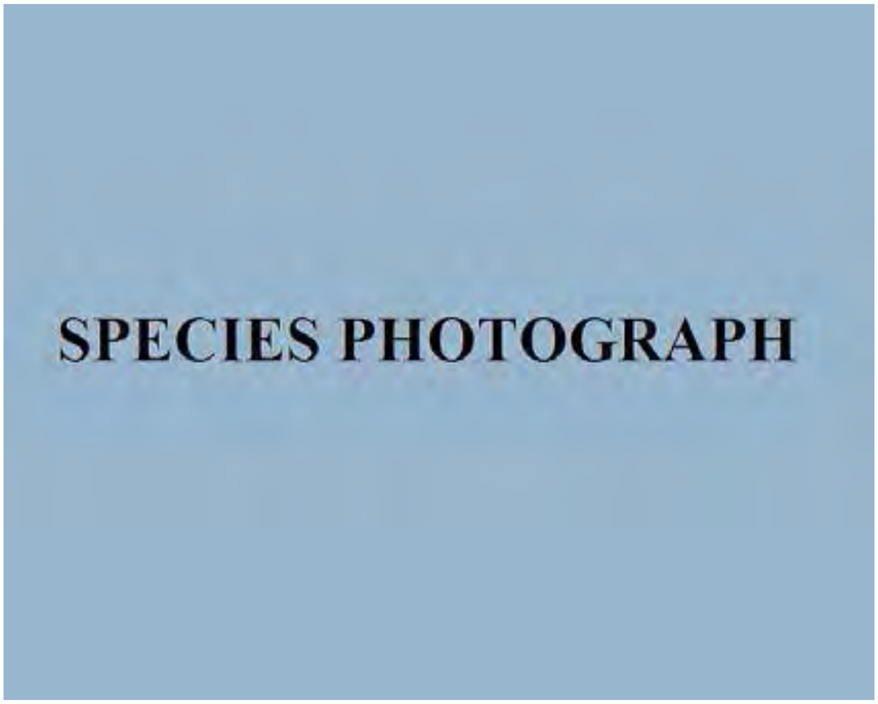

Figure 1: Photo not available.

Figure 2: North American range of *Bassariscus astutus*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

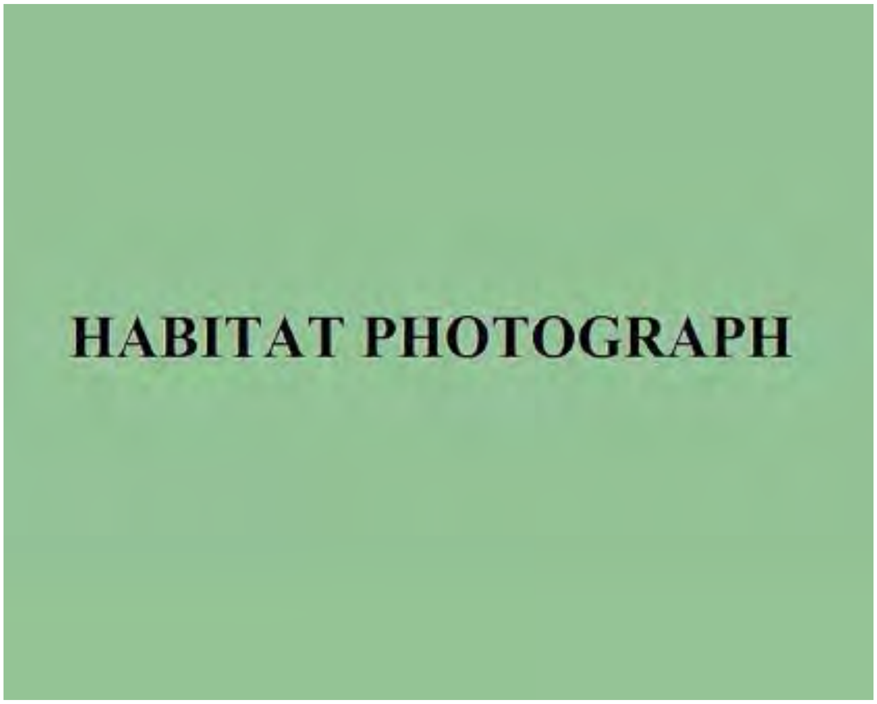

Figure 3: Photo not available.

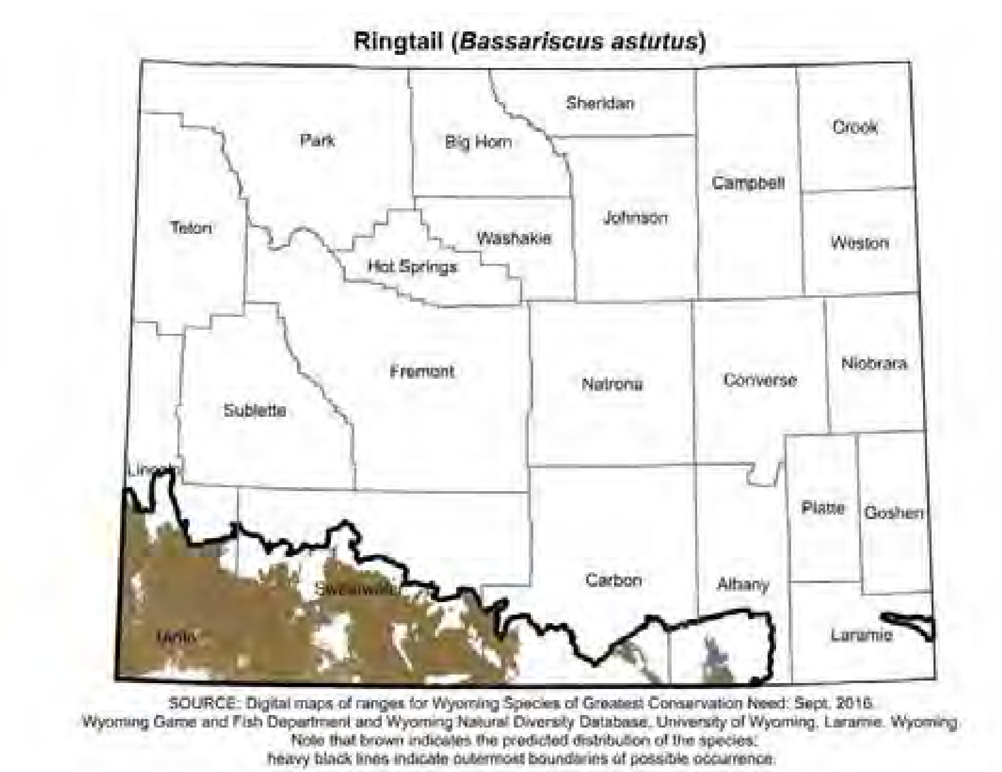

Figure 4: Range and predicted distribution of *Bassariscus astutus* in Wyoming.

Sagebrush Vole
Lemmiscus curtatus

REGULATORY STATUS
USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS4 (Cb), Tier II
WYNDD: G5, S4
Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS
Sagebrush Vole (*Lemmiscus curtatus*) has no additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:
Formerly within the genus *Arvicola* and then *Lagurus* [1], the species is now placed in the monotypic genus *Lemmiscus*. The two previous genera are now reserved exclusively for Eurasian taxa [2, 3]. *Lemmiscus* is assumed to be closely related to the primary genus of North American voles, *Microtus*, but the precise relationship is not well-understood [2, 4]. Six subspecies of *L. curtatus* have been recognized in the past [1]. There is no modern genetic description of these subspecies, nor is there any obvious geographic separation between them. Of the nominal subspecies, only *L. c. levidensis* occupies Wyoming [5].

Description:
Sagebrush Vole is a small, light colored vole with a noticeably short tail (13–20 mm). The relatively long, soft, and dense pelage is pale gray to ashy gray dorsally, transitioning to silver or white on the venter; the tail is only indistinctly bicolored. There is no appearance of a dorsal stripe. Total length is 101–113 mm; hind foot is 12–17 mm; and weight is 17–38 g [1, 5]. Adults can be distinguished from *Microtus* by the short tail, which is only about as long as the hind foot in *Lemmiscus* [5]. Detailed dental characters can identify skulls to species [1].

Distribution & Range:
The range of Sagebrush Vole closely tracks that of Big Sagebrush (*Artemesia tridentata*), extending from southern Alberta and Saskatchewan south through Montana and Wyoming to northwestern Colorado, then west to southern Nevada, eastern Oregon, and eastern Washington. Documented occurrences of Sagebrush Vole in Wyoming are somewhat scattered across the state, with most concentrated in the basins of southern Wyoming. A 2015 field effort captured

Sagebrush Vole in all major basins of the state except the Bighorn Basin [6]. Sagebrush Vole is largely restricted to environments below lower timberline, although population segments can extend into patches of montane sagebrush with shrubland connections to basin environments [1, 5, 7]. Early suggestions that Sagebrush Vole was a colonial species have been refuted by more recent studies indicating a non-colonial spacing [8].

Habitat:
Sagebrush Vole almost always occupies areas with significant coverage of Big Sagebrush. Occupation of sites without sagebrush (e.g., arid grasslands, rabbitbrush, greasewood) is known but considered atypical [1, 5, 7]. One study in the Upper Green River Basin found Sagebrush Vole density decreased with increasing height and density of sagebrush, but more precise habitat preferences are largely unknown [9]. Sagebrush Vole is often captured during small mammal studies in appropriate habitat, but usually at such low rates that researchers find it hard to analyze detailed habitat responses [9-13]. The species constructs and uses underground burrows and nests. Burrows can be extensive enough to describe as tunnel systems and sometimes incorporate tunnels of pocket gophers (*Thomomys* spp). Surface runways are also used and maintained, similar to those of *Microtus* voles [1].

Phenology:
Sagebrush Vole is active and breeds year-round. Reproduction may peak in spring and fall, possibly to match periods of rapid vegetation growth while avoiding summer droughts and winter freezes. Gestation is 25 days; litters range from 1–13 young, with an average of about 5 young. Young are altricial at birth, fully-furred at about 7 days, and weaned and independent at about 20 days. Multiple litters per year are likely. Individuals are active at any time of day, with some indication of a crepuscular pattern [1, 8].

Diet:
Diet is composed almost entirely of plant material. Sagebrush Vole eats a broad variety of vegetation, including seeds, leaves, stems, fruits, and culms of a wide range of grasses and forbs. Bark and leaves of shrubs are known to be eaten as well, and even conifer seeds have been found in the mouths of captured Sagebrush Voles. Sagebrush bark may be more important as a nest building material than as food. Sagebrush Vole is not known to store food. [1, 5, 8].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: COMMON
Sagebrush Vole is generally captured at low rates in most small mammal inventories in appropriate habitat. However, it was the fourth most frequently captured species (out of 20 total) in a small mammal inventory covering all basin environments in Wyoming in 2015. The same study documented Sagebrush Vole at 23 of 47 total trapping sites across the state [6]. That fraction (49%) is lower than the 60% occupancy figure presented for Sagebrush Vole in the Great Basin and Interior Columbia Basin, which was derived via structured literature review [12]. There is a general recognition that Sagebrush Vole increases in abundance following mild winters, above normal summer precipitation, and early autumn precipitation [1].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends of Sagebrush Vole in Wyoming and adjacent states are unknown. Some researchers suggest that long-term declines in sagebrush have probably caused similar declines in Sagebrush Vole [11, 12].

Intrinsic Vulnerability:
LOW VULNERABILITY
Sagebrush Vole is moderately specialized to shrublands dominated by Big Sagebrush, but appears to occur widely within that overall habitat type. The species is generally considered one of the rarer small mammals in the state, but recent studies challenge that notion [6, 9]. Populations fluctuate on par with other species of rodent in similar habitat, and reproductive output is not especially low nor high relative to what is predicted by body size.

Extrinsic Stressors:
MODERATELY STRESSED
The association between Sagebrush Vole and sagebrush suggests that processes that degrade and replace sagebrush (e.g., weed invasion, infrastructure placement, road building) could also reduce habitat quality and numbers of Sagebrush Vole. A literature review focusing on the Great Basin indicated consistently lower densities of Sagebrush Vole where sagebrush had been altered by chemical or mechanical treatments, extensive weed invasion, or heavy livestock grazing [11, 12]. Dispersed infrastructure placement, such as that found in natural gas extraction fields, does not appear to affect density of Sagebrush Vole [9].

KEY ACTIVITIES IN WYOMING
Recent research projects in Wyoming have clarified several aspects of the ecology of Sagebrush Vole [6, 9]. In particular, the 2015–2016 field effort directed by the Wyoming Game and Fish Department and the Wyoming Natural Diversity Database has greatly expanded our knowledge of the distribution and abundance of Sagebrush Vole statewide. Data from this project's 2016 field season is not yet available, but is expected to add important new information in this context.

ECOLOGICAL INFORMATION NEEDS
More detailed information on the preferences of Sagebrush Vole for particular characteristics of sagebrush shrublands would assist wildlife and range managers in predicting the effects of intentional and unintentional vegetation changes occurring in the basins of Wyoming.

MANAGEMENT IN WYOMING
This section authored solely by WGFD; Nichole L. Bjornlie. Recent management activities have focused on funding research projects to improve trapping techniques and understanding of distribution, occupancy, and habitat of Sagebrush Vole and other small mammal species associated with arid shrublands throughout the state. However, additional information that would assist with the development of management recommendations is lacking. Consequently, priorities in Wyoming in the short-term will focus on addressing these data deficiencies. Of particular importance are data on habitat requirements, population trends, and limiting factors, including impacts of sagebrush treatment projects and other anthropogenic development and

habitat manipulations, which will ultimately be used to develop management and conservation recommendations.

CONTRIBUTORS

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Figure 1: Adult Sagebrush Vole photographed in Carbon County, Wyoming. (Photo courtesy of Kristina M. Harkins)

Figure 2: North American range of *Lemmiscus curtatus*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Sagebrush Vole habitat in Sweetwater County, Wyoming. (Photo courtesy of Kristina M. Harkins)

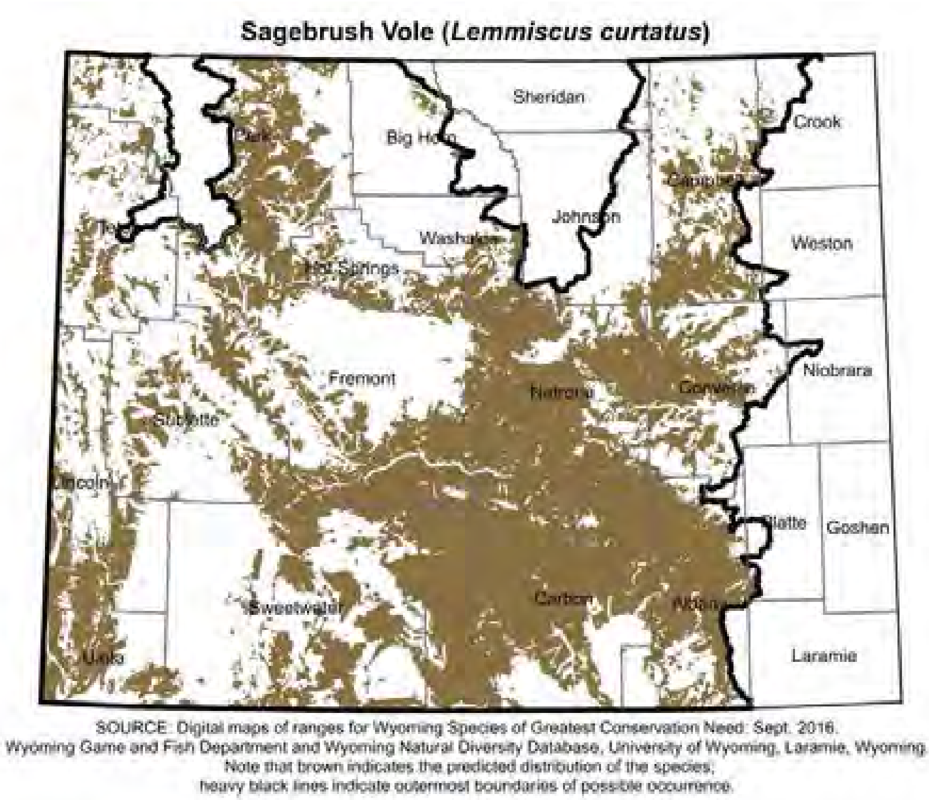

Figure 4: Range and predicted distribution of *Lemmiscus curtatus* in Wyoming.

Sand Hills Pocket Gopher

Geomys lutescens

REGULATORY STATUS

USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G3, S1S3
    Wyoming Contribution: HIGH
IUCN: Least Concern

STATUS AND RANK COMMENTS

Sand Hills Pocket Gopher (*Geomys lutescens*) is assigned a range of state conservation ranks by the Wyoming Natural Diversity Database due to uncertainty concerning its abundance in Wyoming and lack of information on population trends in the state. Also, note that the Global rank (G3) is provisional at this time – NatureServe (Arlington, Virginia) has not yet formalized a Global rank for this species.

NATURAL HISTORY

Taxonomy:

Sand Hills Pocket Gopher was formerly considered a subspecies of Plains Pocket Gopher (*G. bursarius*) and given the sub-specific designation *G. b. lutescens* [1]. It is now considered a full species based on a combination of genetic information and morphology [2] . Though two subspecies of *G. lutescens* have been suggested, none are widely recognized [3]. It is suspected to hybridize with *G. bursarius* in some localities [4].

Description:

Like all pocket gophers, Sand Hills Pocket Gopher is adapted to fossorial life with large foreclaws, a heavy skull, strong jaw muscles, and relatively inconspicuous ears and eyes. It is similar in general appearance to the formerly synonymous *G. bursarius*, which has a sparsely-haired tail and relatively short pelage that can vary substantially in color from buff to black [5]. However, *G. lutescens* is somewhat smaller and lighter in pelage color than *G. bursarius* and other sympatric gophers [2, 4], the latter characteristic likely being adaptive coloration such that pelage color matches the generally light-colored, sandy soils in which they are found [6].

Distribution & Range:

Sand Hills Pocket Gopher has a very small range that is restricted to northern and western Nebraska and small portions of South Dakota, Wyoming and Colorado [2, 3]. Although the exact boundaries of the range are uncertain [2], it is smaller than the range assigned to the former subspecies *G. b. lutescens*, which included parts of Kansas and Colorado [1]. This change does not likely represent a range contraction, but rather improved delineation of species distributions resulting from recent surveys and refined taxonomic analyses. Like its former parent species, *G. bursarius*, Sand Hills Pocket Gopher distribution may be somewhat patchy within its range and dependent upon soil characteristics [4], though there is no evidence of restricted gene flow among populations.

Habitat:
Like all pocket gophers, Sand Hills Pocket Gopher is largely fossorial, living entirely in burrow complexes that are often vigorously defended from the intrusion of other gophers [5]. *G. lutescens* burrows occur in grassland and steppe habitats [7] and are largely confined to areas of relatively fine, sandy soil characteristic of the Sand Hills region of Nebraska and neighboring states [2]. The only study occurring in Wyoming found Sand Hills Pocket Gopher (i.e., *G. bursarius* within the likely range of *G. b. lutescens*, and thus likely to be *G. lutescens*) was restricted to "deep, fine-textured soils covered by various vegetation on the floor of the plains, sand hills, and barrow pits along roads," as opposed to the more generally-distributed sympatric Northern Pocket Gopher (*Thomomys talpoides*) [8].

Phenology:
Very little information is available for the phenology of *G. lutescens*, though it is likely similar to *G. bursarius*. *G. bursarius* mating begins in early spring depending on local climate, with young born throughout the spring and summer (most commonly April–July) after an 18–19 day gestation. There are about 4 young per litter, and they stay with the mother for roughly 2 months before dispersing. Females can breed within 3 months of birth, but males often do not reach sexual maturity until the following year [9].

Diet:
Sand Hills Pocket Gopher consumes a wide variety of plant material, primarily roots and stems of common grasses, rushes, and forbs [10 11]. Grass species seem to be most common in the diet, with Needle-and-Thread Grass (*Hesperostipa comata*) being potentially prominent [10 12].

CONSERVATION CONCERNS

Abundance:
Continental: REGIONAL ENDEMIC
Wyoming: UNCOMMON
There are no studies quantifying the abundance of Sand Hills Pocket Gopher in Wyoming. One study elsewhere in the range of *G. lutescens* found them to be common, with fresh mounds occupying 4.8–8.4% of the landscape surface in study sites in the Niobrara Valley Preserve of central Nebraska [11]. Given *G. lutescens* association with particular soil types, the areas where such densities occur are likely patchy within its range [4], so this species is probably less common, overall, than more generalist gophers like *T. talpoides*. Further, since *G. lutescens* range in Wyoming is very small, the total population size in the state is likely not large, even if the species is locally abundant.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN

There are no estimates of population trends for *G. lutescens* anywhere within its range. Populations of its former parent species, *G. bursarius*, are considered stable by the International Union for Conservation of Nature [13].

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Sand Hills Pocket Gopher appears to be restricted to a narrow range of habitats typified by the Sand Hills of Nebraska (i.e., grassland and shrubland habitats with well-developed, sandy soils), thus resulting in a restricted range and relatively patchy distribution. Given that it is a small, fossorial mammal, dispersal ability may be limited, but there is no evidence that this is biologically restrictive. Sand Hills Pocket Gopher does not appear to exhibit reproductive restrictions that would make it particularly vulnerable.

Extrinsic Stressors:
SLIGHLTY STRESSED
Although most land altering disturbance has the potential to affect local populations, there is no direct evidence that Sand Hills Pocket Gopher populations are stressed by current anthropogenic activities. Habitats within Sand Hills Pocket Gopher range in Wyoming are affected by agriculture, including cattle grazing and conversion to cropland, but it is unknown how these activities affect the species. Much of the Sand Hills ecoregion is still intact, partly because the fragility of the soils has limited grazing and extensive crops; however, there is evidence that overgrazing, when it occurs, could result in reduction of forage species preferred by *G. lutescens*, such as Needle-and-Thread Grass [14]. Because pocket gophers are sometimes considered pests, they are subjected to local extermination due to conflicts with residential landowners or farmers concerned with potential damage to crops [13].

KEY ACTIVITIES IN WYOMING
There are currently no activities in Wyoming directed specifically toward Sand Hills Pocket Gopher.

ECOLOGICAL INFORMATION NEEDS
Assessment of Sand Hills Pocket Gopher status in Wyoming is hampered by lack of information regarding its distribution, abundance, population trends, and potential stressors. Improved information on Wyoming distribution and habitat use is necessary to guide management activities. Better information on how Sand Hills Pocket Gopher responds to events that alter native grassland communities would be helpful in estimating the impact of potential stressors. Estimates of abundance (and/or occupancy rates) are important to establish an accurate conservation rank and as a baseline for eventual population monitoring that can be used to assess trends over time.

MANAGEMENT IN WYOMING
This section authored solely by WGFD; Nichole L. Bjornlie. Little is known about Sand Hills Pocket Gopher in Wyoming. Consequently, management priorities for the species in the short-term will focus on addressing these data deficiencies. Of particular importance are data on presence, distribution, population status and trends, habitat use and availability, and the impact of potential threats, all of which will ultimately be used to develop management and conservation recommendations. Because of the presumed low density and patchy distribution of

Sand Hills Pocket Gopher on the landscape, acquiring these data will likely require targeted survey efforts.

CONTRIBUTORS

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Figure 1: A Sand Hills Pocket Gopher in northwestern Nebraska. (Photo courtesy of Dale G. Luce)

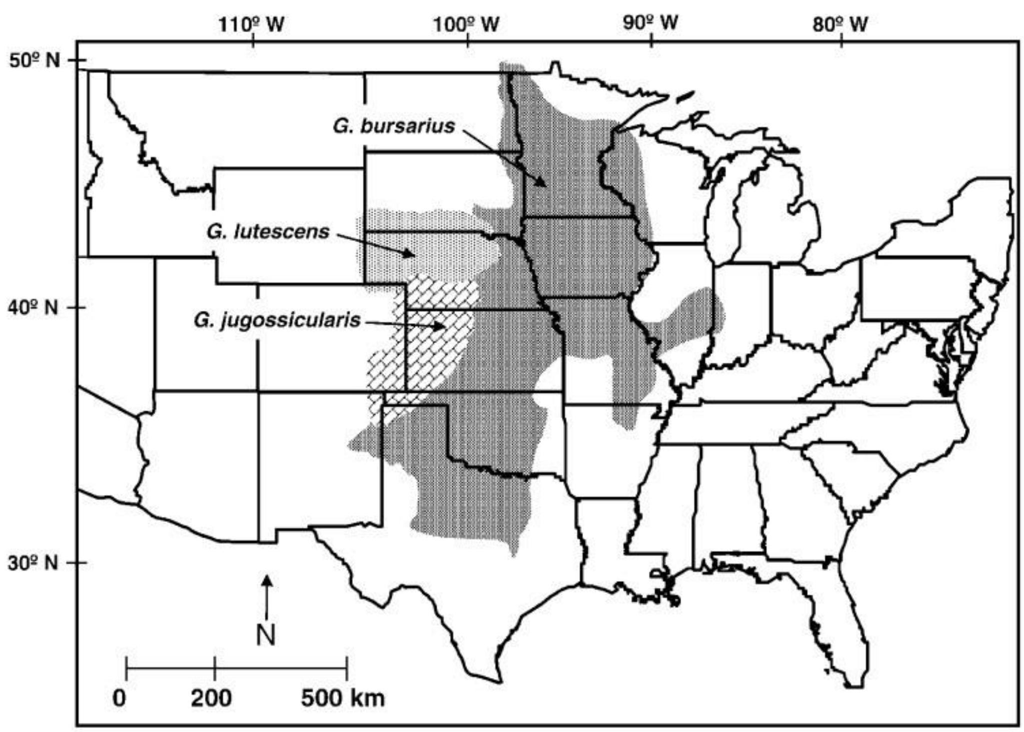

Figure 2: North American range of *G. lutescens* and other pocket gophers formerly conspecific with *G. bursarius*. (Map from: Genoways, H. H., et al. (2008) Hybrid zones, genetic isolation, and systematics of pocket gophers (genus Geomys) in Nebraska, *Journal of Mammalogy 89*, 826-836.)

Figure 3: Sand Hills Pocket Gopher habitat (with gopher mounds) in northwestern Nebraska. (Photo courtesy of Dale G. Luce)

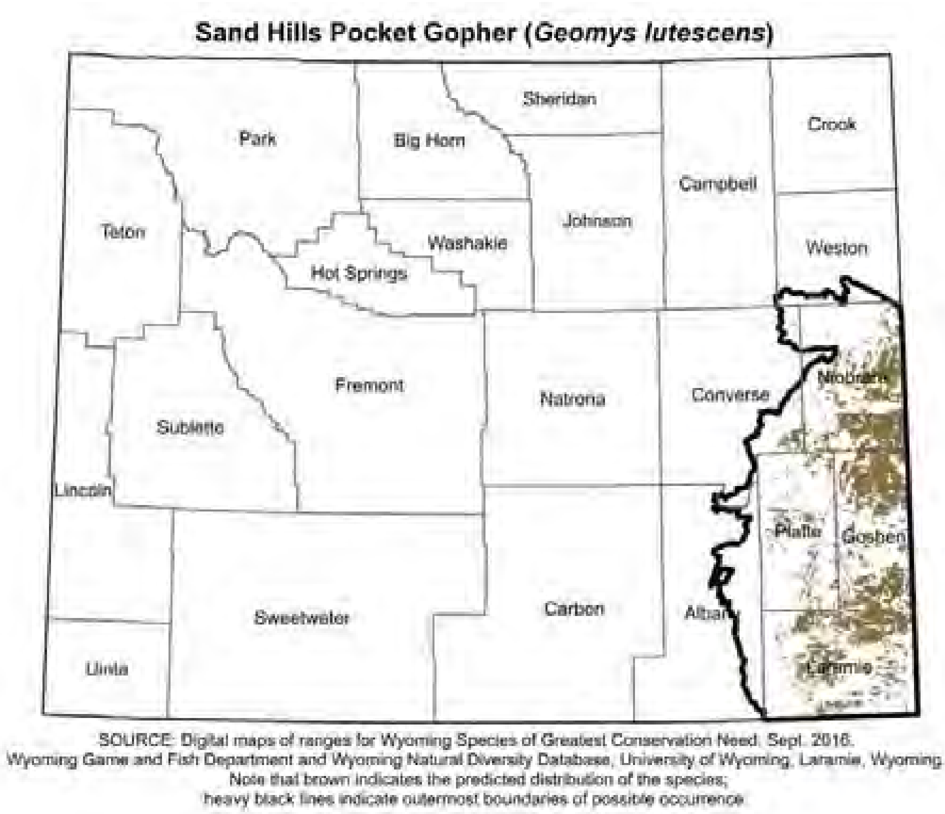

Figure 4: Range and predicted distribution of *Geomys lutescens* in Wyoming.

Silky Pocket Mouse

Perognathus flavus

REGULATORY STATUS

USFWS: No special status
USFS R2: No special status
UWFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS

USFWS: No special status
WGFD: NSSU (U), Tier III
WYNDD: G5, S2S4
Wyoming contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS

Silky Pocket Mouse (*Perognathus flavus*) is assigned a range of state conservation ranks by the Wyoming Natural Diversity Database (WYNDD) due to uncertainty concerning the abundance, population trends, and amount of occupied habitat in Wyoming.

NATURAL HISTORY

Taxonomy:

Silky Pocket Mouse is a member of the family Heteromyidae, which includes the pocket mice and kangaroo rats [1]. There are 14 recognized subspecies of *P. flavus*, two of which may occur in Wyoming: *P. f. piperi* and *P. f. bunkeri* [2]. Most, if not all, of Wyoming's Silky Pocket Mice are likely *P. f. piperi*, with *P. f. bunkeri* potentially occurring in small portions of extreme southeastern Wyoming. Recent genetic evidence reveals complexity in the sub-specific designations that may call some subspecies into question, but those results are not likely to affect the taxonomy of Wyoming animals [3].

Description:

Silky Pocket Mouse is one of the smallest pocket mice in North America. As the name implies, the dorsal fur of Silky Pocket Mouse is long, soft (i.e., 'silky'), and pinkish-buff with blackish-tipped guard hairs, while the ventral fur and forelegs are white. Unlike other pocket mice in Wyoming, it has conspicuous postauricular patches of buff-colored fur that are usually twice the size of the ear and contrast markedly with the remainder of the dorsum [2]. *P. flavus* is similar to the Olive-backed Pocket Mouse (*P. faciatus*), but it has a shorter tail (often < 57 mm as opposed to 57–68 mm), has postauricular patches, and is generally smaller (< 115 mm total length as opposed to > 127 mm) [4]. *P. flavus* is also similar to Plains Pocket Mouse (*P. flavescens*), but it is darker due to black-tipped guard hairs, has more conspicuous postauricular patches (i.e., larger and contrasting more with dorsal pelage), and has a relatively shorter tail (i.e., roughly 86% of body length compared to > 90% in *P. flavescens*) [2].

Distribution & Range:
Wyoming is on the northwestern periphery of Silky Pocket Mouse range. The species range in Wyoming may be greater than suggested by continental range maps, extending into Campbell and Weston counties, but Wyoming still represents < 5% of the species' global range. The range of *P. f. piperi*, the predominant subspecies in Wyoming, extends largely east from Wyoming into Nebraska, while *P. f. bunkeri* occurs largely south of Wyoming in Colorado, Kansas and Oklahoma. There has been no apparent shift in the species' range in Wyoming or globally, although there is no formal survey data with which to confirm this.

Habitat:
Silky Pocket Mouse seems to prefer valley bottoms with well-developed, often sandy or loamy soils. Preferred vegetative structure is generally a mix of weedy vegetation and shrubs [2] that is sometimes characterized as dry, sparse grassland [5]. In the core of its range (e.g., New Mexico), high densities occur in areas with sparse or clumped grass cover with considerable open spaces [2]. In Wyoming, Silky Pocket Mouse seems to occur over a range of grass-shrub communities, perhaps favoring short stature (< 25 cm) grama-needle grass and mixed sagebrush-grassland communities [6]. Silky Pocket Mouse may be more tolerant of habitat variation than other pocket mice, sometimes being found in rockier areas with harder soils [2]. Silky Pocket Mouse uses burrows throughout the year, and is thus restricted to areas with soil that will retain tunnels. Burrows are often constructed at the base of shrubs or other plants with persistent structure (e.g., yucca, cactus), usually have multiple entrances, and have a complex system of tunnels and rooms, including a central room, a nesting chamber, and multiple storage rooms.

Phenology:
Considering the whole range of the species, the breeding season of Silky Pocket Mouse extends from February through October, though there is strong geographic variation, and breeding in the northern portion of the range is likely much more restricted to summer months [2]. Females usually have a single litter of 2–6 young per year after a 26-day gestation, but second litters are possible under the right conditions, particularly in the south of its range. Young are weaned in about 28 days [7]. If spring and summer are sufficiently long with adequate food resources, young born in early spring may become sexually mature, and even reproduce, by late summer. Silky Pocket Mouse is active all winter long, but undergoes regular bouts of torpor in cool winter climates for a couple days at a time [2]. Winter activity is more restricted to burrows than other seasons, and although the species extensively caches foods in burrows, it may periodically forage above ground throughout the year. Silky Pocket Mouse is apparently very short-lived, with most individuals living only a few months; few live > 20 months and very few may live as long as 3 years [2].

Diet:
Like other pocket mice, Silky Pocket Mouse is primarily a granivore, mostly consuming seeds of grasses and herbaceous plants and, to a lesser extent, the seeds of shrubs, with green vegetation and insects being occasional dietary components [7]. Silky Pocket Mouse relies on metabolic water from its food, and therefore does not require regular access to drinking water [2]. Silky Pocket Mouse may prefer smaller grass and weed seeds compared to the larger seeds of some grasses or shrubs [2].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
There are no quantitative estimates of abundance for Silky Pocket Mouse across its range. Local population densities seem to fluctuate greatly among sites, seasons, and years. Reported density ranges ≤ 53 per hectare, but is typically on the order of 1–3 per hectare [2, 8]. In suitable habitat of the Southwest, *P. flavus* can be locally abundant relative to other species. For example, it represented the second and third most abundant species captured in two studies in southern Arizona [8, 9]. In Wyoming, abundance seems to be much lower, with studies reporting < 6 captures per 1000 trap nights [6] and only 3 captures after several thousand nights of trapping in Thunder Basin National Grassland [10]. A recent statewide survey for pocket mice in Wyoming caught no Silky Pocket Mouse from roughly a dozen grassland sites within its range, despite using methods geared toward collecting pocket mice [11], further suggesting that it may be a rare species in the state.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
There are no estimates of historic or recent population trends for Silky Pocket Mouse in Wyoming, or elsewhere. The International Union for Conservation of Nature classifies populations of Silky Pocket Mouse as stable [12], although there is no direct information to support this conclusion.

Intrinsic Vulnerability:
LOW VULNERABILITY
Silky Pocket Mouse exhibits few restrictions that could make it vulnerable to disturbance. Although it has a very short life span (generally less than a year), it produces litters of 2–6 young and can reproduce multiple times per year under ideal conditions [2]. Although moderate specialization on grassland habitats results in a relatively patchy distribution, it does not appear to be so restrictive as to make Silky Pocket Mouse particularly vulnerable.

Extrinsic Stressors:
MODERATELY STRESSED
Threats to Silky Pocket Mouse in Wyoming are largely speculative. It could be impacted by invasive species, particularly nonnative plants such as Cheat Grass (*Bromus tectorum*), as suggested by studies of other pocket mice [9], and grasslands in Wyoming have been impacted by such invasions. Habitats within Silky Pocket Mouse range in Wyoming are affected by agriculture, including cattle grazing and conversion to cropland, but it is unclear how these activities affect the species. In Arizona, Silky Pocket Mouse was shown to respond positively to fire in un-grazed grasslands, hypothetically because it created a sparsely-structured habitat that was more conducive to pocket mice than other rodents [5], although this pattern did not occur in the presence of grazing, suggesting potentially negative synergistic effects of grazing and fire. Climate change can cause shifts in Silky Pocket Mouse populations, as evidenced by long-term studies in Arizona where increased winter precipitation was linked with establishment of cool-season C3 woody shrubs at the expense of warm-season C4 grasses, resulting in a dramatic reduction in *P. flavus* abundance [8]. The extent to which any of these factors are actually affecting Silky Pocket Mouse populations in Wyoming is unclear.

KEY ACTIVITIES IN WYOMING

The Wyoming Game and Fish Department has recently funded two studies relating (directly or indirectly) to Silky Pocket Mouse in Wyoming. First, from 2013–2015 the Wyoming Cooperative Fish and Wildlife Research Unit evaluated the impact of Cheatgrass (*Bromus tectorum*) on small mammal communities in Thunder Basin National Grassland [10]. Second, WYNDD initiated a study in 2015 to refine distributions, estimate occupancy rates, and assess habitat selection for several species of pocket mouse in the state [11, 13]. This project has an expected completion in 2017.

ECOLOGICAL INFORMATION NEEDS

Assessment of Silky Pocket Mouse status in Wyoming is hampered by limited information regarding its distribution, habitat use, abundance, and population trends. Improved distribution and habitat information are necessary to develop refined estimates of potential impact from development activities across Wyoming's basins. Better information on how Silky Pocket Mouse responds to events that reduce grass production and seed set in shrub-grasslands, including management practices and invasive plants, would be helpful. Estimates of abundance and/or occupancy rates are important to establish an accurate conservation rank and as a baseline for eventual population monitoring that can be used to assess trends over time.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Silky Pocket Mouse is assigned an NSSU rank because survey data that would provide for an assessment of population status are lacking. Consequently, priorities in Wyoming in the short-term will focus on addressing these data deficiencies. Of particular importance are data on population status and trends and a more refined understanding of distribution within the state. Because of the low density and patchy distribution of Silky Pocket Mice on the landscape, acquiring these data will likely require targeted survey efforts. Additional priorities will focus on assessing limiting factors and habitat requirements, including the impact of invasive species and energy development, which will ultimately be used to develop management and conservation recommendations.

CONTRIBUTORS

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Figure 1: A Silky Pocket Mouse in the short-grass prairie of Logan County, Kansas. (Photo courtesy of Brian Zinke)

Figure 2: North American range of *Perognathus flavus*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

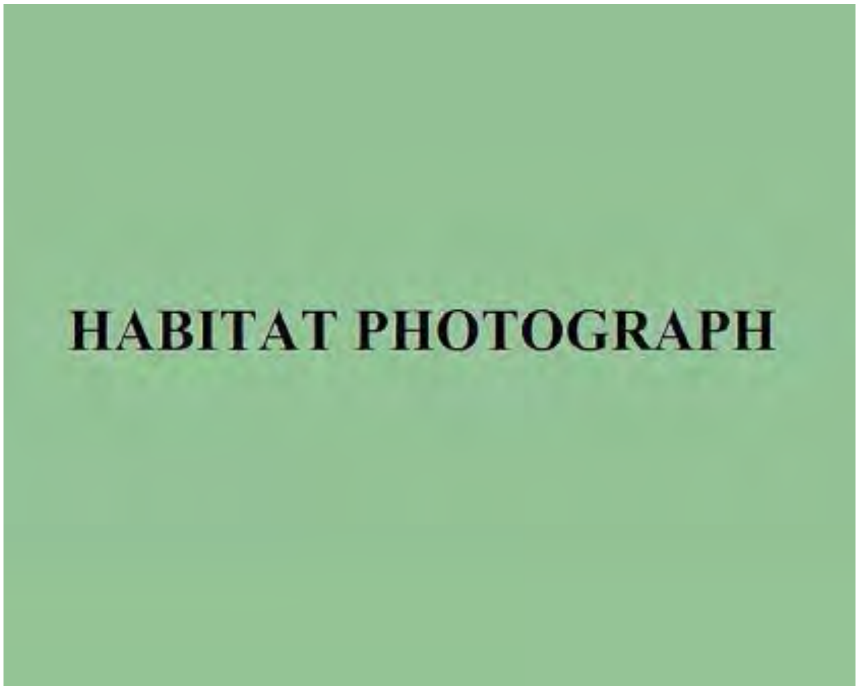

Figure 3: Photo not available.

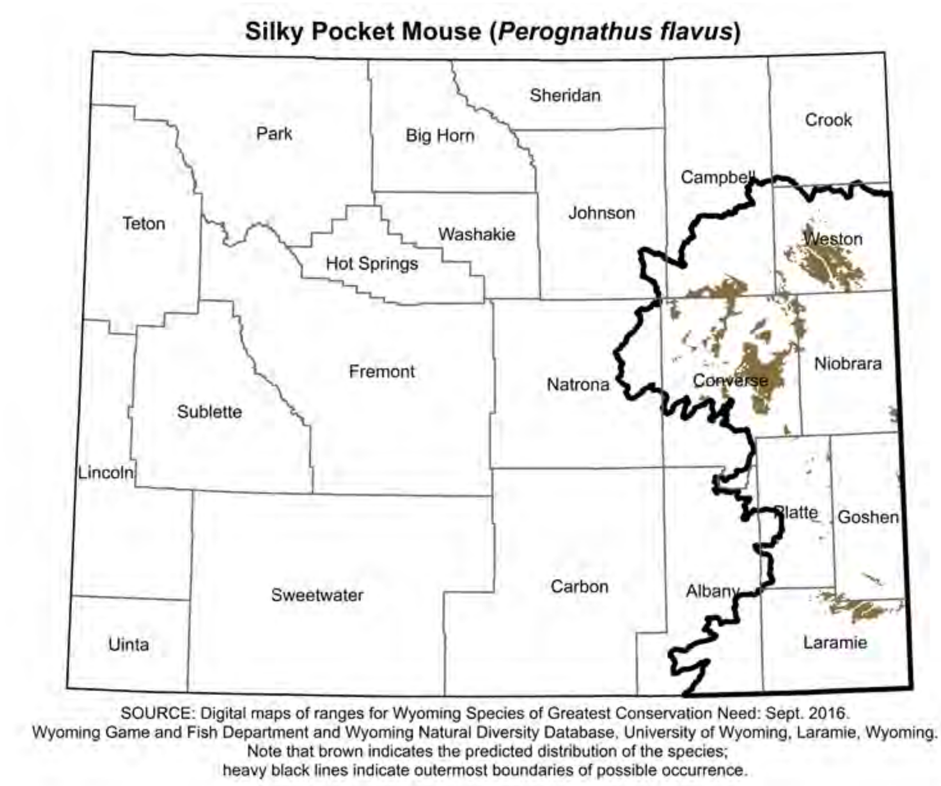

Figure 4: Range and predicted distribution of *Perognathus flavus* in Wyoming.

Spotted Bat
Euderma maculatum

REGULATORY STATUS
USFWS: No special status
USFS R2: Sensitive
UWFS R4: Sensitive
Wyoming BLM: Sensitive
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS4 (Bc), Tier III
WYNDD: G4, S1S2
Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS
Spotted Bat (*Euderma maculatum*) is assigned a range of state conservation ranks by the Wyoming Natural Diversity Database (WYNDD) due to uncertainty about the species' range and population trends in the state.

NATURAL HISTORY
Taxonomy:
The genus *Euderma* is monotypic, and there are no known subspecies of Spotted Bat [1, 2].

Description:
In hand, Spotted Bat is unmistakable. Spotted Bat is among the largest of the vespertilionid bats, with a total length of 10.5–11.5 cm and a wingspan of 34–38 cm [2, 3]. In adults, the ventral side is white; the dorsal side is black with three large white spots, one at the base of the tail and one on each shoulder; and the ears and wing membranes are pink. Due to this unique coloration, Spotted Bat is occasionally referred to as Pinto Bat [4]. The ears are very large, long (45–50 mm), and wide. Males and females are similar in size and appearance. Young juveniles lack distinctive pelage [1], and the growth plates in the phalanges of juveniles are visible throughout the first summer [5]. Spotted Bat produces echolocation calls that are audible to humans (12 to 6 kHz) [3], which allows for detection and identification of flying individuals.

Distribution & Range:
Spotted Bat occurs throughout western North America from southern British Columbia, Canada south to Jalisco, Mexico [3]. Historically, few records were available for Spotted Bat, and the known range of Spotted Bat in the United States has subsequently expanded as sampling for bats has increased [1, 6, 7]. Spotted Bat occurs in northwestern, north-central, and southwestern Wyoming. Northern Wyoming marks the northeastern extent of known Spotted Bat range. All records for Spotted Bat in Wyoming occur in the Bighorn Basin in north central Wyoming and the lower portion of the Green River Basin in south central Wyoming [4]. Confirmed observations

have been documented in 7 of the 28 latitude/longitude degree blocks in Wyoming, although confirmed breeding has been documented in only 1 degree block [8].

Habitat:
Spotted Bat occupies a wide array of habitat types ranging from below sea level to 2,700 m in elevation, including desert shrublands; piñon-juniper (*Pinus edulis-Juniperus* spp.) forests; subalpine meadows; and coniferous forests composed of Ponderosa Pine (*P. ponderosa*), Douglas-fir (*Pseudotsuga menziesii*), and White Fir (*Abies concolor*) [2, 3]. Regardless of habitat type, necessary habitat characteristics include large rock features, such as cliffs, with cracks and crevices for roosting that are near permanent water and open areas for foraging [2, 7, 9]. South-facing roosts may be particularly important for females [9], and Spotted Bat shows high fidelity to roost locations [3]. At night, Spotted Bat has also been observed roosting in trees between foraging bouts [2]. Man-made ponds for livestock may provide important sources of water and potential foraging habitat in arid areas [9]. Known locations of Spotted Bat in Wyoming conform to these habitat requirements and are near large cliffs or canyons with cracks or fissures, bare rock walls, and rocky ridges that provide suitable roost sites and are close to a permanent water source. It is suspected that roost availability near foraging areas drives occurrence patterns more than vegetation type, as vegetation surrounding roost sites varies [10]. There are no records of Spotted Bat in Wyoming during winter [2] and no known Spotted Bat hibernacula. It is unknown if the species migrates out of the state during winter or hibernates locally; winter range and hibernacula are poorly known overall.

Phenology:
Little is known about timing of migration or reproductive events of Spotted Bat. Breeding likely occurs in late summer [3], with females employing delayed implantation, or early spring [2]. In Texas, a pregnant female gave birth on 11 June, suggesting parturition likely occurs in May or June [1, 3]. Like many bat species, Spotted Bat likely produces a single altricial pup annually [1]. Little is known about migration patterns; individuals at lower elevations may not migrate, and southern populations may be active year-round [3].

Diet:
Spotted Bat feeds almost exclusively on flying moths (99.6% of diet), including species in the families Noctuidae, Lasiocampidae, and Geometridae [11]; the lower frequency of calls emitted by Spotted Bat may make them less detectible to their moth prey [12]. Beetles (Coleoptera), grasshoppers (Orthoptera), and other insects, including Hemiptera, are also consumed [1, 2, 11]. Spotted Bat tends to forage at greater heights than other bats (> 10 m above ground) [13], which may contribute to the few number of mist-net captures in general.

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
Spotted Bat is rare range-wide, but may be locally abundant in suitable habitat, particularly in southern British Columbia and portions of Arizona, Utah, Texas, and Colorado [2, 3, 7, 14]. However, Spotted Bat typically represents a small proportion of captures (< 0.5%) overall [3] and comprises only a small proportion of total detections in studies of bats in Wyoming [15-18], which may indicate low abundance in the state [2]. The species was first documented in Wyoming in 1960 [19],

but only 2 records are available for Spotted Bat prior to 1990 [10]. Subsequent survey efforts have increased the number of known records in the state to approximately 100 as of 2014.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends for Spotted Bat in Wyoming are unknown. Changes in the number of observations over time likely reflect survey effort rather than an increase in population size or distribution [2, 7].

Intrinsic Vulnerability:
HIGH VULNERABILITY
Spotted Bat occurs in disjunct, low density subpopulations, making local populations vulnerable to habitat changes or disturbances [2]. Although foraging habitat is variable, prominent rock features such as cliffs typically used for roosting are a relatively rare landscape feature [2, 3], and proximity of suitable roosting and foraging habitats likely limits Spotted Bat distribution [2, 7]. Additionally, the apparent specialization on specific moth species in the diet may further limit foraging habitat [2]. Spotted Bat is a long-lived species with very low reproductive rates and long generational turnover [1-3], which may limit population growth in the face of other stressors. Finally, Spotted Bat has been documented with rabies in California [20, 21]; although it is unknown to what degree the disease may impact populations.

Extrinsic Stressors:
SLIGHTLY STRESSED
Spotted Bat is potentially exposed to a number of extrinsic stressors; however, many of these still require targeted research in order to better understand if and to what degree they impact the species on a population level. Spotted Bat is sensitive to disturbance while roosting and may abandon a site if disturbed. Although roost sites tend to be remote, which may insulate them from disturbance, recreational rock climbing, water impoundment projects, and urbanization may have the potential to impact populations on a local scale [2, 3]. Furthermore, cliffs are the only roosting habitat in which reproductive females have been observed, indicating the importance of these features to the species [5]. Habitat alteration also poses an extrinsic threat to Spotted Bat, especially the loss or degradation of foraging habitat. Desertification from livestock overgrazing, conversion of wetlands to more xeric sites, and timber harvest in riparian areas may adversely impact the species in Wyoming by removing water sources or limiting insect prey. A potential threat to most bat species is pesticide use, which reduces food resources and may lead to acute poising or chronic effects; although it is unknown to what degree this affects Spotted Bat in Wyoming. Additionally, waste collection ponds and reserve pits from coal bed methane and oil drilling operations have the potential to negatively impact bats [2, 3]. Wind turbines have also impacted bat populations in many areas. Spotted Bat has not been significantly impacted to date, but it is possible that the species may be impacted if wind energy development occurs in areas of local species abundance. Although collection of Spotted Bat by humans was historically a chief threat to the species [2], permitting requirements by state agencies for take has likely limited this threat. Finally, white-nose syndrome (WNS) has affected bat populations in the eastern United States [22]. WNS does not currently exist in Wyoming and it is unknown if it affects Spotted Bat; natural history traits of Spotted Bat such as low density and small roost size may make Spotted Bat populations fairly resistant to WNS.

KEY ACTIVITIES IN WYOMING

In recent years, bats have received increasing research attention across North America and in Wyoming. To address concerns regarding potential WNS infection of bats in Wyoming, the Wyoming Game and Fish Department (WGFD) in cooperation with the Wyoming Bat Working Group authored "A strategic plan for white-nose syndrome in Wyoming" in 2011. This document presents a plan of action to minimize impacts of WNS if it is detected in Wyoming or adjacent states [22]. To facilitate early detection of the disease, WGFD requires researchers to use the Reichard Wing-Damage Index [23] to evaluate all bats captured during research activities for signs of WNS infection. WGFD conducts periodic surveys at known hibernacula throughout the state; however, no Spotted Bat hibernacula have been documented thus far. From 2008–2011 and 2012–2015, the WGFD conducted statewide inventories of bats in forested habitats and cliff and canyon habitats, respectively. Throughout the 8-year effort, 8 Spotted Bats were captured, representing 0–1.8% of captured bats annually, and Spotted Bat was detected acoustically 45 times throughout the known range of the species in Wyoming [15-18]. In 2015, WYNDD developed a bat monitoring plan and initiated survey activities at Bighorn Canyon National Recreation Area (BICA). The primary objective of this monitoring plan is to develop a baseline activity level or other index of abundance for bats that can be used to detect changes in populations within BICA through time. Surveys thus far have detected Spotted Bat acoustically in this area [24, 25]. In addition to research, conservation organizations and federal and state agencies have developed outreach and education materials to inform the general public of the importance of bats and concerns regarding the persistence of bats in the future.

ECOLOGICAL INFORMATION NEEDS

Little is known about Spotted Bat life history in general. The species would benefit from more data on reproductive habits as well as habitat requirements year-round, including documenting important roost locations. Wyoming likely represents the upper altitudinal limit for the species, and Spotted Bat populations in Wyoming may demonstrate different distribution and structure than populations in other portions of the range, which may be important to conservation and management efforts. Detailed information is needed on the distribution of Spotted Bat in Wyoming, including if and when the species migrates and the locations of hibernacula if Spotted Bat overwinters in the state. Information is also lacking on abundance and population trends in Wyoming. Finally, additional data are needed on how Spotted Bat is potentially impacted by extrinsic stressors in the state, including energy development and land management practices that may result in loss or degradation of both roosting and foraging habitat.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Little is known about Spotted Bat in Wyoming. Consequently, management priorities for the species in the short-term will focus on addressing these data deficiencies, including data on presence, abundance, and population trends. In addition to on-going and future inventory projects for bats, WGFD, in collaboration with the Wyoming Bat Working Group and other state-wide partners, is implementing the North American Bat Monitoring Program that will use acoustic monitoring to assist with state and region-wide assessments of bat trends. However, given the rarity of Spotted Bat and its patchy distribution on the landscape, targeted survey efforts may be needed to adequately monitor population trends. Information on habitat requirements throughout the year and wintering locations of Spotted Bat, if it hibernates in the state, is needed, and additional priorities will focus on further defining the distribution of the species and locating and monitoring roost locations. Habitat assessments will also be incorporated with survey efforts to better understand what influences species presence and distribution at a finer scale to help direct management and conservation efforts. Mist-net surveys will continue to implement WNS protocols and assessment in an effort to assist with early detection should the disease reach the state. Additional priorities will include updating and revising the Conservation Plan for Bats in Wyoming [5] as well as the Strategic Plan for WNS in Wyoming [22]. Finally, outreach and collaboration with private landowners will remain a priority to ensure conservation of bats and bat habitat.

CONTRIBUTORS

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Figure 1: Ventral view of a Spotted Bat captured in Wyoming. (Photo courtesy of Shelly Johnson, WGFD)

Figure 2: North American range of *Euderma maculatum*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Spotted Bat habitat in Devil's Canyon in Bighorn Canyon National Recreation Area, Montana. (Photo courtesy of Robert J. Luce)

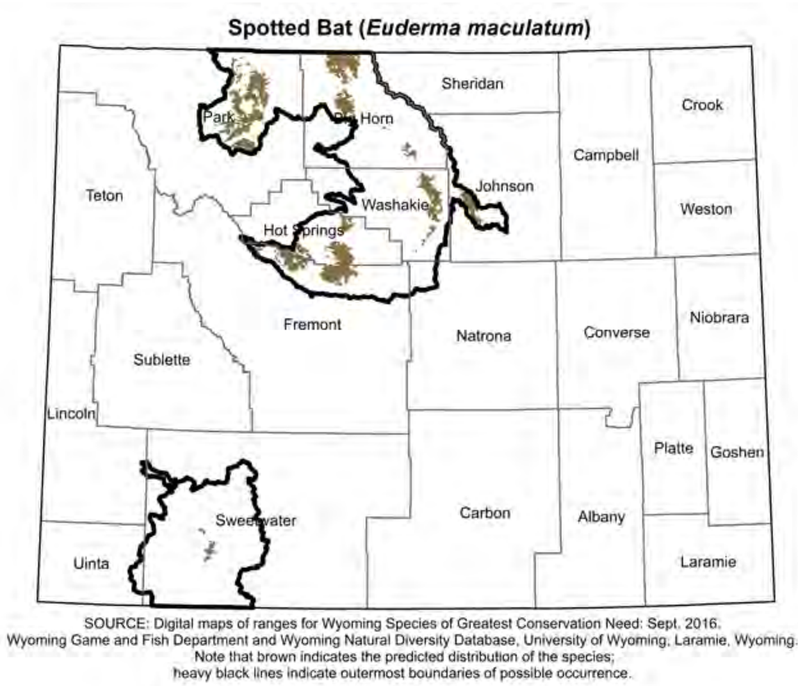

Figure 4: Range and predicted distribution of *Euderma maculatum* in Wyoming.

Figure 5: Dorsal view of a live-captured Spotted Bat showing the species' distinctive spots and coloring. (Photo courtesy of Shelly Johnson, WGFD)

Spotted Ground Squirrel
Xerospermophilus spilosoma

REGULATORY STATUS
USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife; Pest

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS4 (Bc), Tier III
WYNDD: G5, S2S5
Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS
In Wyoming, management of Spotted Ground Squirrel (*Xerospermophilus spilosoma*) is shared by the Wyoming Game and Fish Department (WGFD), which classifies the species as Nongame Wildlife, and the Wyoming Department of Agriculture, which classifies all ground squirrels as Pest species. The Wyoming Natural Diversity Database has assigned Spotted Ground Squirrel a state conservation rank ranging from S2 (Imperiled) to S5 (Secure) because of uncertainty about the abundance, state range, proportion of range occupied, and population trends for this species in Wyoming.

NATURAL HISTORY

Taxonomy:
Following the reclassification of the genus *Spermophilus* in 2009, Spotted Ground Squirrel (formerly *S. spilosoma*) was moved to the genus *Xerospermophilus* [1, 2]. There are 13 recognized subspecies of Spotted Ground Squirrel [1], but only *X. s. obsoletus* is found in Wyoming [3-5].

Description:
Identification of Spotted Ground Squirrel is possible in the field. Spotted Ground Squirrel is a small ground squirrel. Dorsal pelage ranges from smoke gray to various shades of brown with scattered white or buff dorsal spots, and the venter is whitish. The head is characterized by small ears and large, dark eyes rimmed by white or buff hair [3, 4, 6]. Males and females are similar in size and appearance. Adults weigh between 166–195 g, and total length ranges from 185–253 mm [4]. Tail, hind foot, and ear length ranges from 55–92 mm, 28–37 mm, and 6–8 mm, respectively [4]. Within its Wyoming distribution, Spotted Ground Squirrel can be distinguished from Wyoming Ground Squirrel (*Urocitellus elegans*) by its smaller size and presence of dorsal spots, and from Thirteen-lined Ground Squirrel (*Ictidomys tridecemlineatus*) by its lack of dorsal stripes.

Distribution & Range:
Spotted Ground Squirrel is widely distributed from southern South Dakota to central Mexico [7]. Southeastern Wyoming is on the extreme northwestern edge of the species' distribution, and Spotted Ground Squirrel is restricted to the southeastern corner of the state [3, 8]. Confirmed breeding has been documented in 3 of 28 latitude/longitude degree blocks in Wyoming [8].

Habitat:
Spotted Ground Squirrel is found in a wide variety of arid and semi-arid environments across its continental distribution including vegetated sand hills and dunes, desert scrubland, oak-mesquite grasslands and mesquite savanna, short-grass prairie, and sand sagebrush (*Artemisia filifolia*) grasslands [4-6, 9, 10]. This species may also utilize disturbed habitat adjacent to roadways and active cropland, as well as heavily grazed rangeland [6, 11]. Vegetation structure and soil type are important components of Spotted Ground Squirrel habitat. This burrowing species is most common in open environments with deep, dry, sandy soil and short, sparse vegetation [4-6]. In Wyoming, Spotted Ground Squirrel is known to inhabit High Plains vegetated dunes and short-grass prairie interspersed with Soapweed Yucca (*Yucca glauca*) or sagebrush (*Artemisia* spp.), with sand or loamy sand soil, dominant vegetation > 25 mm high, and < 60% vegetation cover [4, 6].

Phenology:
The breeding phenology and life history of Spotted Ground Squirrel in Wyoming are not well known. This species is diurnal but will regulate above-ground activity based on temperature and weather conditions [4-6]. Adults enter hibernation beginning in July (males) or September (females), with both sexes emerging in April. Breeding likely occurs between April and July. The gestation period of this species is unknown, but females give birth to a single litter of 4–12 altricial young. Young first venture from the nest burrow when they reach a body weight of 40–50 g but remain dependent on the mother for an additional 2–4 weeks [4-6].

Diet:
Spotted Ground Squirrel consumes a variety of seeds, flowers, grasses, forbs, and arthropods and may opportunistically prey on small mammals and reptiles [4, 6, 9, 10].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
There are no robust estimates of abundance available for Spotted Ground Squirrel in Wyoming. The species has an estimated statewide abundance rank of RARE and also appears to be rare within suitable environments in the occupied area [8].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends for Spotted Ground Squirrel in Wyoming are unknown.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Spotted Ground Squirrel has moderate intrinsic vulnerability in Wyoming. Spotted Ground Squirrel appears to have low abundance in the state, even within suitable habitat. Although the

species will use a wide variety of arid and semi-arid habitat types across its distribution, the High Plains vegetated dune and shortgrass prairie environment in the southeastern corner of the state is limited in extent in Wyoming. Spotted Ground Squirrel would likely have little opportunity for range expansion within the state should disturbance or loss of existing habitat occur.

Extrinsic Stressors:
SLIGHTLY STRESSED
Primary potential extrinsic stressors to Spotted Ground Squirrel in Wyoming are loss or degradation of existing habitat from natural or anthropogenic disturbances. Prairie grassland environments in the state are vulnerable to development for energy, infrastructure, and agriculture; invasive plant species; anthropogenic disturbance from off-road recreational activities; altered fire and grazing regimes; and drought and climate change [12]. Spotted Ground Squirrel has shown tolerance for disturbance from grazing and agriculture in other parts of its continental distribution [6, 11]. As a species that prefers open environments with a high percentage of bare ground, Spotted Ground Squirrel may be negatively affected by Cheatgrass (*Bromus tectorum*), Canada Thistle (*Cirsium arvense*), and other invasive plant species that can form tall, dense stands. However, it is not currently known how potential extrinsic stressors may impact Spotted Ground Squirrel in Wyoming.

KEY ACTIVITIES IN WYOMING

Spotted Ground Squirrel is classified as a Species of Greatest Conservation Need by the WGFD. There are currently no research or management projects designed specifically for Spotted Ground Squirrel in Wyoming.

ECOLOGICAL INFORMATION NEEDS

Spotted Ground Squirrel is not well studied in Wyoming, and little is known about the natural history or reproductive habits of this species in the state. Spotted Ground Squirrel would benefit from research to better understand its distribution and abundance. The impacts of natural and anthropogenic disturbances within Spotted Ground Squirrel's limited Wyoming distribution are largely unknown.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Spotted Ground Squirrel is classified as both a pest and a nongame species in Wyoming, and, as such, both the Wyoming Department of Agriculture and the WGFD have shared management authority for ground squirrels, which makes management of Spotted Ground Squirrel difficult. Overall, little is known about the species in Wyoming. Consequently, management priorities for the WGFD for the species in the short-term will focus on addressing these data deficiencies. Of particular importance are data on distribution, presence and abundance, population status and trends, and the impact of extrinsic stressors, all of which will ultimately be used to develop management and conservation recommendations.

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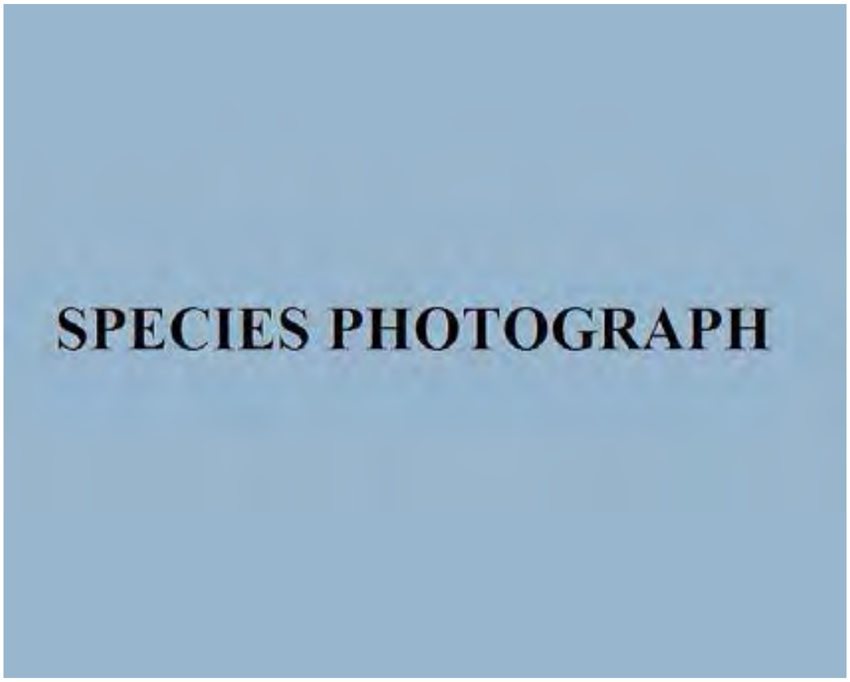

Figure 1: Photo not available.

Figure 2: North American range of *Xerospermophilus spilosoma*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

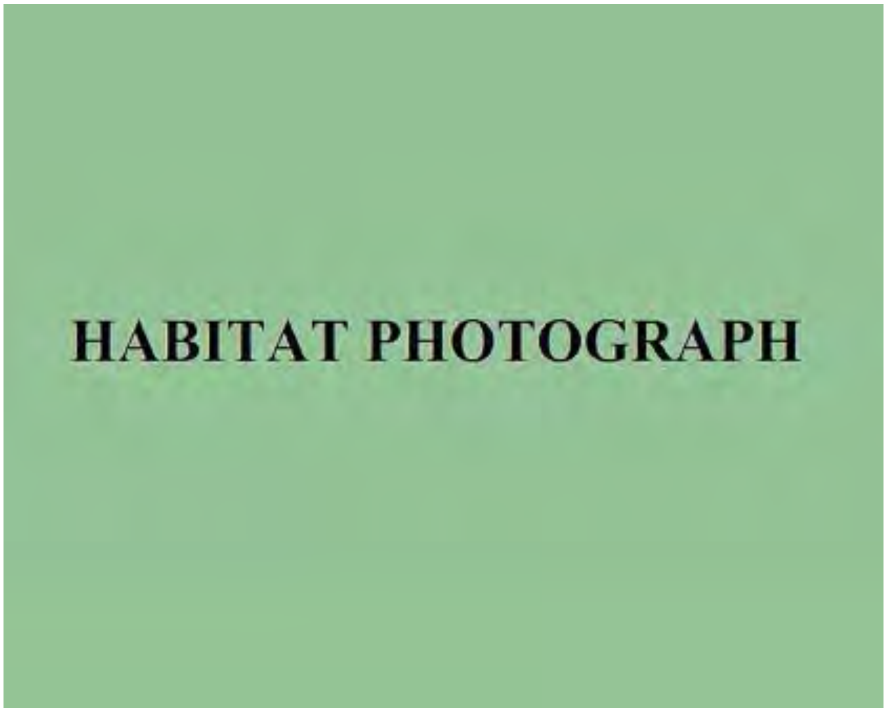

Figure 3: Photo not available.

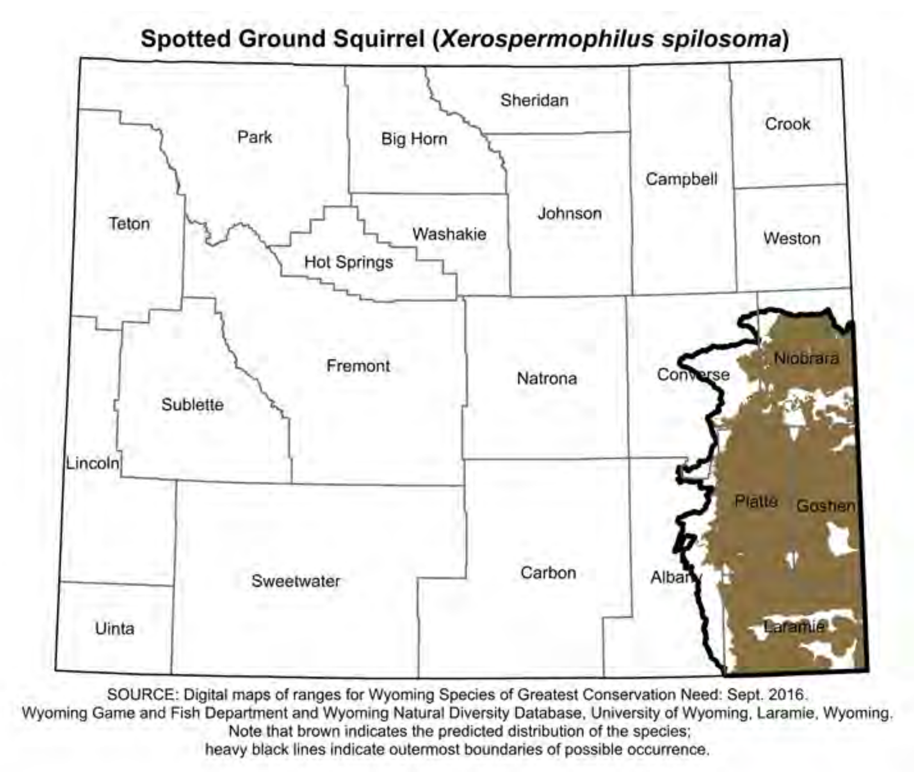

Figure 4: Range and predicted distribution of *Xerospermophilus spilosoma* in Wyoming.

Swift Fox
Vulpes velox

REGULATORY STATUS
USFWS: Listing Not Warranted
USFS R2: Sensitive
USFS R4: No special status
Wyoming BLM: Sensitive
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS4 (Cb), Tier II
WYNDD: G3, S2
 Wyoming contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS
Swift Fox (*Vulpes velox*) was petitioned for listing under the Endangered Species Act (ESA) in 1992. A "warranted but precluded" finding was issued in 1995 [1]. In 2001 that finding was changed to "not warranted" based on new information that suggested Swift Fox was more abundant and widespread and had greater flexibility in habitat and food requirements than originally thought [2].

NATURAL HISTORY
Taxonomy:
Although 2 subspecies were once described for Swift Fox, a later reevaluation removed the split. Consequently, there are no currently recognized subspecies of *V. velox* [3]. Some researchers suggest Swift Fox and Kit Fox (*V. macrotis*) are subspecies of the same species; however, genetic differentiation currently supports classification as distinct species [4].

Description:
Swift Fox can be identified by its small stature, black-tipped tail, and black spots on the side of the snout. It is the smallest canid species in the United States (adults 1.8–2.9 kg) [5]. Although males are larger than females, the sexes have similar coloring [5]. In winter the coat is dark buffy gray on the back; yellow-tan on the sides and legs; and pale yellow to white on the throat, chest, and belly. In summer the fur is shorter and redder in appearance. Kit Fox is easily confused with Swift Fox where they overlap, but Wyoming supports only Swift Fox [6]. In Wyoming, Swift Fox may be confused with Red Fox (*V. vulpes*), but Red Fox can be distinguished by a larger size, white-tipped tail, and black legs [5]. Very young Coyotes (*Canis latrans*) may also occasionally be mistaken for Swift Fox.

Distribution & Range:
The range of Swift Fox contracted greatly following European settlement of the plains in the 1800s. The species started to recover beginning in the 1950s, but Swift Fox remains absent from

most of its historic range [7]. Wyoming is located on the western edge of the species continental range. Within the state, Swift Fox distribution is largely unchanged from historic distribution [8]. Apparent westward range expansions have been documented in Wyoming, including roadkilled individuals observed near Farson and a pair of Swift Fox in Worland (pers. obs.).

Habitat:
Typical Swift Fox habitat consists of short-grass and mid-grass prairies with flat or gently sloping topography. However, Swift Fox also utilizes a mixture of non-native and atypical habitat throughout portions of their range, including agricultural croplands [9]. Habitat in Wyoming, for example, includes grasslands with a higher shrub component, including sagebrush (*Artemisia spp.*), greasewood (*Sarcobatus vermiculatus*), and saltbush (*Atriplex gardneri*) [10]. Within these sagebrush shrub communities, areas of lower-growing shrubs (≤ 30 cm) are used more often than those with taller shrubs [10, 11]. Swift Fox depends greatly on burrows (dens), which are used year-round for pup-rearing as well as refuge. Swift fox may excavate their own dens or enlarge old burrows from ground squirrels or Badgers (*Taxidea taxus*) [9]. Den sites are typically characterized by well-drained, loamy soils and flat terrain, sloping plains, and hill tops [6, 10]. Prairie dog (*Cynomys* spp.) colonies may also provide important habitat for Swift Fox, although this may vary throughout the range of the species [12].

Phenology:
Mating occurs between December and February, depending on latitude, and an average of 4–5 pups are born approximately 51 days later [9], with most young born in March or April [6]. Juveniles are nearly full grown within 4 to 5 months, and dispersal typically occurs in September and October [9]. Swift Fox may form pair bonds in December of their first year and reproduce the following spring [6].

Diet:
Swift Fox appears to be an opportunistic predator, and is known to consume mammals, insects (particularly grasshoppers), birds, herptiles, and grass. Small mammals, lagomorphs in particular, may be especially important [6]. Swift Fox diet in Wyoming is broad and tends to track prey abundance. However, the consumption of mammalian prey, including scavenged pronghorn (*Antilocapra americana*), is common year round [10]. Swift Fox is known to cache excess food under the snow in the winter months [8].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: UNCOMMON
Estimates of Swift Fox abundance in Wyoming are not available. The species is widely distributed across suitable habitat in the state [13, 14], and may be locally abundant, especially in Laramie County [5].

Population Trends:
Historic: MODERATE DECLINE
Recent: STABLE to INCREASE
Range-wide, Swift Fox populations started to decrease in the 1800s due to widespread habitat conversion and loss and poisoning campaigns targeting Coyotes. Swift Fox populations started recovering in the 1950s following changes in poisoning regulations. Recently, Swift Fox has

been documented well west of its assumed historic range boundary in the state (pers. obs.). Swift Fox demonstrated a slight decrease in occupancy rates at 48 grids throughout the predicted distribution in eastern Wyoming from 2010 to 2013 [14]. However, long-term trend analyses are still needed.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Across most of its range the Swift Fox depends on short- to mid-grass prairies, making the species sensitive to the threats affecting those ecosystems. In Wyoming, Swift Fox also utilizes a variety of non-native (e.g., short-stature dryland crops) and atypical (e.g., shrub-steppe) habitats that may insulate populations from habitat changes in traditional habitats [9, 10]. Environmental conditions and features that allow denning and predator avoidance may be the most important components of Swift Fox habitat [10, 15].

Extrinsic Stressors:
SLIGHTLY to MODERATELY STRESSED
Habitat alteration and loss may be the biggest current threat to Swift Fox range-wide. In Wyoming there has been little large-scale habitat modification [8]. However, in an evaluation of Swift Fox occupancy in eastern Wyoming, probability of local extirpation from 2010 to 2013 increased with length of time exposed to energy development [14]. Predation by Coyotes, and to a lesser extent raptors, is a major cause of direct mortality for Swift Fox; individuals are also often killed by vehicle collisions [9, 15, 16]. The widespread use of strychnine to kill carnivores has been banned, but Swift Fox remains susceptible to poisoning and trapping efforts that target larger carnivores and rodents [9], although it is unknown if this represents a major source of mortality for the species.

KEY ACTIVITIES IN WYOMING

Following the petition to list Swift Fox under the ESA the Wyoming Game and Fish Department (WGFD) and 9 other western state agencies founded the Swift Fox Conservation Team (SFCT) in 1994 in an effort to compile existing and future data, monitor and manage populations, and advance conservation and restoration of Swift Fox [12]. The Wyoming Cooperative Fish and Wildlife Research Unit conducted intensive field work near Medicine Bow, Wyoming from 1996 to 1999 to evaluate population characteristics, habitat, and survival of Swift Fox [10]. The WGFD began monitoring Swift Fox in 1999 in an effort to determine distribution throughout the state [17]. In 2009, the WGFD evaluated a number of detection and survey protocols [18] and, based on their findings, implemented an occupancy-based monitoring protocol beginning in 2010 [13]. Wyoming has also provided Swift Foxes to South Dakota in 2004–2006 and 2009, and Canada from 1994–1996, to assist with reintroduction efforts [19, 20].

ECOLOGICAL INFORMATION NEEDS

Swift Fox habitat use in Wyoming differs from other areas of the range. Although specific projects have focused on habitat characteristics throughout portions of the state, the apparently expanding distribution and larger shrub component present in Swift Fox habitat in Wyoming likely warrant further investigation. Additionally, research is needed to better understand the importance of prairie dog colonies to Swift Fox survival and reproduction in Wyoming. Finally, given the relatively recent and accelerating alteration of Swift Fox habitat by energy development, a deeper understanding of potential effects on Swift Fox populations and behavior is needed.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Management priorities for Swift Fox in Wyoming will continue to focus on evaluating trends and the impact of potential threats, including predation and energy development, on occupancy rates. Additional projects will evaluate and delineate the apparent westward expansion of Swift Fox in the state. The WGFD will also continue active participation in the SFCT and coordinating with landowners in order to promote information dissemination and conservation and management priorities.

CONTRIBUTORS

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Figure 1: A Swift Fox at a Black-tailed Prairie Dog (*Cynomys ludovicianus*) colony in the short-grass prairie of Logan County, Kansas. (Photo courtesy of Brian Zinke)

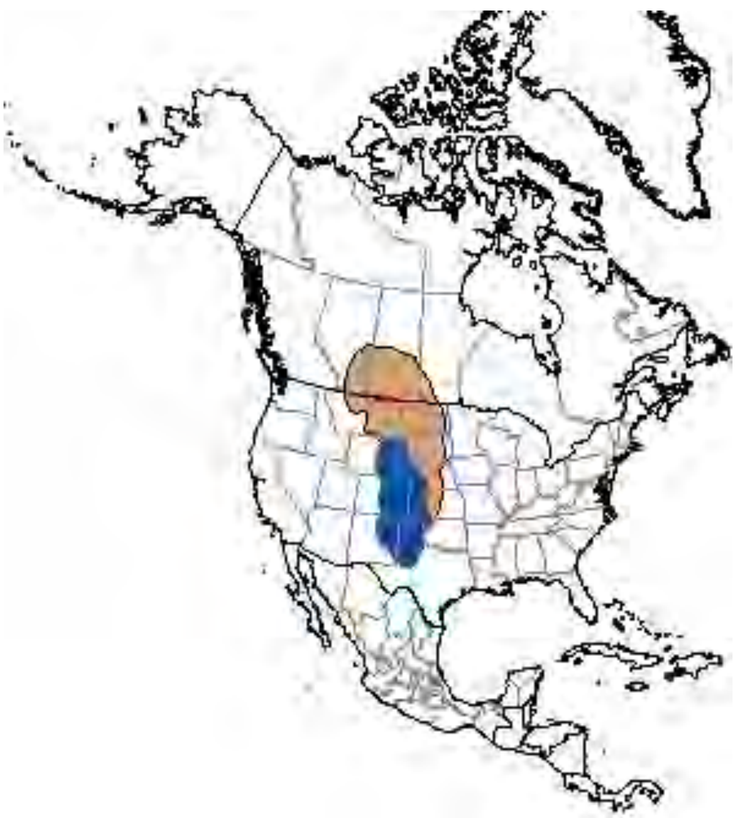

Figure 2: Current North American range of *Vulpes velox* in blue and historic range in brown. (Map modified from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Full moon over Swift Fox short-grass prairie habitat in the Shirley Basin, Wyoming. (Photo courtesy of Nichole L. Bjornlie)

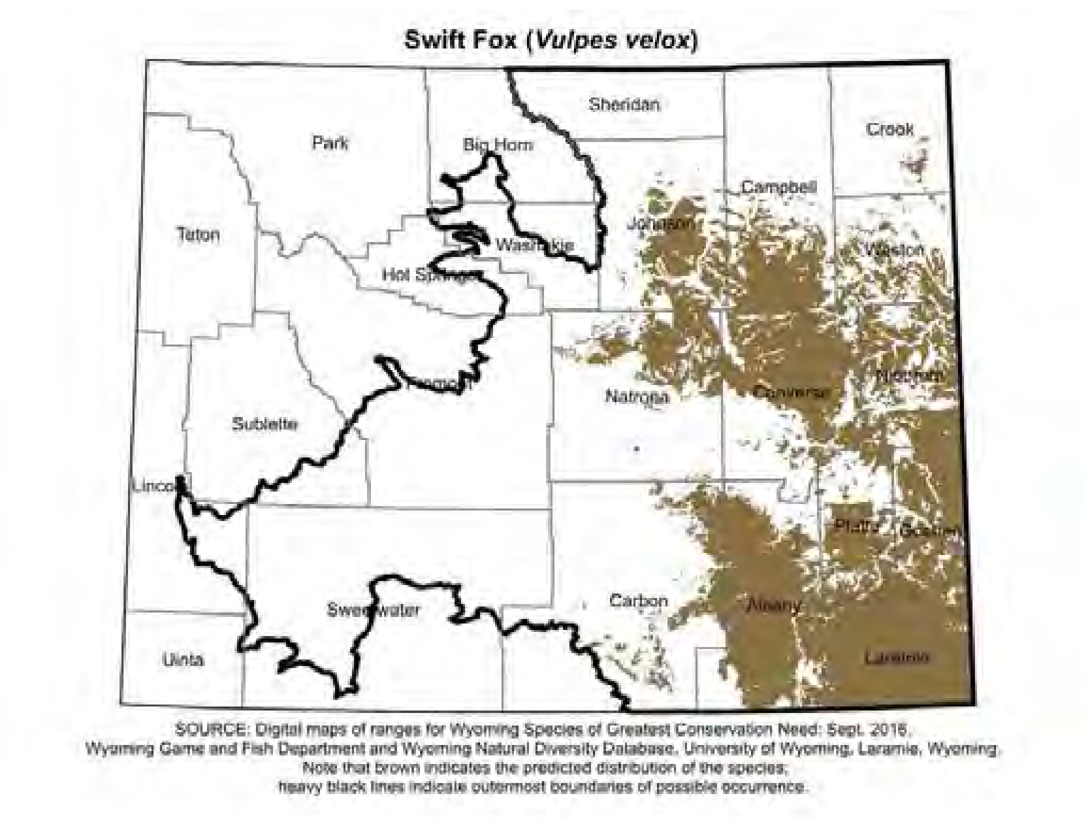

Figure 4: Range and predicted distribution of *Vulpes velox* in Wyoming.

Townsend's Big-eared Bat
Corynorhinus townsendii

REGULATORY STATUS
USFWS: No special status
USFS R2: Sensitive
UWFS R4: Sensitive
Wyoming BLM: Sensitive
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G4, S2B/S1N
Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS
Two subspecies of Townsend's Big-eared Bat (*Corynorhinus townsendii*), Virginia Big-Eared Bat (*C. (formerly Plecotus) t. virginianus*) and Ozark Big-eared Bat (*C. (formerly Plecotus) t. ingens*), were listed as Endangered under the Endangered Species Act (ESA) in 1979 [1]. Neither subspecies occurs in Wyoming. Townsend's Big-eared Bat has been assigned both a breeding season and non-breeding season state conservation rank by the Wyoming Natural Diversity Database because of increased extrinsic stressors during hibernation.

NATURAL HISTORY

Taxonomy:
There are five recognized subspecies of Townsend's Big Eared Bat. The geographic distribution of these subspecies has previously been called into question by taxonomic authorities [2]. The most recent literature indicates that only *C. t. townsendii* occurs in Wyoming [2-4]. Earlier authors also assigned *C. t. pallescens* throughout much of western North America, including Wyoming [4]. Prior to 1992, Townsends Big-eared Bat was included in the genus *Plecotus*. Phylogenetic evidence based on morphological and genetic differences placed New World Big-eared Bats in the genus *Corynorhinus* [5]. It is important to note that literature from the New World prior to this time refers to Townsend's Big-eared Bat as *P. townsendii*. Additionally, the United States Fish and Wildlife Service still uses the genus *Plecotus* for Virginia Big-eared Bat and Ozark Big-eared Bat.

Description:
Townsend's Big-eared Bat is easily identified in the field. The species is medium in size among bat species that occur in Wyoming. As the common name suggests, Townsend's Big-eared Bat has large, rounded ears ranging from 30–39 mm in length with long, pointed tragi measuring 11–17 mm. When in torpor or hibernation, the ears may curl back, forming distinctive "rams horns". The species also has a distinctive nose with large, raised pararhinal glands that form a "U" over

the top of the snout [3]. Dorsal pelage is slate gray with hair tips ranging from cinnamon to black-brown. Ventral pelage is slightly lighter in color and ranges from light slate gray to buff. In many populations, females are slightly larger than males but are otherwise identical in appearance [6]. Other large-eared bat species found in Wyoming include Spotted Bat (*Euderma maculatum*) and Pallid Bat (*Antrozous pallidus*). Unlike Townsend's Big-eared Bat, Spotted Bat has black dorsal pelage with three white spots, and Pallid Bat is smaller with inconspicuous pararhinal glands [3].

Distribution & Range:
Townsend's Big-eared Bat is widely distributed across the western half of North America from British Columbia to southern Mexico. Wyoming marks the northeastern edge of this distribution, and confirmed breeding has been documented in 5 of the 28 latitude/longitude degree blocks in the state [7]. Two subspecies exist in geographically disparate populations in the eastern United States and include Virginia Big-eared Bat, which is found in Kentucky, North Carolina, Tennessee, Virginia, and West Virginia, and Ozark Big-eared Bat, which is found in Arkansas and Oklahoma [1]. Changes in distribution may be observed seasonally as the species moves between summer habitat and winter hibernacula. However, Townsend's Big-eared Bat typically does not undergo long-distance migrations, with movements of approximately 64 km or less reported in portions of its range [6].

Habitat:
Across its range, Townsend's Big-eared Bat is found in a variety of xeric to mesic upland habitats ranging from shrublands to woodlands to montane forests [3, 6, 8, 9]. At regional and local scales, distribution is limited by suitable roosting habitat. The species is considered a cave obligate, requiring natural caves or cave-like structures, such as abandoned mines, throughout the year. In the summer, day roosts generally include caves and mines, although the species will occasionally use abandoned buildings or large hollow trees [3]. Males roost singly in cooler locations, while females congregate in maternity colonies in warmer areas. In winter, Townsend's Big-eared Bat hibernates in caves and mines. Within hibernacula, the species selects relatively cold locations, often near the entrance or other areas that experience air movement, but may move to warmer locations during extreme cold [6].

Phenology:
The phenology of Townsend's Big-eared Bat in Wyoming is largely unknown but is assumed to be similar to other portions of its range. The species hibernates from early fall to early spring. Movements from summer range to winter hibernacula begin in late summer, with individuals arriving at hibernacula by October [3]. Reproductive phenology is similarly unknown in Wyoming. In California, mating occurred primarily in the fall but was occasionally documented throughout the winter. Females store sperm over the winter and ovulate upon arousal from hibernation in the spring. A single pup is born following a 40–60 day gestation period. Juveniles are capable of flight at about 3 weeks of age but continue to nurse for up to 6 weeks following birth [3, 6].

Diet:
Townsend's Big-eared Bat is strictly insectivorous and primarily consumes small moths in the family Lepidoptera [10].

Conservation Concerns

Abundance:
Continental: WIDESPREAD
Wyoming: UNCOMMON
There are no robust abundance estimates for Townsend's Big-eared Bat in Wyoming. While the species is widely distributed across Wyoming in a number of different habitat types, Townsend's Big-eared Bat typically represents a very small proportion of mist-net captures and acoustic recordings, suggesting that the species occurs at low density in the state [11-21]. However, Townsend's Big-eared Bat is commonly detected during hibernacula surveys across Wyoming [22].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
There are no robust population trend estimates for Townsend's Big-eared Bat in Wyoming. However, several authors have reported marked declines in abundance across the western United States over the past several decades [3]. It is unknown if similar trends have occurred in Wyoming.

Intrinsic Vulnerability:
HIGH VULNERABILITY
Townsend's Big-eared Bat is highly vulnerable to extrinsic stressors. The species is considered an obligate of caves and abandoned mines, and it is thought that the distribution and abundance of populations is limited by the presence of suitable, undisturbed roost sites on the landscape [3]. Additionally, Townsend's Big-eared Bat displays high site fidelity, especially at hibernacula and maternity colonies. Given the inherent rarity of these features on the landscape, the species may be unable to find new roost sites should existing sites be lost or degraded [3]. Townsend's Big-eared Bat exhibits low fecundity, with females giving birth to a single pup each year [6]. This makes it difficult for populations to recover following declines.

Extrinsic Stressors:
MODERATELY STRESSED
The primary stressor to Townsend's Big-eared Bat in Wyoming and across its continental distribution is the loss, modification, and disturbance of roosting habitat. Disturbance from visitors to caves and abandoned mines represents a substantial stressor to bats using these structures. During hibernation, even a small number of disturbances can lead to a significant increase in arousal events and energy expenditure that may increase mortality of hibernating bats [9, 23, 24]. Townsend's Big-eared Bat may be more prone to disturbance during hibernation than other bat species because it often selects locations near the entrance of caves and mines. Additionally, the species is reliant upon caves and abandoned mines year round, making it prone to disturbance throughout the year. Abandonment of roosts used as hibernation sites and maternity sites following human disturbance has been documented across the species' range [3]. Townsend's Big-eared Bat may also be vulnerable to White-Nose Syndrome (WNS). The pathogenic fungus that causes WNS, *Pseudogymnoascus destructans* (formerly *Geomyces destructans*), was unintentionally introduced to North America in 2006 [25] and has led to large declines of several bat species in eastern North America [25]. *P. destructans* has been documented on a subspecies of Townsend's Big-eared Bat, Virginia Big-eared Bat, but no mortalities resulting from WNS have been documented in this subspecies to date [26]. It is currently unknown if and how WNS will affect Townsend's Big-eared Bat in the west.

KEY ACTIVITIES IN WYOMING

State and federal wildlife and land management agencies have taken several actions to protect Townsend's Big-eared Bat and other bat species from WNS. Specifically, the Black Hills National Forest implemented an adaptive management strategy for caves and abandoned mines to limit the potential for introduction and spread of WNS [27, 28]. The Wyoming Game and Fish Department (WGFD) along with the Wyoming Bat Working Group developed "A strategic plan for white-nose syndrome in Wyoming" in 2011 [29]. This plan is intended to minimize the impacts of WNS if it is detected in Wyoming or adjacent states. To facilitate early detection of the disease, WGFD requires researchers to evaluate all bats captured during research activities for signs of WNS infection using the Reichard Wing-Damage Index [30], and to implement WNS decontamination protocols when handling bats or conducting hibernacula surveys. Beginning in 2012, WGFD personnel placed temperature and humidity loggers in a number of known or suspected hibernacula across Wyoming to determine if climatic conditions at these sites are favorable for growth of *P. destructans*. Preliminary results suggest that temperature and relatively humidity in known hibernacula could facilitate the growth of the fungus [22, 31]. Personnel have also begun collecting swabs of hibernating bats and hibernacula substrates in an effort to assist with early detection of *P. destructans*. Collectively, WGFD and the Wyoming Natural Diversity Database (WYNDD) have conducted statewide systematic and project-specific surveys for bats since 2008, with numerous, smaller-scale projects occurring prior to this time. In 2011, the WGFD conducted an inventory of forest bats in southeastern Wyoming; Townsend's Big-eared Bat was not captured during these surveys, but recordings of the species were made at nine sites [32]. From 2012 to 2015, WGFD conducted an inventory of cliff and canyon habitats across western Wyoming and captured Townsend's Big-eared Bat at eight sites and made acoustic recordings of the species at 17 sites [19, 20, 33-35]. In 2011, 2012, and 2013, WYNDD conducted a bat inventory across southern Wyoming and captured Townsends Big-eared Bat at five sites made acoustic recordings of the species at 16 sites [11, 12, 17]. In 2016, WYNDD made the first documentation of the species at Devils Tower National Monument, and two Townsend's Big-eared Bats were fitted with radio transmitters and tracked to day roosts at this site. Finally, the WGFD periodically conducts hibernacula surveys at both known and suspected hibernacula throughout the state; Townsend's Big-eared Bat is frequently encountered at low numbers during these surveys [22].

ECOLOGICAL INFORMATION NEEDS

Despite nearly a decade of systematic survey efforts for bats in Wyoming, Townsend's Big-eared Bat remains understudied in Wyoming. The species would benefit from a better understanding of habitat use, especially in relation to landscape features used during hibernation and at maternity colonies. Additional information is also needed on the amount and degree of disturbance at important roosts and the impact of those disturbances on populations. Information on abundance and population trends is largely unavailable but is important in the face of growing stressors. It is also unknown how WNS might affect Townsend's Big-eared Bat in Wyoming and across North America.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Although Townsend's Big-eared Bat is one of the more commonly encountered bats during hibernacula surveys, little is still known about the majority of wintering locations of the species in Wyoming. Although WNS has not been detected in the state, the westward progression of the fungus necessitates the need for these data before it reaches Wyoming. Consequently, priorities will focus on locating and monitoring hibernacula as well as other roost locations (e.g., maternity roosts) to monitor populations and recommend and assist with bat-friendly closures of important caves and mines. In 2016, the WGFD began a project in collaboration with the state of Nebraska to evaluate occurrence, abundance, and reproductive status of bats in eastern Wyoming, which represents an important zone of overlap between eastern and western bat species. Mist-net surveys will continue to implement WNS protocols and assessment in an effort to assist with early detection should the disease reach the state. Habitat assessments will be incorporated with survey efforts to better understand what influences species presence and distribution at a finer scale. In addition to inventory projects, the WGFD, in collaboration with the Wyoming Bat Working Group and other state-wide partners, will implement the North American Bat Monitoring Program that will use acoustic monitoring to assist with state and region-wide assessment of bat trends. Additional priorities will include updating and revising the Conservation Plan for Bats in Wyoming and the Strategic Plan for WNS in Wyoming. Finally, outreach and collaboration with private landowners will remain a priority to ensure conservation of bats and bat habitat.

CONTRIBUTORS

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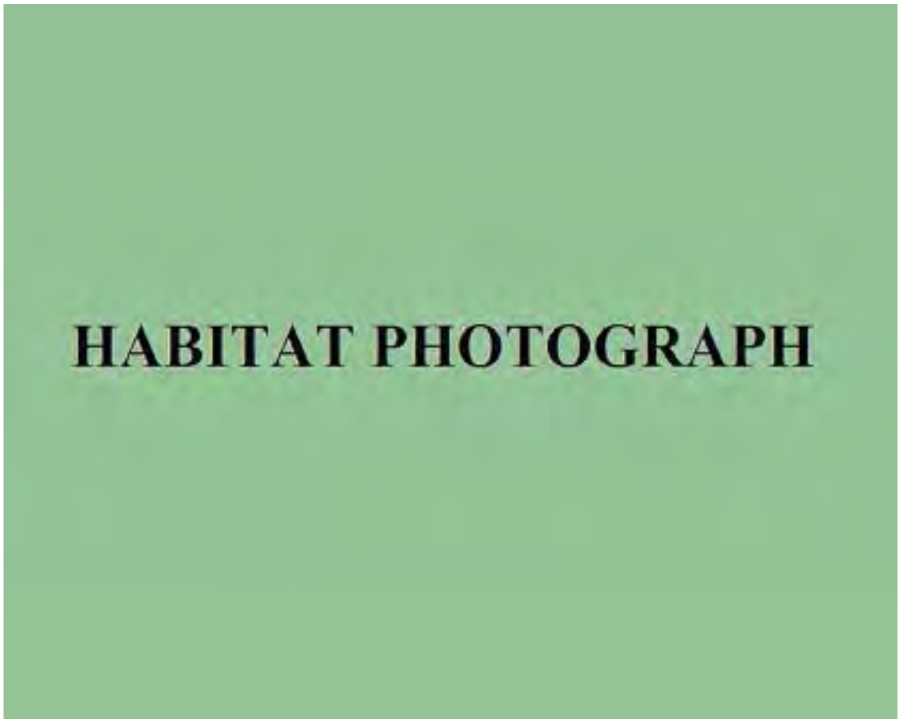
Figure 1: A Townsend's Big-eared Bat in Wyoming. (Photo courtesy of Robert J. Luce, WGFD)

Figure 2: North American range of *Corynorhinus townsendii*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)



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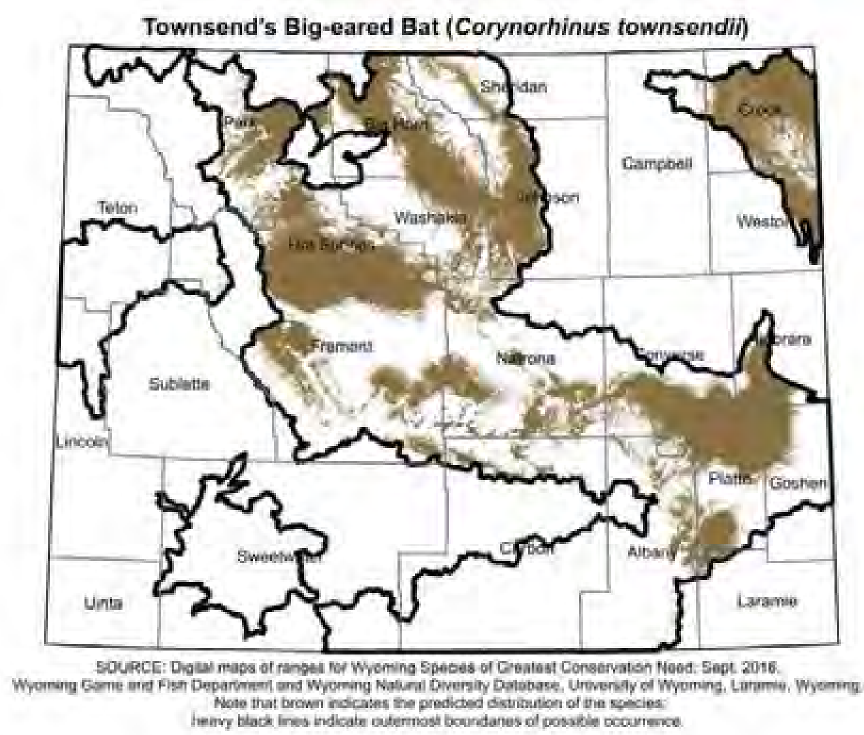

Figure 4: Range and predicted distribution of *Corynorhinus townsendii* in Wyoming.

Figure 5: A captured Townsend's Big-eared Bat in hand showing the distinctive face and ears. (Photo courtesy of Leah H. Yandow, WGFD)

Uinta Chipmunk
Tamias umbrinus

REGULATORY STATUS
USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS4 (Bc), Tier III
WYNDD: G5, S2S5
Wyoming Contribution: HIGH
IUCN: Least Concern

STATUS AND RANK COMMENTS
The Wyoming Natural Diversity Database has assigned Uinta Chipmunk (*Tamias umbrinus*) a state conservation rank ranging from S2 (Imperiled) to S5 (Secure) because of uncertainty about the abundance, proportion of range occupied, and population trends for this species in Wyoming.

NATURAL HISTORY
Taxonomy:
Chipmunk taxonomy remains disputed, with some arguing for three separate genera (i.e., *Neotamias*, *Tamias*, and *Eutamias*) [1-3], while others support the recognition of a single genus (i.e., *Tamias*) [4]. Uinta Chipmunk (briefly *N. umbrinus*) [5] has since been returned to the currently recognized genus *Tamias*, along with all other North American chipmunk species [6]. Of the seven recognized subspecies of Uinta Chipmunk, three are found in Wyoming: *T. u. fremonti*, *T. u. montanus*, and *T. u. umbrinus* [7-10]. These subspecies are geographically isolated on different mountain ranges and are not believed to interbreed [10].

Description:
Identification of Uinta Chipmunk is possible in the field. Uinta Chipmunk is a medium-sized, brownish chipmunk with dark facial stripes, three dark and four light longitudinal dorsal stripes, white underbelly, long bushy tail, and a large head that is longer than 34 mm [8, 10]. Males and females are similar in size and appearance [10]. Adults weigh between 55–80 g and can reach total lengths of 200–243 mm [10]. Tail, hind foot, and ear length ranges from 90–115 mm, 30–35 mm, and 16–19 mm, respectively [10]. Within its Wyoming distribution, Uinta Chipmunk can be distinguished from Cliff Chipmunk (*T. dorsalis*) by its defined dorsal stripes, and from Yellow-pine Chipmunk (*T. amoenus*) and Least Chipmunk (*T. minimus*) by its larger size and outermost dorsal stripes that are white instead of dark [8, 10].

Distribution & Range:
The continental distribution of Uinta Chipmunk consists of six or seven disjunct populations spread across the western United States in parts of California, Nevada, Arizona, Utah, Idaho, Montana, Colorado, and Wyoming [8, 9, 11]. The three subspecies found in Wyoming have non-overlapping distributions. Specifically, *T. u. fremonti* is widely distributed in the northwestern mountains; *T. u. montanus* is found in south-central and southeastern Wyoming in the Sierra Madre, Medicine Bow, and possibly Laramie mountain ranges; *T. u. umbrinus* is found primarily in the Uinta Mountains of far southwestern Wyoming [8, 10]. Confirmed or suspected breeding has been documented in 7 of 28 latitude/longitude degree blocks in the state [12].

Habitat:
Uinta Chipmunk is a highly arboreal, montane and subalpine species that is typically found between elevations of 1,417–3,660 m in coniferous forests [8]. Habitat varies slightly for the three subspecies of Uinta Chipmunk in Wyoming. *T. u. fremonti* inhabits the edges of clearings and meadows within spruce-fir forests typical of montane forests of northwestern Wyoming, but can also be found in rocky habitat above timberline; *T. u. montanus* is found in closed-canopy Lodgepole Pine (*Pinus contorta*) and Douglas Fir (*Pseudotsuga menziesii*) forests with open understories as well as rocky Ponderosa Pine (*Pinus ponderosa*) and Subalpine Fir (*Abies lasiocarpa*) ecosystems; *T. u. umbrinus* lives in spruce-fir forests [8, 10]. Uinta Chipmunk nests in logs, rock crevices, underground burrows, and occasionally in trees [8].

Phenology:
Uinta Chipmunk likely hibernates in a state of intermittent torpor from October to May, and probably breeds immediately after emergence [8, 10]. Females give birth to a single litter of 3–5 young after a gestation period of approximately 30 days [8, 10].

Diet:
Uinta Chipmunk forages primarily on seeds and fruits from numerous species of trees and shrubs, but will also consume buds, pollen, tender green shoots, fungi, insects, and carrion [8-10].

CONSERVATION CONCERNS

Abundance:
Continental: REGIONAL ENDEMIC
Wyoming: UNCOMMON
There are no robust estimates of abundance available for Uinta Chipmunk in Wyoming. The species has an estimated statewide abundance rank of UNCOMMON and also appears to be uncommon within suitable environments in the occupied area [12].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends for Uinta Chipmunk in Wyoming are unknown.

Intrinsic Vulnerability:
LOW VULNERABILITY
Uinta Chipmunk has low intrinsic vulnerability in Wyoming because it is found across a range of coniferous forest habitats, elevations, and montane systems. Likewise, the species does not appear to have any life history characteristics that make it inherently vulnerable to changing environmental conditions.

<u>Extrinsic Stressors</u>:
SLIGHLTY STRESSED
Montane forests in Wyoming are vulnerable to altered fire regimes, loss or fragmentation from harvest and management practices, disease and insects, and drought and climate change [13]. As a species associated with Lodgepole Pine forests in parts of its range, Uinta Chipmunk has likely been exposed to tree mortality from the ongoing outbreak of Mountain Pine Beetle (*Dendroctonus ponderosae*) in the state; however, a study in northern Utah found that Uinta Chipmunk and Least Chipmunk were actually more abundant in stands with moderate tree mortality [14]. In another study of montane mammals, Uinta Chipmunk was one of only two species predicted to persist across their entire Great Basin ranges despite potential effects of global warming [15]. The species experienced only minor upslope elevational range contractions over an 80-yr period of increasing maximum summer temperatures and precipitation in the Ruby Mountains of northeastern Nevada, which may suggest that the species is less likely to be impacted by the effects of global warming than some other small mammal species [16]. It is not known how potential extrinsic stressors might impact Uinta Chipmunk in Wyoming.

KEY ACTIVITIES IN WYOMING
Uinta Chipmunk is classified as a Species of Greatest Conservation Need by the Wyoming Game and Fish Department. Little work has been done on Uinta Chipmunks in Wyoming, and most records are from incidental sightings or trapping records from survey efforts for other species. There are currently no research projects designed specifically for Uinta Chipmunk in Wyoming.

ECOLOGICAL INFORMATION NEEDS
Uinta Chipmunk is not well studied, and little is known about the natural history and reproductive habits of this species in Wyoming [10]. This species would benefit from research to determine the status, distribution, and abundance of the three subspecies across their respective ranges in the state. Although Uinta Chipmunk appears able to withstand some forms of disturbance, it is not known how potential natural or anthropogenic stressors may impact the species in Wyoming.

MANAGEMENT IN WYOMING
This section authored solely by WGFD; Nichole L. Bjornlie. Little is known about Uinta Chipmunk in Wyoming. Consequently, management priorities for the species in the short-term will focus on addressing these data deficiencies. Of particular importance are data on presence, distribution, population status and trends, and the impact of potential threats, including the current condition of montane forest habitat, which will ultimately be used to develop management and conservation recommendations. Because of the differences in habitat use and lack of connectivity among subspecies, state-wide recommendations may not be appropriate for Uinta Chipmunk, and it will be important to tailor recommendations to address localized data needs and habitat threats.

CONTRIBUTORS
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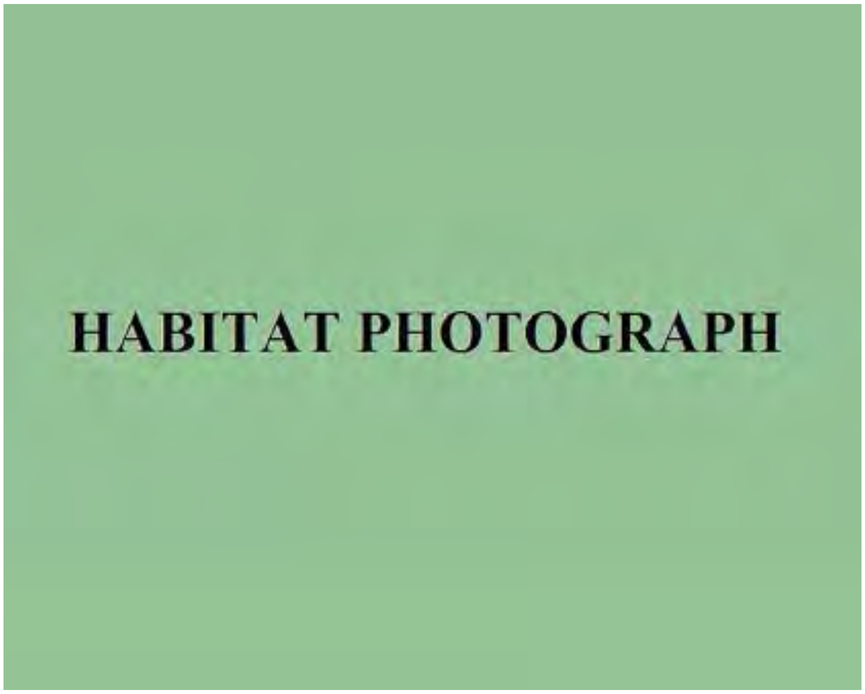
Figure 1: A Uinta Chipmunk in Zion National Park, Utah. (Photo courtesy of Nichole L. Bjornlie)

Figure 2: North American range of *Tamias umbrinus*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)



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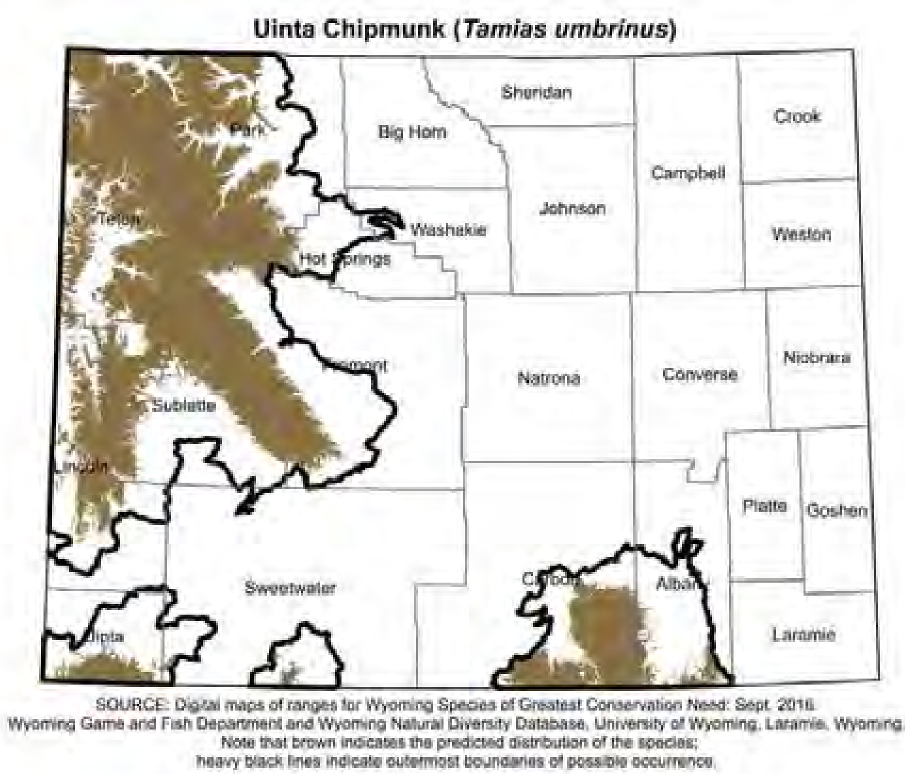

Figure 4: Range and predicted distribution of *Tamias umbrinus* in Wyoming.

Water Vole
Microtus richardsoni

REGULATORY STATUS
USFWS: No special status
USFS R2: Sensitive
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G5, S1
Wyoming Contribution: HIGH
IUCN: Least Concern

STATUS AND RANK COMMENTS
As discussed below, the Water Vole (*Microtus richardsoni*) population on the Bighorn Mountains is isolated from adjacent populations, and thus may be treated as an independent element of biological diversity for some purposes. If treated as such, the Bighorn Mountain population of Water Vole would receive a higher degree of conservation concern than the full species – specifically, a Wyoming Contribution Rank of VERY HIGH.

NATURAL HISTORY

Taxonomy:
Historically, there was confusion regarding the separation of Water Vole in North America from its European counterpart, *Arvicola terrestris* [1, 2]. Genetic and morphological evidence has since confirmed the discrete taxonomic position of *Microtus* in general and *M. richardsoni* in particular, and Water Vole is currently considered a distinct and legitimate species. Four subspecies are currently recognized: *M. r. arvicoloides,* geographically isolated to the Cascade Mountains; and *M. r. richardsoni, M. r. macropus,* and *M. r. myllodontus*, collectively occupying the Northern and Central Rocky Mountains. Only *M. r. macropus* is known to inhabit Wyoming, with *M. r. myllodontus* approaching (but not known to enter) the southwestern corner of the state [2, 3]. Water Voles on the Bighorn Mountains are considered geographically isolated from neighboring populations on the Absaroka and Beartooth Mountains and likely represent a Pleistocene relict. The subspeciation of other small mammals (e.g., *Lepus americanus seclusus, Tamias minimus confinis, M. montanus zygomaticus*) on the Bighorn Mountains raises the possibility of similar divergence of Water Vole on the range, but this has not been formally evaluated [3-5].

Description:
Water Vole is notably larger than all other arvicoline rodents within its range, with the exception of Common Muskrat (*Ondatra zibethicus*). In most external aspects the species appears as a very

large and densely-furred version of other *Microtus*: dorsal pelage uniformly gray-brown to reddish brown and often darkened by black-tipped hairs, ventral pelage approaching silvery-gray or even white, total length 198–274 mm, tail 66–98 mm, hind foot 25–34 mm, and mass 85–120 g. Both sexes have large flank glands that become prominent during the breeding period. Adults can be distinguished from other *Microtus* by their large size and large hind feet (> 23 mm) [2, 3]. Juveniles may be confused with adults of other *Microtus*, but hind feet > 23 mm appears to be a distinguishing characteristic even for young animals. Detailed dentition patterns can be used to identify skulls to species [2, 6]. The number of plantar tubercules on the hind foot was previously thought useful for species identification, but was subsequently found to be unreliable [3, 7].

Distribution & Range:
This species occupies two discrete subranges: one on the Cascade Mountains from southwestern British Columbia south through Oregon, and another on the Rocky Mountains from central British Columbia and Alberta south through Idaho, western Montana, and western Wyoming to central Utah. Within this overall range the fine-scale distribution of Water Vole is highly discontinuous. As with other semi-aquatic mammals, population segments occur in small patches of suitable habitat along stream networks. Overland dispersal between close drainages is possible, but large upland expanses, sharp divides, and warm and arid basins separate otherwise nearby populations. Extensive forests are also barriers, as Water Vole strongly prefers riparian meadows over forested streamsides [2, 3, 8, 9]. In Wyoming, Water Vole occupies the western mountains and the Bighorn Mountains [3, 4]. A genetic study found no significant differentiation among Water Voles on the Beartooth Mountains, but also found that those populations were genetically distinct from populations near Togwotee Pass on the Absaroka Mountains [9]. Water Voles on the Bighorn Mountains have likely been isolated for many generations, with little to no interchange with populations on neighboring mountain ranges.

Habitat:
Water Vole is specialized to riparian meadows within the alpine and sub-alpine life zones. Preferred habitat is clear, low-gradient, gravel-bottomed streams (and occasionally ponds and marshes) bordered by alpine tundra or subalpine meadow. Occupied sites have heavy and extensive herbaceous cover, occasionally with some willow (*Salix* spp.) overstory [2, 3, 5, 10, 11]. A well-developed herbaceous layer may be especially important in suspending snow and providing a large subnivean space in which Water Vole lives in winter [5]. The species is almost never observed more than 17 m from open water, but it is assumed that dispersers may occasionally traverse uplands for short distances [2, 9]. Dispersers may also travel along forested stream segments in search of riparian meadows, but long forested reaches may be movement barriers. Moreover, downstream dispersal is naturally limited by elevation (presumably as a surrogate for suitable climatic conditions) – in the Bighorn Mountains, no Water Voles were captured below 2,440 m [3, 5], and the species was only captured in mountain big sagebrush (*Artemisia tridentata vaseyana*) and subalpine meadows. Within these habitats, sites with Water Vole captures tended to have higher thallophyte cover [7]. Like other *Microtus*, individual Water Voles construct and use extensive runway systems, including surface segments and sub-surface tunnels, in herbaceous vegetation. Unlike other *Microtus*, Water Vole runway systems frequently cross streams and incorporate the streams themselves as runway segments. The species swims well and often, and likely uses water to escape predators. Underground nests and resting chambers are dug periodically along runways and used year-round. Entrances to chambers and sub-surface tunnels are often placed in streambanks near or even below water level, and streambank stability has

been cited as an important habitat feature [3]. Runway systems are used and maintained under snow, which can persist for 7–8 months in Water Vole habitat [2].

Phenology:
Water Vole is active year-round. In Alberta, first pregnancies were recorded in late May and last pregnancies in early September. It is assumed that breeding start- and end-dates are modulated by snow depth and general climatic conditions. Gestation is about 22 days, and trappable young have been recorded in the first week of July. Litter size ranges from 2–10 and averages 5. Mature females can produce 2 litters in favorable years. Some individuals may breed in their first year, but most breed after their first winter [2, 12]. Early fall may be a critical period for Water Vole survival, as frozen ground prevents maintenance of sub-surface chambers and tunnels, stream ice obstructs swimming, and persistent insulating snow has yet to develop [8].

Diet:
The leaves and stems of forbs are the primary foods of Water Vole. Grasses, sedges, and willow bark are also frequently eaten, and seeds and insects are consumed as available. Rhizomes and other subterranean plant parts may be especially important winter foods. Water Vole is not known to store food for the winter [2].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD BUT DISJUNCT
Wyoming: UNCOMMON
There are no population estimates of Water Vole for Wyoming or adjacent regions. The UNCOMMON abundance at the state scale is inferred from the small portion of the state encompassed by the species' range and the sparse and discontinuous pattern of suitable habitat within that range. Populations fluctuate dramatically between seasons and years. Precipitation and population size are positively correlated, but the mechanism behind this effect is unclear [3]. As discussed above, Water Voles on the Bighorn Mountains are completely isolated from adjacent populations, and thus are of special concern. If treated as an independent element of biological diversity, the Bighorn Mountain population of Water Vole would receive a RARE or VERY RARE statewide abundance rank. Water Vole was captured on 71% of apparently-suitable stream segments in the Beartooth Mountains, but only on 33% of apparently-suitable stream segments in the Bighorn Mountains [5, 11]. More recently, Water Vole was captured at only 4 of 22 sites surveyed in the Bighorn Mountains, and no individuals were detected below 44.6° latitude despite historic records [7]. Furthermore, sign (e.g., scat, runways, tunnels) of Water Vole was evident at occupied sites on the Beartooth Mountains, but not at occupied sites on the Bighorn Mountains, possibly because abundances on the latter range were lower [3].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends of Water Vole in Wyoming are unknown.

Intrinsic Vulnerability:
HIGH VULNERABILITY
Water Vole is a habitat specialist restricted to harsh high-elevation environments known to be sensitive to disturbance, slow to recover following disturbance, and likely to change rapidly as a

result of climate change. Additionally, Water Vole populations are naturally fragmented into small local segments that are restricted to high headwater basins and connected by only infrequent inter-basin dispersal [8]. Local population segments undergo dramatic annual and seasonal fluctuations [2, 5, 12]. In one study, 89% of captured adults disappeared by the end of September each year, suggesting that local extirpations may be frequent. Also, reproductive output is lower than expected for a rodent of this size [8, 12].

Extrinsic Stressors:
MODERATELY STRESSED
On both the Beartooth and Bighorn Mountains, Water Vole was less common in sites grazed by livestock than in ungrazed sites – thus, livestock grazing is commonly cited as a threat [4, 5, 10, 11]. It is assumed that grazing by native ungulates (e.g., *Cervus elaphus*) adds to an overall grazing effect on Water Vole habitat. Other activities that compact streamside soils and break down stream banks, such as road building and motorized recreation, may also threaten some populations [3]. However, much Water Vole habitat in the state exists within federally-designated Wilderness, which receives far less livestock grazing and vehicle pressure than non-Wilderness lands. Projected effects of climate change on subalpine and alpine systems, including the upwards migration of forests, reduced snowpack, and lower late summer stream flows, are likely long-term threats to Water Vole.

KEY ACTIVITIES IN WYOMING

In 2014 the Wyoming Game and Fish Department (WGFD) began cooperating with the Bighorn National Forest to survey Water Voles there, with a main goal of measuring occupation at previously occupied sites [7]. This work will continue in 2016 as a collaboration between WGFD, Bighorn National Forest, and the Wyoming Natural Diversity Database (WYNDD). Prior to this effort, the work by Klaus represented the latest investigations of Water Vole in the state, specifically on the Bighorn [5], Beartooth, and Absaroka Mountains [10].

ECOLOGICAL INFORMATION NEEDS

Coarse-scale distribution within Wyoming is known with some confidence, as are general habitat needs. Priority information needs now include a finer-scale knowledge of distribution, perhaps with attention to southern mountain ranges (e.g., Wind River, Gros Ventre, Wyoming Ranges), and information on Water Vole responses to specific characteristics of vegetation, soil, and stream channels that are known to be affected by livestock grazing. Additionally, a better understanding of whether and to what extent beavers (*Castor canadensis*) create habitat would be beneficial to habitat management and restoration projects. A formal monitoring program, possibly based on occupancy modeling across a sample of stream segments that represent the full range of the species in the state, would inform managers of range-wide population trends. Also, a modern genetic investigation could elucidate the extent to which Bighorn Mountain Water Vole has diverged from adjacent populations.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Recent management activities for Water Vole in Wyoming have included developing a better understanding of distribution and habitat use, especially in the isolated Bighorn Mountains. Moving forward, priorities will expand to include evaluating the impact of external stressors, especially grazing, and developing a monitoring protocol for the Bighorn Mountains in collaboration with the U.S. Forest Service and

WYNDD. During this effort, field personnel will collect genetic samples from all captured individuals, both in the Bighorn Mountains as well as other sites throughout the western mountains, that will be stored for future genetic analyses to elucidate if and to what degree individuals from the Bighorn Mountains have diverged from other, geographically connected populations.

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Figure 1: Adult Water Vole photographed along a subalpine meadow stream in the Bighorn Mountains in Sheridan County, Wyoming. (Photo courtesy of Brian Zinke)

Figure 2: North American range of *Microtus richardsoni*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Water Vole habitat in a subalpine meadow in the Bighorn Mountains in Sheridan County, Wyoming. (Photo courtesy of Brian Zinke)

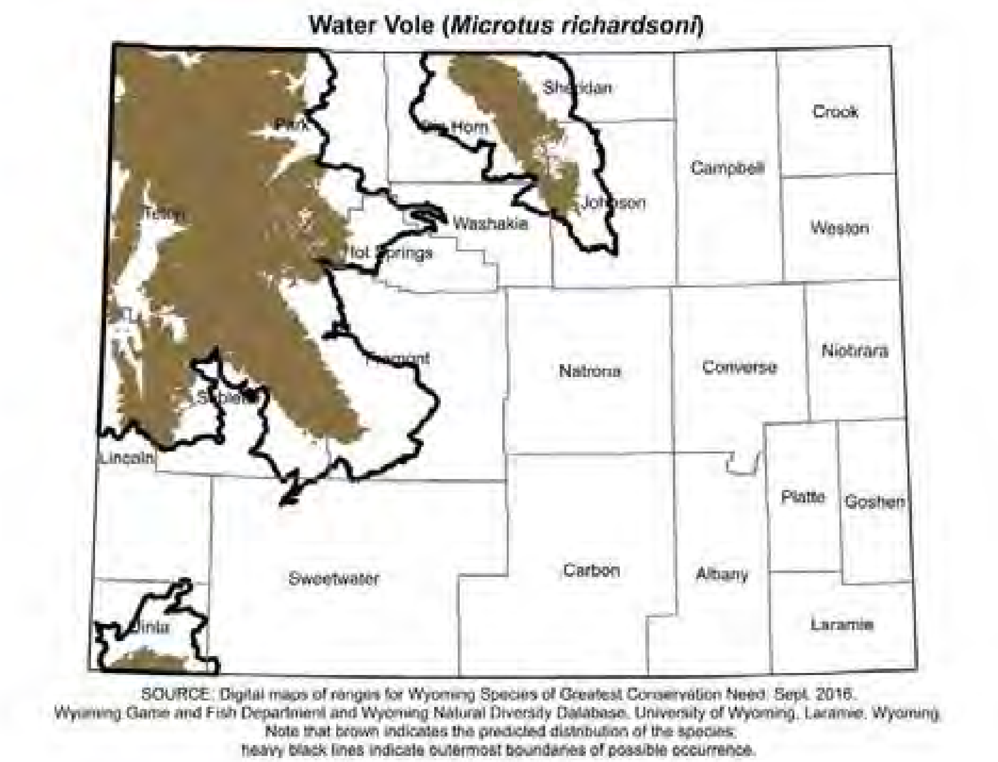

Figure 4: Range and predicted distribution of *Microtus richardsoni* in Wyoming.

Western Small-footed Myotis
Myotis ciliolabrum

REGULATORY STATUS
USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS4 (Cb), Tier II
WYNDD: G5, S4
Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS
Western Small-footed Myotis (*Myotis ciliolabrum*) has no additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY
Taxonomy:
There is considerable uncertainty regarding the taxonomy of Western Small-footed Myotis. At the species level, it is unclear if Western Small-footed Myotis and California Myotis (*M. californicus*) constitute two recently diverged species or a single morphologically variable species [1]. Prior to 1984, Western Small-footed Myotis was considered the western subspecies of *M. leibii*, now commonly referred to as Eastern Small-footed Myotis [2]. Additionally, Eastern Small-footed Myotis and Western Small-footed Myotis were referred to as *M. subulatus* as recently as 1981 [3]. Currently, Western Small-footed Myotis is considered monotypic [4]. Some researchers suggest two subspecies, *M. c. ciliolabrum* , and *M. c. melanorhinus* [5], but subspecific designations are not widely applied.

Description:
Western Small-footed Myotis is identifiable in the field by skilled observers. The species is quite small among bats in the genus *Myotis*. Dorsal pelage is pale light brown to light yellowish brown. Ventral pelage is similar to dorsal pelage but lighter in color, almost white. The face is dark brown to black forming a distinctive face mask contrasting with the light pelage. Similarly, the ears and patagia are dark brown to black. The ears are relatively long, ranging from 11 to 16 mm in length. The tragus is slender and tapering and is approximately half the total length of the ear. As the name suggests, the species has very small feet that are less than half the length of the tibia. The calcar is distinctively keeled. Where sympatric, Western Small-footed Myotis is very similar in appearance to California Myotis. However, the tail of Western Small-footed Myotis

extends approximately 2–4 mm beyond the uropatagium, while the tail of California Myotis does not extend beyond the uropatagium [5 6].

Distribution & Range:
Western Small-footed Myotis is widely distributed across western North America. Wyoming is central to the continental distribution of Western Small-footed Myotis, and the species occurs throughout the state in a variety of environments. Locally, seasonal changes in distribution may be observed as individuals move between summer range and winter hibernacula.

Habitat:
Western Small-footed Myotis is generally associated with arid landscapes, usually in the vicinity of cliffs, canyons, rock-outcrops, or badlands. It also occurs near riparian areas in a variety of other habitat types including montane forests, juniper woodlands, various shrublands, and grasslands [5]. In summer, Western Small-footed Myotis utilizes a variety of day roosts. Generally, these include rock features such as crevices in cliffs or rock-outcrops, but the species will also roost in crevices in badland formations, eroded stream banks, under rocks, and even in cracks in the ground. Occasionally, Western Small-footed Myotis will roost in buildings or other man-made structures [5]. In winter, the species hibernates in a variety of settings, but most frequently in caves or abandoned mines [5].

Phenology:
Phenology of Western Small-footed Myotis is poorly understood across its range and in Wyoming in particular. A single non-volant pup is born in late June or July. It is likely that, like other Myotis, Western Small-footed Myotis breeds in the fall prior to entering hibernation. The species enters hibernation late in the fall and emerges as early as March [5].

Diet:
Western Small-footed Myotis feeds on flying insects. Insects from the order Lepidoptera are most frequently consumed, but Diptera, Hemiptera, Coleoptera, and Trichoptera are also eaten [5].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: COMMON
There are no robust estimates of abundance for Western Small-footed Myotis in Wyoming. Survey data from across Wyoming suggests that the species is well represented within bat communities and may be relatively common in suitable habitat [7-13].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Both historic and recent population trends for Western Small-footed Myotis in Wyoming are unknown.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Western Small-footed Myotis is moderately vulnerable to extrinsic stressors in Wyoming. Western Small-footed Myotis has low fecundity, producing only one offspring per year [5].

Western Small-footed Myotis hibernates in caves and abandoned mines during the winter, which are rare landscape features.

Extrinsic Stressors:
MODERATELY STRESSED
White-nose Syndrome (WNS) is a fungal disease that affects hibernating bats. WNS has killed several million bats in North America [14, 15]. The pathogenic fungus *Pseudogymnoascus destructans* (formerly *Geomyces destructans*) that causes WNS has not been detected within the range of Western Small-footed Myotis or in Wyoming to date [16], but it is thought that the disease will continue to expand westward. It is unknown if Western Small-footed Myotis will be affected by WNS, but Eastern Small-footed Myotis and other hibernating bat species have experienced large population declines from the disease [14]. Similar to other insectivorous organisms, Western Small-footed Myotis is negatively affected by pesticide use, both from reduced food availability and acute and chronic toxicity from the pesticides themselves [17]. Disturbance from visitors to caves and abandoned mines used as hibernacula represents a significant threat to cave-roosting bats and bat habitat [17]. Even a small number of short-duration disturbances can significantly increase arousal events and subsequent energy expenditures that may lead to increased mortality of Western Small-footed Myotis [18]. Western Small-footed Myotis may be negatively affected by global climate change [19]. In northern Colorado, long-term monitoring of bat species, including Western Small-footed Myotis, indicated that the number of reproductive (i.e., pregnant, lactating, or post-lactating) females declined by approximately 50% under drought conditions that mimicked those predicted by climate change models [19]. While this decline was not statistically significant, it is biologically relevant. Given the geographic proximity and habitat similarities between this study location and Wyoming, it likely that similar patterns could occur in Wyoming.

KEY ACTIVITIES IN WYOMING

Bats have received increasing research attention across North America and in Wyoming. To address concerns regarding potential WNS infection of bats in Wyoming, the Wyoming Game and Fish Department (WGFD) in cooperation with the Wyoming Bat Working Group authored "A strategic plan for white-nose syndrome in Wyoming" in 2011. This document presents a plan of action to minimize impacts of WNS if it is detected in states adjacent to or in Wyoming [20]. To facilitate early detection of the disease, WGFD requires researchers to evaluate all bats captured during research activities for signs of WNS infection using the Reichard Wing-Damage Index [21]. Beginning in 2012, WGFD personnel placed temperature and humidity loggers in a number of known or suspected hibernacula across Wyoming to determine if climatic conditions at those sites are favorable for growth of *P. destructans*. Personnel have also begun collecting swabs from hibernating bats and hibernacula substrates in an effort to assist with early detection of *P. destructans*. While placing loggers, surveyors also searched for hibernating bats and detected Western Small-footed Myotis at seven sites [22-24]. WGFD conducts periodic surveys at known hibernacula throughout the state, including known Western Small-footed Myotis hibernacula. Currently, 49 Western Small-footed Myotis hibernacula have been documented, with 1 to 33 individuals observed during winter surveys, which represents a small fraction of the number of individuals captured during summer survey efforts. Several studies have been completed or are underway that have increased our understanding of bat species in the state, including Western Small-footed Myotis. Both WGFD and the Wyoming Natural Diversity Database (WYNDD) have conducted numerous bat inventories across the state including a statewide forest bat inventory from 2008 to 2011 [9, 10, 13, 25-27], a statewide inventory of cliffs, caves, and rock outcroppings from 2012 to 2015 [11, 12], an inventory of bats at Devils Tower National Monument from 2010 to 2011, a bat monitoring effort in southern Wyoming from 2011 to 2013 [7, 8, 28], and bat surveys in northeastern Wyoming in 2014 and 2015 [29]. Western Small-footed Myotis was frequently captured and recorded during these investigations [11, 12, 25-27, 29, 30]. In 2011, 2013, 2014, and 2015, WYNDD conducted multi-taxa inventories, which included bat surveys, within the Ferris Mountain Wilderness Study Area (WSA), Gardner Mountain WSA, Fortification Creek WSA, and North Fork WSA. Several bat species were detected within these four WSAs including Western Small-footed Myotis [31-33]. In 2015, WYNDD developed a bat monitoring plan and initiated survey activities at Bighorn Canyon National Recreation Area (BICA). The primary objective of this monitoring plan is to develop a baseline activity level or other index of abundance for Little Brown Myotis (*M. lucifugus*) that can be used to detect changes in populations within BICA through time, but Western Small-footed Myotis was frequently captured and recorded throughout the area. In addition to research activities, many conservation organizations and federal and state agencies, including WGFD, have developed outreach and education materials to inform the general public of the importance bats and concerns regarding the persistence of bats in the future.

ECOLOGICAL INFORMATION NEEDS

There is considerable uncertainty regarding the taxonomy of Western Small-footed Myotis, with some researchers suggesting synonymy with California Myotis. Clarification of this taxonomic uncertainty may change state and global rankings and conservation priorities for both species. While Western Small-footed Myotis is known to hibernate in caves and abandoned mines in Wyoming, the full breadth of suitable hibernacula for the species in the state is poorly understood. Hibernation sites represent critical habitat components for bats, and a better understanding of hibernacula selection and use would benefit Western Small-footed Myotis. Abundance and population trends of the species in Wyoming are largely unknown but would be valuable in light of potential threats such as WNS. Furthermore, while WNS has not been documented in Wyoming to date, continued monitoring is essential to ensure that potential mitigation actions can be implemented.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Very little is known about the wintering locations of Western Small-footed Myotis in Wyoming. Although WNS has not been detected in the state, the westward progression of the fungus and recent confirmation of WNS in Washington necessitates the need for these data before it reaches Wyoming. Consequently, priorities will focus on locating and monitoring hibernacula as well as other roost locations (e.g., maternity roosts) to monitor populations and recommend and assist with bat-friendly closures of important caves and mines. In 2016, WGFD will begin a project in collaboration with the state of Nebraska to evaluate occurrence, abundance, and reproductive status of bats in eastern Wyoming, which represents an important zone of overlap between eastern and western bat species. Mist-net surveys will continue to implement WNS protocols and assessment in an effort to assist with early detection should the disease reach the state. Habitat assessments will be incorporated with survey efforts to better understand what influences species presence and distribution at a finer scale. In addition to inventory projects, WGFD, in collaboration with the Wyoming Bat Working Group and other state-wide partners, will implement the North American

Bat Monitoring Program that will use acoustic monitoring to assist with state and region-wide assessment of bat trends. Additional priorities will include updating and revising the Conservation Plan for Bats in Wyoming and the Strategic Plan for WNS in Wyoming. Finally, outreach and collaboration with private landowners will remain a priority to ensure conservation of bats and bat habitat.

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Figure 1: A Western Small-footed Myotis in Wyoming. (Photo courtesy of Robert J. Luce, WGFD)

Figure 2: North American range of *Myotis ciliolabrum*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Rock outcrop typical of Western Small-footed Myotis roosting and foraging habitat in Fremont County, Wyoming. (Photo courtesy of Ian M. Abernethy)

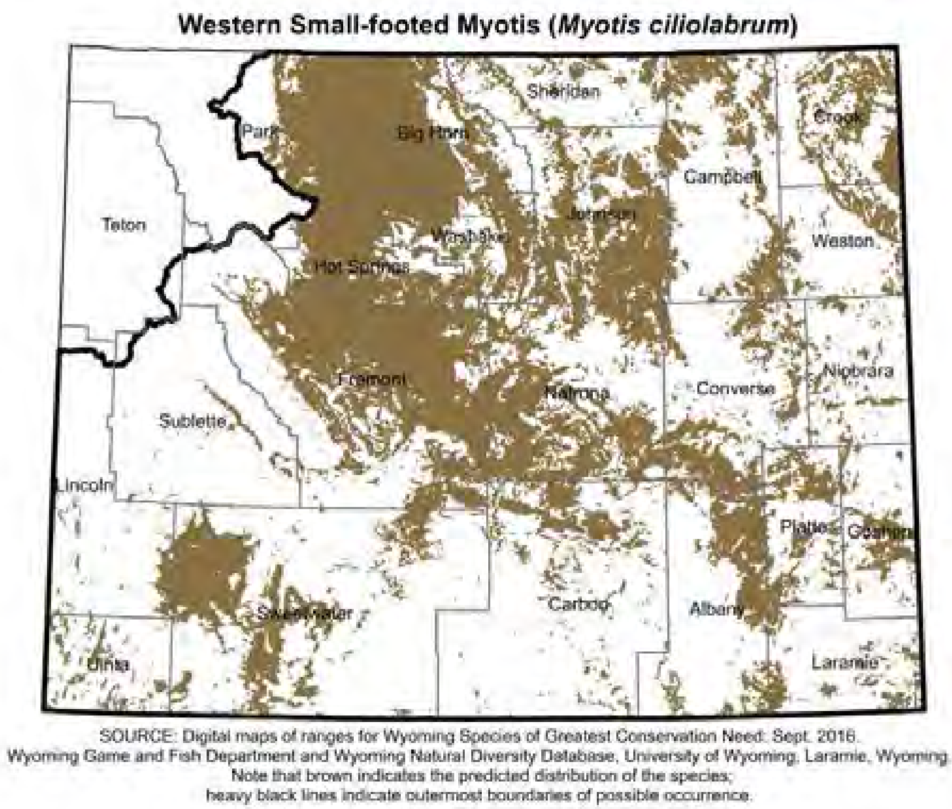

Figure 4: Range and predicted distribution of *Myotis ciliolabrum* in Wyoming.


Figure 5: Ventral view of a Western Small-footed Myotis captured in Wyoming. (Photo courtesy of Shelly Johnson, WGFD)

Western Spotted Skunk
Spilogale gracilis

REGULATORY STATUS
USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Predatory Animal

CONSERVATION RANKS
USFWS: No special status
WGFD: NSSU (U), Tier III
WYNDD: G5, S3S4
Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS
Western Spotted Skunk (*Spilogale gracilis*) is assigned a range of state conservation ranks by the Wyoming Natural Diversity Database (WYNDD) due to uncertainty concerning the proportion of its Wyoming range that is occupied, the resulting impact of this on state abundance estimates, and, to a lesser extent, due to uncertainty about extrinsic stressors and population trends in the state.

NATURAL HISTORY

Taxonomy:
Spotted skunks are carnivores in the genus *Spilogale* within the Mephitidae family. There are currently two species of spotted skunk recognized in the United States: Eastern Spotted Skunk (*S. putorius*) and Western Spotted Skunk (*S. gracilis*) [1-4]. The distinction between the eastern and western species has been questioned over the years, with some authors suggesting that *S. gracilis* is a subspecies of *S. putorius* [5, 6], while others maintain that the two taxa are distinct species based on morphologic characteristics, differences in breeding strategy, and molecular data [7-9]. There are 7 subspecies of *S. gracilis* recognized by most authorities [3, 4]. *S. g. gracilis* is the most widespread of these, occurring throughout the intermountain west and Great Basin, and is the only subspecies occurring in Wyoming.

Description:
Spotted skunks are the smallest skunks in North America and are easily distinguished by their distinct black and white pelage. Western Spotted Skunk has 3 pairs of white stripes, or oblong patches, on the front half of the body and 3 more vertical patches on the back half. This pattering is much different than the large, white stripes of the sympatric Striped Skunk (*Mephitis mephitis*). However, it can be very difficult to tell Western Spotted Skunk from Eastern Spotted Skunk in the field, particularly based on visual sighting rather than a captured animal. The primary and subjective differentiating characteristic is that Western Spotted Skunk may have

more extensive white markings than Eastern Spotted Skunk [4]. In particular, Western Spotted Skunk has more extensive white on the end and underside of tail and may have a somewhat longer white spot on the forehead. However, in Wyoming these pelage characteristics may not be definitive, and other methods of identification are needed[10]. Pending development of suitable genetic differentiation, the two species are ultimately distinguished by chromosome number (Eastern has 64 chromosomes; Western has 60 chromosomes) and reproductive strategy (Eastern has a gestation period of 50–65 days with no delayed implantation; Western has a gestation period of 210–250 days and exhibits delayed implantation) [1, 4, 8, 11].

Distribution & Range:
Wyoming is on the eastern periphery of Western Spotted Skunk range and represents less than 5% of the species global range. In Wyoming, it is assumed to occur throughout suitable habitat in the western basins of the state roughly west of the Laramie and Bighorn mountain ranges, but this is based on relatively limited occurrences [10, 12, 13]. There has been no apparent contraction or shift in the species' range, nationally or in Wyoming, although information is lacking [10].

Habitat:
Western Spotted Skunk occurs in a variety of habitats but is most commonly associated with relatively open wooded and shrub habitats with brushy and herbaceous components that promote a diversity of edge habitat, often along streams, and often in association with rock outcroppings [4, 14, 15]. Western Spotted Skunk uses dens, which are typically burrows excavated by the skunks, modifications of other burrows (e.g., ground squirrel burrows), natural cavities (e.g., hallows in rock piles or the roots and trunks of trees), or man-made structures (e.g., gaps under buildings or road cuts) [4]. Limited information from Wyoming suggests a preference for wooded areas with rock outcrops and moderate to low overstory canopy cover [13].

Phenology:
Western Spotted Skunk exhibits delayed implantation. Mating occurs in late summer or fall, typically in September, but likely earlier in southern latitudes [8]. Following fertilization, embryo development is retarded, and implantation does not occur until April. Young are born in May, resulting in a total gestation period of roughly 210–250 days [8, 11]. Litters range from 2 to 5 young (average = 4) [8]. Western Spotted Skunk typically has one litter per year, but southern populations can have a second litter following breeding in July or August [4, 8]. Hibernation has not been reported, and spotted skunks appear active year-round throughout their range.

Diet:
Western Spotted Skunk is an omnivore that predominantly consumes insects and small mammals [4]. Carrion, fruits, berries, herpetofauna, and human left-overs have also been reported as diet items [4].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: RARE
In areas where they are not abundant, their secretive nocturnal nature means that spotted skunks can be difficult to detect unless targeted surveys are conducted to identify them. Population density is variable across its range, but does not seem to be particularly high anywhere [16]. Capture rates of Western Spotted Skunk may reach peak levels in isolated island populations

(e.g., 5.7 captures per 1000 trap nights; Santa Crus Island, California). Old and second-growth western forests generally show moderate capture rates (e.g., 0.9–1.2 captures per 1000 trap nights; Olympic Peninsula, Washington and Coast Range, Oregon), with lower rates in other forest types (e.g., 0.2 captures per 1000 trap nights in regenerating stands of the Olympic Peninsula) [4]. Abundance of Western Spotted Skunk in Wyoming is unclear, since there are no formal, quantitative estimates of abundance in the state, but is likely to be quite low since most previous accounts report only few, opportunistic observations [10, 12]. A recent survey effort targeting spotted skunks in Wyoming documented *Spilogale* spp. in 16 out of 160 locations that straddled the range of both species in the state [13] and likely includes detections of both species. Thus, the actual occupancy rate of *S. gracilis* across its purported range in Wyoming could be much lower than 10%. Limited survey effort and difficulty in identifying spotted skunks to the species level hinder our ability to quantify abundance of these species without genetic analyses.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
The International Union for Conservation of Nature classifies populations of Western Spotted Skunk as decreasing, but suggests that, although it may be declining in parts of the U. S., declines are not sufficient to merit a more threatened classification [16]. In contrast, population increases have been reported for the endemic population on Santa Cruz Island, but the ecology of that system is sufficiently different from the rest of the species' distribution that such trends are unlikely to represent conditions elsewhere [17]. As with other parts of the range, Western Spotted Skunk does not appear to be abundant in Wyoming [10, 12]. However, very limited information suggests that the species persists where it was recorded historically in the state [13], so it is perhaps unlikely that populations in Wyoming have recently declined.

Intrinsic Vulnerability:
LOW VULNERABILITY
Ample vegetative cover is necessary to support populations of Western Spotted Skunk, but the type of cover varies across its range and does not, therefore, seem restrictive. The species is fairly opportunistic in den selection and is a relative omnivore, so den sites and diet are also likely not limiting. It appears adaptable to human presence, often denning in man-made structures [4], so it is not likely to be particularly vulnerable to human disturbance outside extensive control efforts, pesticide use, or habitat conversion. There is no information on disease susceptibility for the Western Spotted Skunk, but the closely-related Eastern Spotted Skunk is hypothesized to be vulnerable to a variety of diseases [18]. However, there is no evidence for either species that disease affects population distribution or abundance. Western Spotted Skunk does not have limiting reproductive biology or unusually low fecundity.

Extrinsic Stressors:
SLIGHLTY STRESSED
Widespread declines in populations of *S. p. interrupta*, a subspecies of Eastern Spotted Skunk, have led to speculation regarding stressors to populations of spotted skunks in general. Although none of these have been confirmed as definite contributors to spotted skunk declines, some hypothesized stressors include: advent of large-scale pesticide use in agricultural systems, thus reducing insect prey and/or directly affecting spotted skunks; the advent of large-scale farming and concurrent reduction in wildland edge habitats, fence rows, and haystack construction that spotted skunks prefer; extensive trapping for the fur trade, long-term drought; changes in forest

management practices that reduced brushy understory; and diseases such as distemper, rabies, and parvo viruses [18-20]. Some of these stressors are not likely to apply in Wyoming, since most of the species' Wyoming range is not subject to intensive, crop-based agriculture, and very few skunks are trapped in the state. The remaining stressors could occur in Wyoming, but there is substantial uncertainty regarding their actual level of stress in the state and subsequent impacts on Western Spotted Skunks.

KEY ACTIVITIES IN WYOMING

The Wyoming Game and Fish Department (WGFD) has recently funded a number of projects pertaining to spotted skunks. The WGFD conducted pilot surveys in the winter of 2014–2015 to assess the presence of spotted skunks in central Wyoming [13]. A subsequently project has been funded through WYNDD and the University of Wyoming Department of Zoology and Physiology to conduct an extensive inventory of spotted skunks in Wyoming. This study will focus predominantly on *S. putorius*, but will also cover much of the potential introgression zone between the two species and will assess the genetic divergence between *S. gracilis* and *S. putorius*. This project is expected to begin in the fall of 2016 and has an expected completion in 2018. Finally, the WGFD is coordinating with the University of Wyoming to solicit and compile trapping and observational records of spotted skunks throughout the state in order to help direct research efforts and develop a baseline distribution throughout the state.

ECOLOGICAL INFORMATION NEEDS

Assessment of Western Spotted Skunk status is hampered by limited information regarding its distribution, abundance, population trends, and taxonomic distinctness, all of which are also needed for *S. putorius*. Improved distribution and habitat information are necessary to assess whether development activities across Wyoming's basins might be a stressor. Estimates of abundance and/or occupancy rates are important for establishing an accurate state conservation rank and as a baseline for eventual population monitoring that can be used to assess trends over time. Assessing taxonomic distinctness of *S. gracilis* from *S. putorius* will help in directing species-specific conservation efforts.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Western Spotted Skunk is assigned an NSSU rank because survey data that would provide for an assessment of population status are lacking. Additionally, the current classification of all skunks in Wyoming as predatory animals makes management of Western Spotted Skunk difficult. Consequently, conservation concerns for both spotted skunk species in the state may necessitate the need to reevaluate the current classification of these species. Management priorities for the species in the short-term will focus on addressing data deficiencies, including data on presence, distribution, population status and trends, and the impact of extrinsic stressors, which will ultimately be used to develop management and conservation recommendations. Additionally, a better understanding of habitat use, range boundaries, and areas of overlap with the sympatric Eastern Spotted Skunk are needed at this eastern range boundary. Because of the overlap and difficulty in distinguishing between Eastern and Western Spotted Skunk in the field, upcoming projects will focus on the use of genetic analyses for positive identification, to delineate distribution, and to evaluate the potential for and degree of hybridization between the species.

CONTRIBUTORS

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Figure 1: A recently released adult spotted skunk (*Spilogale* spp.) that was captured in Albany County, Wyoming. (Photo courtesy of Kristina M. Harkins)

Figure 2: Map not available.

Figure 3: Spotted skunk (*Spilogale* spp.) habitat in the Pedro Mountains in Carbon County, Wyoming. (Photo courtesy of Jesse Boulerice, WGFD)

Figure 4: Map not available.

White-tailed Prairie Dog

Cynomys leucurus

REGULATORY STATUS

USFWS: Petitioned for Listing
USFS R2: Sensitive
USFS R4: No special status
Wyoming BLM: Sensitive
State of Wyoming: Nongame Wildlife; Pest

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS4 (Cb), Tier II
WYNDD: G4, S2S3
  Wyoming contribution: VERY HIGH
IUCN: Least Concern

STATUS AND RANK COMMENTS

White-tailed Prairie Dog (*Cynomys leucurus*) was petitioned for listing under the Federal Endangered Species Act in 2002. In 2010, the United States Fish and Wildlife Service (USFWS) concluded that the species was not at risk of extinction in all or a significant portion of its range and, therefore, listing was not warranted [1]. This decision was subsequently challenged in court and, in September 2014, the decision was remanded back to the USFWS for evaluation. A final decision is expected in early 2017. The Wyoming Natural Diversity Database (WYNDD) has assigned White-tailed Prairie Dog a range of state conservation ranks because of uncertainty regarding the proportion of the species' range occupied and intrinsic vulnerability in Wyoming.

NATURAL HISTORY

Taxonomy:

Five species of prairie dogs are found worldwide; all are in the genus *Cynomys*, and all are found in North America. The genus is further divided into two subgenera, *Cynomys* and *Leucocrossuromys*, the latter of which includes White-tailed Prairie Dog as well as Utah Prairie Dog (*C. parvidens*) and Gunnison's Prairie Dog (*C. gunnisoni*) [2]. White-tailed Prairie Dog is monotypic and does not have any recognized subspecies [3, 4].

Description:

White-tailed Prairie Dog is identifiable in the field. It is a large rodent with a robust, stocky body and short legs [5]. When standing upright, individuals exhibit a slender head and torso with a rounded abdomen [6]. Males are larger than females, but pelage is similar between sexes [6]. White-tailed Prairie Dog has yellowish buff brown pelage with a dark brown-black patch above the eye and on the check [3]. White-tailed Prairie Dog can be distinguished from the only other prairie dog in Wyoming, Black-tailed Prairie Dog (*C. ludovicianus*), where they overlap by a white as opposed to black tail. Its large size (body length = 34–37 cm) and lack of conspicuous eye ring and dorsal patterns distinguish it from other ground squirrels [6]. Among other vocalizations, White-tailed Prairie Dog emits a conspicuous bark-like sound used for communication [3, 6].

Distribution & Range:
White-tailed Prairie Dog is thought to exist across most of its historic range but is now found in relatively smaller, more fragmented colonies than in the past [2]. Specifically, White-tailed Prairie Dog is found in shrub-steppes throughout the Wyoming Basin in Montana, Wyoming, Utah, and Colorado and farther south into northeastern Utah and northwestern Colorado [3]. Wyoming makes up about 55–75% of the entire species' range [1, 6], and the eastern-most portion of White-tailed Prairie Dog range overlaps with that of Black-tailed Prairie Dog.

Habitat:
White-tailed Prairie Dog is typically found in semi-arid and arid grassland, desert grassland, and shrub-land habitats with low to moderate slopes. In Wyoming, the species is found between 1,300 and 2,300 m in elevation. Colonies are found in areas with open plant communities, likely because of increased predator detection and avoidance provided by short plants. The species requires deep and well-drained soils in which to develop burrow systems [2].

Phenology:
White-tailed Prairie Dog hibernates throughout the winter, emerging in late February to mid-March. Adult males are the first to emerge, followed by adult females 2 to 3 weeks later [7]. Individuals are strictly diurnal, and activity patterns are closely tied to temperature. In the hot summer months, activity is bimodal, with peaks of activity between sunrise and 0900 and again between 1500 to before sunset. In the cooler months, activity peaks early afternoon [3]. Breeding occurs in late March and early April; juveniles emerge from burrows in late May and early June following a 30-day gestation [7]. Average litter size is 5 young, and a single litter is produced annually [3]. Juvenile dispersal from the natal burrow occurs in July and August [5], with most emigration to new colonies occurring in early spring [3]. Activity levels tend to decrease in mid-July for adults, with adult males entering hibernation before adult females. All adults are inactive by late August, and all age classes enter hibernation by late October or early November [3].

Diet:
White-tailed Prairie Dog is an opportunistic feeder, and diet items vary seasonally. The species consumes a variety food, mainly vegetation including shrub and grass leaves, forbs, cacti, seeds, and roots. The species will also consume insects and carrion [5, 6].

CONSERVATION CONCERNS

Abundance:
Continental: REGIONAL ENDEMIC
Wyoming: ABUNDANT
Estimates of White-tailed Prairie Dog abundance in Wyoming are generally assessed as area of occupied habitat (i.e., habitat containing active colonies). Recent estimates of occupied area in Wyoming vary from roughly 186,000 ha [8] to over 300,000 ha [9].

Population Trends:
Historic: MODERATE DECLINE
Recent: STABLE
Although the geographical distribution of the species has changed little since European settlement, the species likely has experienced some decline in abundance [1], although the exact

level of decline is difficult to quantify because accounts prior to settlement are lacking [10]. State-wide aerial surveys conducted in 2008 and 2011 demonstrated little change in amount of area occupied by active colonies, although both surveys likely overestimated total active area overall due to the difficulty in correctly assigning activity status from the air [9, 11]. Recent trend analyses in Meeteetse, Wyoming demonstrate a 4-fold increase in abundance of prairie dogs from 4.8–5.2 prairie dogs per ha in 2013 to 15.0–26.7 prairie dogs per ha in 2015 [12]. Nonetheless, it is generally accepted that the species has experienced at times drastic, localized declines attributed to disease, large-scale control efforts, and habitat modification [5]. Such factors have resulted in populations and colonies fluctuating considerably among years [13, 14], which further complicates trend assessment.

Intrinsic Vulnerability:
MOERATE to HIGH VULNERABILITY
White-tailed Prairie Dog is very susceptible to sylvatic plague, and, with mortality rates exceeding 90% in infected colonies, epizootic outbreaks of sylvatic plague can lead to localized extirpation of prairie dog colonies [15]. Although the species is widely distributed throughout the Wyoming Basin, relatively low dispersal rates make it difficult for White-tailed Prairie Dog to colonize new sites or recolonize formerly occupied sites [8].

Extrinsic Stressors:
MODERATELY STRESSED
Because prairie dogs are classified as a pest by the Wyoming Department of Agriculture [16], control activities, including poisoning and shooting, are legal throughout the range of the species in Wyoming. Although such efforts can have small-scale impacts, up to and including eradication of colonies, the USFWS has concluded that these are generally localized and do not translate into a large-scale threat [1]. Conversion of habitat to cropland and urban or exurban development are also generally localized threats and thought to impose a relatively small threat to the species range-wide. Energy development within the distribution of the species is increasing and likely impacts a significant portion of White-tailed Prairie Dog range in Wyoming [2], although impacts are largely un-quantified [1].

KEY ACTIVITIES IN WYOMING

Most work for prairie dogs to-date has revolved around developing and implementing methods to monitor population trends as well as localized mapping efforts in support of Black-footed Ferret (*Mustela nigripes*) recovery efforts (e.g., Van Fleet 2009) [17]. Beginning in 2008, the Wyoming Game and Fish Department (WGFD) evaluated and implemented range-wide aerial surveys for White-tailed Prairie Dog [11, 18], which were again completed in 2011 [9]. However, given the difficulty in assessing status and colony boundaries from aerial surveys, the WGFD will implement occupancy surveys in the future to monitor trends [19, 20]. In 2013, the WGFD joined a nationwide, multi-agency collaborative effort with the United States Geological Survey, state agency, and non-agency personnel to evaluate the efficacy of an oral vaccine for sylvatic plague throughout the range of prairie dog species in the United States [21, 22]. The WGFD study took place on a White-tailed Prairie Dog colony near Meeteetse, Wyoming [12, 23, 24]. In 2015, the WYNDD, through funding provided by the WGFD, completed a pilot project to implement recommended occupancy surveys throughout Wyoming [25]. Statewide surveys were conducted in conjunction with surveys in Colorado and Utah in the summer of 2016 following the "Protocol for conducting prairie dog occupancy surveys" published by the White-tailed Prairie Dog and Gunnison Prairie Dog Working Group [26].

Ecological Information Needs

A better understanding of trends of White-tailed Prairie Dog is needed in order to quantify abundance and monitor populations. Given the extreme variability in abundance of White-tailed Prairie Dog, additional research is needed to evaluate the causes of these fluctuations and to evaluate why some colonies exhibit rapid recovery following declines while others demonstrate little to no recovery. Although our knowledge of the plague cycle has increased, a better understanding of the difference in plague dynamics among prairie dog species is needed to inform conservation and management activities. For example, White-tailed Prairie Dog is less social and more widely spaced on the landscape than Black-tailed Prairie Dog [2], which may impact rates of transmission and prairie dog mortality. Information on how populations respond to the disease in enzootic and epizootic states as compared to other stochastic events (e.g., drought) would also be beneficial. Additionally, improved understanding of how different habitats (e.g., grasslands versus sagebrush) affect abundance, distribution, and persistence of populations of White-tailed Prairie Dog across its range would greatly improve conservation. Finally, prairie dogs throughout their range are exposed to a number of stressors, and a quantification of these stressors and an understanding of their impacts to population dynamics and persistence are needed.

Management in Wyoming

This section authored solely by WGFD; Nichole L. Bjornlie. White-tailed Prairie Dog is classified as both a pest and a nongame species in Wyoming, and, as such, both the Wyoming Department of Agriculture and the WGFD have shared management authority for prairie dogs, which makes management of White-tailed Prairie Dog difficult. Current management priorities for the WGFD for White-tailed Prairie Dog include continuing state-wide monitoring efforts and coordinating with other state agencies within the range of the species to develop a range-wide occupancy estimate in 2016. This will serve as a baseline that can be used to evaluate population trends every 6 years and evaluate the impacts of potential threats. Additional priorities include continued localized on-the-ground colony mapping and population monitoring in support of Black-footed Ferret reintroduction efforts. Although the official field-trials for the sylvatic plague vaccine at Meeteetse were completed in 2015, the WGFD completed one additional field season in 2016 to provide additional data to evaluate the efficacy of the oral vaccine. Sylvatic plague control efforts, including dusting and vaccine baits, will be implemented on a local scale as necessary, with priority given to active and potential Black-footed Ferret reintroduction sites. Finally, the WGFD will continue active involvement with the interstate Prairie Dog Conservation Team and collaborate with the Western Association of Fish and Wildlife Agencies on the range-wide conservation needs for this species. Outreach and collaboration with private landowners will remain a priority to ensure conservation of prairie dogs and prairie dog habitat.

Contributors

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Figure 1: Adult White-tailed Prairie Dog in Albany County, Wyoming. (Photo courtesy of Ian M. Abernethy)

Figure 2: North American range of *Cynomys leucurus*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

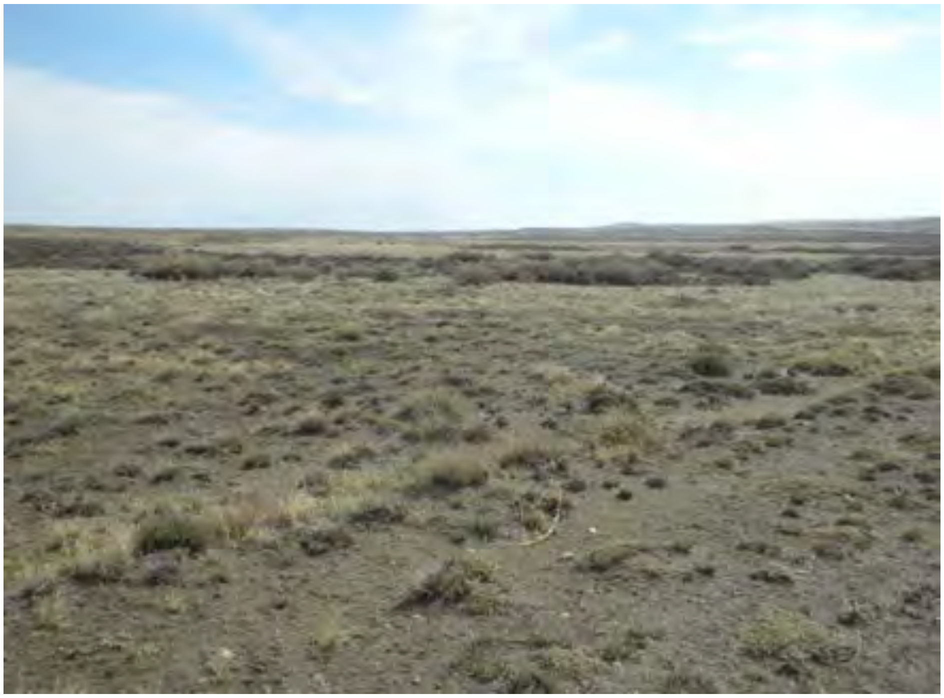

Figure 3: White-tailed Prairie Dog habitat in Shirley Basin, Wyoming. (Photo courtesy of Katie Leuenberger)

Figure 4: Range and predicted distribution of *Cynomys leucurus* in Wyoming.

Wolverine
Gulo gulo

REGULATORY STATUS
USFWS: Proposed Threatened
USFS R2: Sensitive
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Protected Animal

CONSERVATION RANKS
USFWS: No special status
WGFD: NSS3 (Bb), Tier II
WYNDD: G4, S1S2
Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS
Wolverine (*Gulo gulo*) has a complicated history with the U.S. Endangered Species Act (ESA) involving several decisions, litigations, and re-decisions, starting with a 1994 listing petition. In 2014 the U.S. Fish and Wildlife Service (USFWS) withdrew the species' Proposed Threatened status [1], but that withdrawal was litigated and eventually reversed by the District Court of Montana in April 2016, effectively reinstating the Proposed Threatened status [2]. The same court decision also effectively reinstated a proposed USFWS rule to designate all Wolverines in the Southern Rocky Mountains, including southern Wyoming, as part of a Nonessential Experimental Population. Wolverine is assigned a range of state conservation ranks by the Wyoming Natural Diversity Database due to uncertainty in the amount of range actually occupied, population trends, and effects of extrinsic stressors in the state.

NATURAL HISTORY

Taxonomy:
Gulo gulo is currently the only species recognized within the genus. Several Wolverine subspecies were recognized in the past, but only two subspecies are generally recognized today: *G. g. luscus* in North America and *G. g. gulo* in Eurasia [3, 4]. The older name *G. luscus* infrequently appears in reference to the New World form, but has formally yielded to *G. gulo*.

Description:
Identification of Wolverine is possible in the field. The species generally appears as a small bear or large badger, with massive limbs, dark brown fur, bushy tail, and relatively large feet. The fur is paler on the head, and there are two broad yellowish stripes extending from the shoulders and joining at the rump [3, 5]. In Idaho, adult females averaged 87.5 cm in total length and 7.9 kg in weight; adult males averaged 97.2 cm and 12.7 kg [5].

Distribution & Range:
Wolverine has a Holarctic distribution, occupying boreal regions of North America, Asia, and Europe. The species once occupied mountain ranges in the western U.S. as far south as the Colorado/New Mexico border. In North America Wolverine is currently found in Alaska, Canada, Washington, Idaho, Montana, and Wyoming [6, 7]. Single animals are occasionally documented in other states – including California, Colorado, Utah, and North Dakota – but these are assumed to be non-breeding dispersers. The species' secretive nature, naturally low density, and high mobility make it difficult to know precise range limits [8]. Historically, Wolverine likely occupied all major mountain ranges in Wyoming. Currently, breeding populations are likely only found in the northwestern mountains, although the full extent of breeding populations is unknown, with irregular detections and unknown breeding status elsewhere in the state [8-10]. Wolverine has been observed in 11 of Wyoming's 28 degree blocks, with suspected breeding in 6 degree blocks [11].

Habitat:
In parts of Alaska and Canada suitable Wolverine habitat occurs in non-mountainous landscapes, but in Wyoming suitable habitat is almost completely restricted to prominent mountain ranges [12]. Wolverine uses a variety of mountain habitats, but centers its activities in large subalpine and alpine landscapes. Important habitat needs include cold temperatures and cold microsites like persistent snow drifts and chilled talus fields; ample den structures such as caves, rock crevices, fallen trees, and deep snow drifts; and abundant carrion, usually supplied by large populations of ungulates [8, 9, 13]. By regularly producing ungulate carrion, large carnivores such as Gray Wolf (*Canis lupus*), Mountain Lion (*Puma concolor*), and Grizzly Bear (*Ursus arctos*) may enhance Wolverine habitat quality [14], although these species are also known to prey on Wolverine.

Phenology:
Wolverine does not hibernate. Mating typically occurs in the summer, with delayed implantation of the embryo in early winter [8]. Although litters of up to 4 and even 5 young have been recorded elsewhere, litters in the contiguous U.S. are generally assumed to include only 1–3 young. Young are born in late winter, typically in February and early March, after a 30–50 day post-implantation pregnancy. Kits are tended only by the mother, are weaned at about 8 weeks of age, and are adult sized in about 8 months. Young disperse from the natal area at 10–15 months of age [3, 8]. Wolverine generally moves to higher elevations in the summer, likely following lower temperatures, persistent snow fields, and large prey/carrion sources [8]. The species tends to remain at relatively high elevations – even higher than most ungulate herds – in winter [12].

Diet:
Wolverine is a strongly opportunistic feeder, eating berries, insect larvae, fish, birds and mammals of almost all sizes, and carrion of all types. Wolverine relies especially heavily on carrion as a food source, and population performance may depend on a regular supply of carrion from ungulates such as Mule Deer (*Odocoileus hemionus*), Elk (*Cervus elaphus*), and Moose (*Alces americanus*) [3, 8]. In the Greater Yellowstone Ecosystem (GYE), Wolverine may rely more heavily on ungulate carrion in the winter, with small prey, especially Yellow-bellied Marmot (*Marmota flaviventris*), becoming more prevalent in the diet during the warmer months [15]. Gut piles from hunter-killed ungulates are an important food source for Grizzly Bear in Wyoming, and may function similarly for Wolverine [16].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD BUT PATCHY
Wyoming: VERY RARE
The secretive nature, naturally low density, and high mobility of Wolverine make it difficult to precisely estimate population size. Most Wolverines in North America occupy Canada and Alaska. In 2013, the contiguous U.S. population was estimated at 318 (95% CI = 249–926) individuals, with most in Montana and Idaho. The GYE, the bulk of which falls in Wyoming, was estimated to support 20% (63 individuals; 95% CI = 51–175) of that total [7]. A coarse approximation from these data suggests about 50 total individuals occupying Wyoming, which means the species is rare even within suitable habitat in the state [11]. From a survey of 18 grid cells in the mountains of western Wyoming in 2015, Wolverine occupancy was estimated at 62.9% (95% CI = 36.2–83.7) throughout suitable habitat [17].

Population Trends:
Historic: LARGE DECLINE
Recent: INCREASE
Wolverine is thought to have been more abundant prior to Euro-American settlement than now. Near the turn of the 20th century, human-caused mortality drastically reduced, and possibly extirpated, Wolverine in the contiguous 48 states. This was followed by a slow re-colonization by animals dispersing south from Canada [4]. It is suspected that Wolverine numbers in Wyoming have been slowly increasing for a few decades. The suspected increase is based on increasing numbers of sightings in the state and may be due to reduced fur trapping, less broad-scale carnivore poisoning, increasing numbers of Elk, and increased ungulate carrion resulting from predation by reintroduced Gray Wolf [8].

Intrinsic Vulnerability:
HIGH VULNERABILITY
Wolverine habitat requirements, space use, and breeding biology make the species highly vulnerable. An individual Wolverine requires a huge amount of subalpine and alpine habitat. In the GYE, female home ranges averaged 303 km^2, and male home ranges averaged 797 km^2. Furthermore, home ranges of same-sex adults did not overlap, suggesting territoriality and consequent low population density. Wolverine density in the GYE was estimated at 3.5 individuals per 1,000 km^2 of suitable habitat [12]. Individuals of both sexes typically do not breed until at least 2 years of age, at which point females produce only 1 small litter per year. Mortality of kits and dispersing sub-adults is assumed to be high, although reliable estimates for populations in the contiguous U.S. are difficult to find [8, 13]. Site fidelity of Wolverines in Wyoming may be high [8], although individuals have been known to disperse several hundred kilometers from Wyoming points of origin [5].

Extrinsic Stressors:
MODERATELY STRESSED
Evidence for most extrinsic stressors on Wolverine come from studies performed across the species' range, and thus the degree to which they pertain specifically to Wyoming populations is unclear. In the contiguous U.S., a primary near-term stressor to Wolverine is increasing human use and development of core habitat (i.e., subalpine and alpine landscapes) and, especially, the valleys and basins between "islands" of core habitat through which Wolverines disperse [7]. Wolverine avoids landscapes with higher levels of human presence and development, including

backcountry skiing, residential subdivision, oil and gas extraction, and timber harvesting operations [18-20]. Direct human-caused mortality via illegal shooting, inadvertent trapping, and roadkill may account for numerically few Wolverine, but has a functionally high impact due to the species' overall small population size, low density, and slow reproductive rate [8]. Individual home ranges may include portions of 2 or 3 states, so mortality in adjacent states will negatively impact populations in Wyoming [21, 22]. Wolverine appears to depend on persistent snow drifts and cold microsites for a range of life history functions, and thus the possible effects of global climate change on the species are being debated in the expert community and are receiving current research attention [8, 23, 24].

KEY ACTIVITIES IN WYOMING

Wolverine is currently proposed for listing as Threatened under the ESA. The final listing decision is expected in federal fiscal year 2018 (July 2017–June 2018). Currently, there is no legal trapping or hunting of Wolverine in Wyoming or any surrounding state, although incidental take in traps set for other species may occur. There is a rapidly developing scientific literature on Wolverine, and several on-going studies involve portions of Wyoming or individuals that range through the state. In addition to ongoing Wyoming Game and Fish Department (WGFD) efforts, there are several working groups (e.g., Western Association of Fish and Wildlife Agency [WAFWA] Wildlife Chiefs Wolverine Sub-committee, Alberta Wolverine Working Group) and non-profit organizations (e.g., Wolverine Network, The Wolverine Foundation, Wildlife Conservation Society, Round River Conservation Studies) sponsoring Wolverine conservation and research initiatives across the species' range. Ongoing work by Round River Conservation Studies in the Teton Mountains focuses on the effects of recreational activity on Wolverine movement patterns. The WGFD has collected some Wolverine observations as part of camera trapping inventories targeting a range of other species [25]. In 2015, the WGFD funded a pilot project through The Wolverine Initiative to evaluate Wolverine detection and monitoring techniques, status, and distribution in the state [17]. Concurrent with this project, WAFWA developed a multi-state, multi-agency working group to identify and address issues pertaining to Wolverine conservation and management in the contiguous U.S. The pilot project conducted in Wyoming contributed to a multi-state effort among Wyoming, Idaho, Montana, and Washington to develop a coordinated multi-state monitoring strategy and define baseline Wolverine distribution. The WGFD began implementing this monitoring strategy in Wyoming throughout the GYE and the Bighorn Mountains in the winter of 2015–2016, and final results from all states will be available in 2017. Additional priorities of the Multistate Wolverine Working Group include modeling range-wide connectivity to focus and prioritize habitat conservation delivery; this project is currently being conducted through the University of Montana.

ECOLOGICAL INFORMATION NEEDS

Given the species' naturally low population density and extreme movement ability, understanding the residency status of individual Wolverine (particularly females) in Wyoming, and the relative dependence of the state population segment on immigrants versus recruitment of individuals produced within Wyoming itself, will be valuable to Wyoming managers. A better understanding of the extent of breeding Wolverine in Wyoming, including outlying mountain ranges such as the Bighorn and Medicine Bow Mountains, would allow more appropriate implementation of management and research activities. Research from some portions of Wolverine range suggests the species may be more tolerant of human presence and impacts to the landscape than previously assumed [26] - further knowledge of how this and other extrinsic stressors operate specifically in Wyoming would allow better estimation of extent, distribution, and connectivity of suitable habitat. Wyoming-specific estimates of litter frequency, litter size, kit survival, and disperser survival would also help with management of the species.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Recent management activities for Wolverine include evaluating and implementing monitoring protocols throughout suitable habitat in western Wyoming. Initiated in 2015, results from this effort will provide a state- and range-wide baseline occupancy estimate. Moving forward, priorities will include continued coordination and collaboration with other western states to periodically repeat surveys in order to evaluate population trends and distribution. Incorporating genetic analyses from hair snares will also allow for a better understanding of number of individuals as well as the distribution of female Wolverine, information critical to better evaluating extent of breeding distribution in the state. Additional priorities will include continued participation in the WAFWA Multistate Wolverine Working Group and collaborating among states and agencies to promote Wolverine conservation and management in the contiguous U.S. Results from monitoring efforts and connectivity models will be used to develop conservation and management recommendations for Wolverine in Wyoming.

CONTRIBUTORS

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Figure 1: Female Wolverine (front) and two five-month old cubs in the Gravelly Range, Montana. (Photo courtesy of Mark Packila, WCS Wolverine Program)

Figure 2: North American range of *Gulo gulo*. Note that this map does not adequately depict Wyoming range, and does not include range data from research since 2007. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

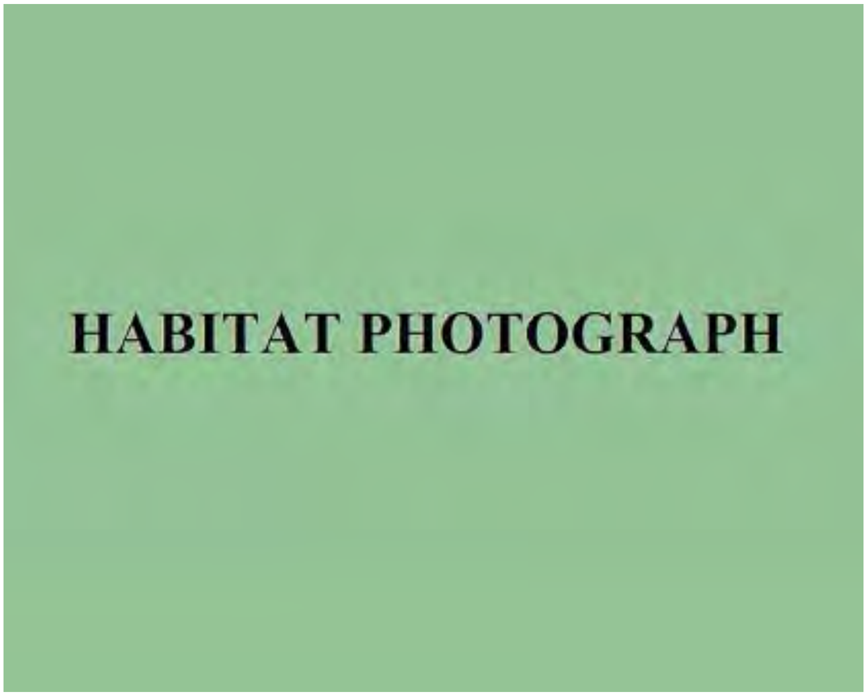

Figure 3: Photo not available.

Figure 4: Range and predicted distribution of *Gulo gulo* in Wyoming.

Figure 5: Wolverine tracks in snow-covered alpine habitat at an elevation of 9,000 ft in Gallatin National Forest, Montana. (Photo courtesy of Robert Inman)

Wyoming Pocket Gopher

Thomomys clusius

REGULATORY STATUS

USFWS: Listing Not Warranted
USFS R2: Sensitive
UWFS R4: No special status
Wyoming BLM: Sensitive
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS2 (Ab), Tier I
WYNDD: G2G3, S1
Wyoming Contribution: VERY HIGH
IUCN: Least Concern

STATUS AND RANK COMMENTS

Wyoming Pocket Gopher (*Thomomys clusius*) was petitioned for listing under the Federal Endangered Species Act in 2007. In 2010, the U.S. Fish and Wildlife Service (USFWS) determined that listing was not warranted (12-month decision) because the species was not likely in danger of extinction throughout all or significant portions of its range [1]. The species was again petitioned for listing in 2016, and the USFWS again determined that listing was not warranted (via a "not substantial" 90-day decision) in September 2016 [2].

NATURAL HISTORY

Taxonomy:

Although Wyoming Pocket Gopher was initially described as unique species in 1875 [3], subsequent revisions of the *Thomomys* genus placed Wyoming Pocket Gopher as a subspecies (*T. talpoides clusius*) of Northern Pocket Gopher (*T. talpoides*) until 1979 [4]. Wyoming Pocket Gopher is now considered a unique species based on genetic evidence [5]. Wyoming Pocket Gopher is monotypic, having no defined subspecies [4].

Description:

Wyoming Pocket Gopher is the smallest member of the genus *Thomomys* (total length: 161–184 mm; weight: 44.0–71.5 g). The species does not demonstrate sexual dimorphism [5]. Like other pocket gophers, Wyoming Pocket Gopher has a large head and shoulders tapering towards the posterior end. The front feet are large and strong with large claw-like nails used for digging. The species has small eyes and ears and fur-lined cheek pouches that open externally of the mouth [6, 7]. Pelage is generally pale yellow-brown [3], with young individuals lighter than adults. On the dorsal side, pelage is uniform in color. Wyoming Pocket Gopher can be distinguished from the sympatric Northern Pocket Gopher by its smaller size, lack of dark post-auricular patches, and presence of white hairs on the margins of pinnae that are lighter than the hair of the dorsum [5].

Distribution & Range:
Wyoming Pocket Gopher is Wyoming's only endemic mammal and is found only in south-central Wyoming. The distribution of the species extends roughly from southeast of Rock Springs in Sweetwater County to northwest of Rawlins in Carbon County [4]. It is unknown if changes in distribution have occurred either historically or recently. Confirmed breeding has been documented in 2 of the 28 latitude/longitude degree blocks in Wyoming [8].

Habitat:
Wyoming Pocket Gopher is found in shrub steppe and mixed desert shrublands. The species is often associated with relatively flat habitat characterized by well-drained clay soils and greater amounts of bare soil with little rock or litter cover along gravelly ridgelines and stream-cut riverbanks [5, 9, 10]. Wyoming Pocket Gopher is fossorial, spending the majority of its life underground. Therefore, soils that are deep and tractable enough to hold burrow systems are necessary to maintain pocket gopher populations [6]. It is suspected that Wyoming Pocket Gopher can utilize harder soils with higher clay content than sympatric pocket gopher species [9]. Further, the species is associated with areas containing less Big Sagebrush (*Artemisia tridentata*) and Yellow Rabbitbrush (*Chrysothamnus viscidiflorus*) and more Gardner's Saltbush (*Atriplex gardneri*), Winterfat (*Krascheninnikovia lanata*), and potentially greasewood (*Sarcobatus* spp.) [5, 9, 10]; the presence of Gardner's Saltbush may be the best predictor of the presence of Wyoming Pocket Gopher [10], although this may amount to only 0.01–15.00% cover [9]. Because pocket gophers in general have small home ranges, it is unlikely that habitat use varies greatly among seasons [6].

Phenology:
Phenology of Wyoming Pocket Gopher is largely unknown, but it is assumed to be similar to the closely related and well-studied Northern Pocket Gopher [4]. Northern Pocket Gopher is fossorial and active year-round, with above-ground movements limited to nighttime or overcast daytime conditions [11]. Breeding occurs from mid-March to mid-June with juveniles dispersing from early June to late July, at which time they begin to develop their own burrow systems [11, 12]. While it is thought that Wyoming Pocket Gopher disperses above ground based on evidence from other species, it is not explicitly known how this species disperses. Litter size is also unknown, although Northern Pocket Gopher in Wyoming gives birth to 4 (range: 1–10) young annually [11, 12].

Diet:
Wyoming Pocket Gopher diet is poorly understood but is also assumed to be similar to sympatric *Thomomys* species. For Northern Pocket Gopher, primary dietary components include roots, tubers, shoots, and leaves of forbs, grasses, and shrubs. Most food items are likely collected underground, although above-ground food items are also collected and pulled into burrow entrances. Food is likely cached [11].

CONSERVATION CONCERNS

Abundance:
Continental: LOCAL ENDEMIC
Wyoming: VERY RARE
The global distribution of Wyoming Pocket Gopher is limited to an area roughly 19,700 km^2 in size in south-central Wyoming [4], although actual presence of individuals within this distribution is patchy [13]. While little is known about the abundance of the species, it is assumed to be quite

rare on the landscape based on low capture rates during targeted sampling efforts – Wyoming Pocket Gopher was captured in only 29% of 84 quarter sections (0.65 km^2 each) known to be occupied by pocket gophers in the predicted range of the species [10].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends for Wyoming Pocket Gopher in Wyoming are unknown.

Intrinsic Vulnerability:
HIGH VULNERABILITY
Wyoming Pocket Gopher is a local endemic with a global distribution limited to a very small area of south-central Wyoming [4]. Further, within this limited distribution, Wyoming Pocket Gopher appears to be relatively rare and is about half as common on the landscape as the more widespread Northern Pocket Gopher [10]. Species with small geographic ranges are vulnerable to a single localized threat, including anthropogenic and stochastic factors, and thus face a higher probability of extinction than do species occupying a large range [6]. In general, pocket gophers have limited dispersal ability [6, 7], which may impact Wyoming Pocket Gopher's ability to expand its distribution.

Extrinsic Stressors:
MODERATELY STRESSED
Wyoming Pocket Gopher range coincides with existing and planned oil, natural gas, and wind energy developments [1]. Development of energy resources and construction of associated infrastructure has the potential to result in the loss, fragmentation, and degradation of Wyoming Pocket Gopher habitat; soil compaction from oil and gas exploration and extraction may be particularly detrimental to this fossorial species, especially if individuals disperse below ground [6, 9, 14]. However, effects of these activities on Wyoming Pocket Gopher are unquantified. Furthermore, responses to natural and anthropogenic disturbances by other pocket gopher species are mixed, making it hard to make any predictions about Wyoming Pocket Gopher [1]. Finally, livestock grazing has reduced abundance of some pocket gopher species in some systems [6]. Although grazing does occur at some level across parts of the distribution of Wyoming Pocket Gopher [1], it is unknown how grazing practices affect Wyoming Pocket Gopher.

KEY ACTIVITIES IN WYOMING

As a Wyoming-endemic species, all work to date on the Wyoming Pocket Gopher has occurred in the state, much of it in response to a petition to list the species as threatened or endangered (e.g., Hayden-Wing Associates 2008, Griscom and Keinath 2010, Griscom et al. 2010). Recent work has addressed developing a better understanding of genetics, distribution, and habitat use. Genetic analyses completed in 2010 further elucidated the relatedness among pocket gophers in Wyoming and supported the species designation of Wyoming Pocket Gopher by demonstrating genetic uniqueness and a lack of hybridization with Northern Pocket Gopher [15]. Also in 2010, the Wyoming Natural Diversity Database and other partners completed field efforts that greatly increased current understanding of the distribution, status, and habitat use of Wyoming Pocket Gopher [9, 10], results of which are mentioned throughout this document.

ECOLOGICAL INFORMATION NEEDS

Although recent research has greatly increased our knowledge of Wyoming Pocket Gopher distribution and habitat, small sample sizes necessitate additional surveys to better assess range-wide distribution and habitat use of the species. Additionally, knowledge of basic biology, including phenology, diet, and dispersal behavior, remains poorly understood. Abundances, population densities, and trends are also not well known for this species. A number of potential threats have been identified for Wyoming Pocket Gopher, including soil compaction from energy development; habitat loss and fragmentation; and stochastic weather events, including runoff from melting snow, high groundwater tables, late and early season freezes, and weather-caused limitations on the availability of food and cover; however, an understanding of the impacts from these threats is needed. Finally, the distribution of Wyoming Pocket Gopher is completely overlapped by the distribution of Northern Pocket Gopher, and additional information is needed to determine whether and to what extent this larger species competes with and potentially limits Wyoming Pocket Gopher.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Although recent work has increased our knowledge of the habitat and distribution of Wyoming Pocket Gopher, very little is known regarding abundance, density, and population trends. Consequently, priorities for the species include developing and implementing a monitoring strategy that will address these data deficiencies. Because of the low density and limited distribution of Wyoming Pocket Gopher on the landscape, acquiring these data will likely require targeted survey efforts. The most pressing management needs for Wyoming Pocket Gopher in the short-term are an understanding of the current population status and impacts of potential limiting factors, particularly threats resulting from energy development. Long-term priorities will focus on increasing the understanding of basic biology for the species, all of which will ultimately be used to develop management and conservation recommendations.

CONTRIBUTORS

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Figure 1: Adult Wyoming Pocket Gopher. (Photo courtesy of Hannah Griscom)

Figure 2: North American range of *Thomomys clusius*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

Figure 3: Typical Wyoming Pocket Gopher habitat in south-central Wyoming. Note fresh gopher mounds in foreground of photo. (Photo courtesy of Hannah Griscom)

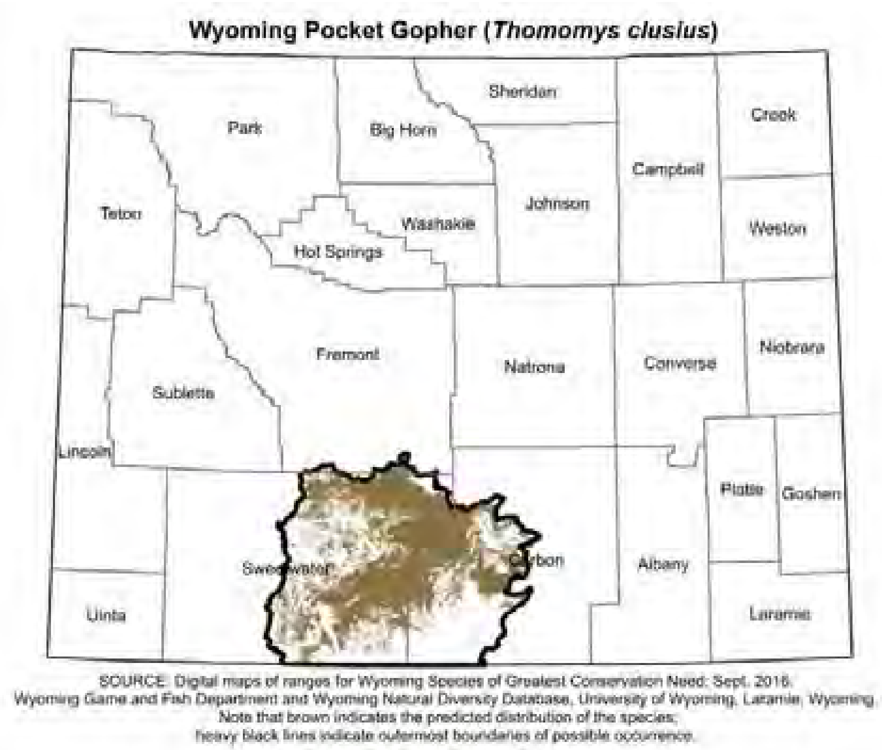

Figure 4: Range and predicted distribution of *Thomomys clusius* in Wyoming.

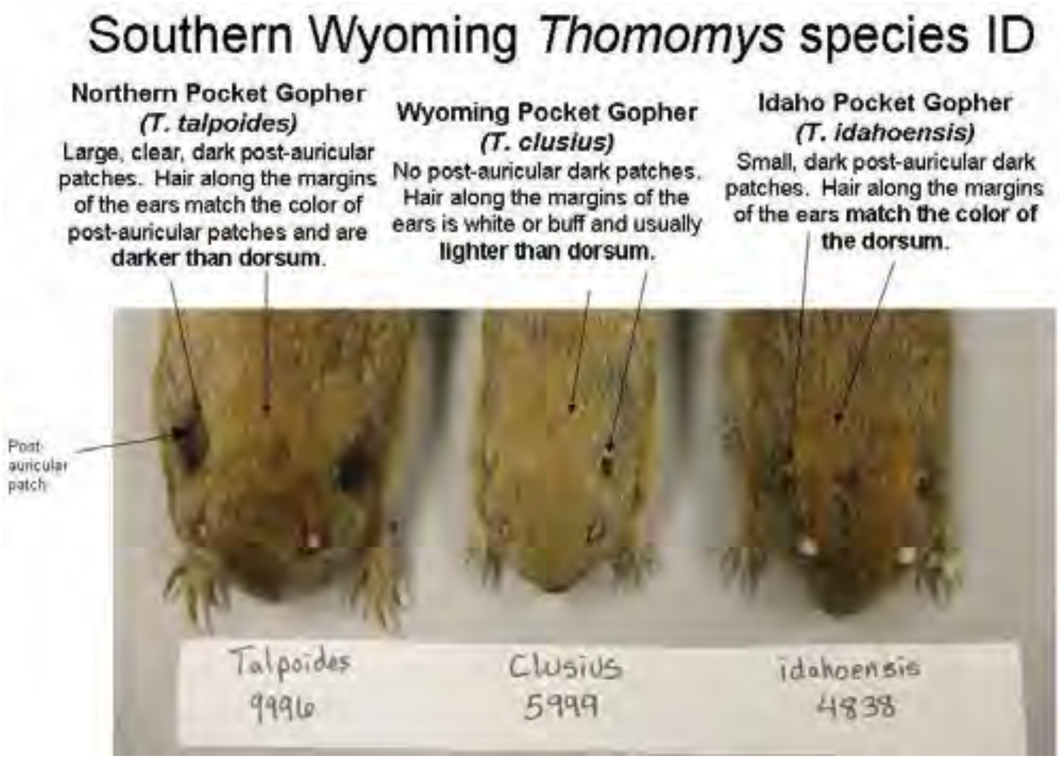

Figure 5: Key morphological characteristics of *Thomomys* species found in southern Wyoming. (Photo courtesy of Hannah Griscom)

Yellow-pine Chipmunk

Tamias amoenus

REGULATORY STATUS

USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS4 (Bc), Tier III
WYNDD: G5, S3S4
    Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS

The Wyoming Natural Diversity Database has assigned Yellow-pine Chipmunk (*Tamias amoenus*) a state conservation rank ranging from S3 (Vulnerable) to S4 (Apparently Secure) because of uncertainty about the proportion of range occupied and population trends for this species in Wyoming.

NATURAL HISTORY

Taxonomy:

Chipmunk taxonomy remains disputed, with some arguing for three separate genera (i.e., *Neotamias*, *Tamias*, and *Eutamias*) [1-3], while others support the recognition of a single genus (i.e., *Tamias*) [4]. Yellow-pine Chipmunk (briefly *N. amoenus*) [5] has since been returned to the currently recognized genus *Tamias*, along with all other North American chipmunk species [6]. Fourteen subspecies of Yellow-pine Chipmunk are currently recognized. There is no modern genetic description of these subspecies, nor is there any obvious geographic separation between most of them. Of the nominal subspecies, only *T. a. luteiventris* occupies Wyoming [7-10].

Description:

Identification of Yellow-pine Chipmunk is possible in the field. Yellow-pine Chipmunk is a small, reddish chipmunk with a buffy underbelly, dark facial stripes, and five dark and four light longitudinal dorsal stripes (i.e., outermost stripes are dark) [8, 10]. The crown of the head, rump, and thighs are smoke gray mixed with cinnamon [8, 10]. This species exhibits sexual size dimorphism, with females averaging larger than males [8, 11-13]. Adults weigh between 29–62 g and can reach total lengths of 203–225 mm [10]. Tail, hind foot, and ear length ranges from 81–100 mm, 32–33 mm, and 17–19 mm, respectively. Within its Wyoming range Yellow-pine Chipmunk may be confused with Least Chipmunk (*T. minimus*), Cliff Chipmunk (*T. dorsalis*), and Uinta Chipmunk (*T. umbrinus*). However, Least Chipmunk is smaller with a white underbelly, Cliff Chipmunk has overall grayish pelage and indistinct dorsal stripes, and Uinta Chipmunk has white outermost dorsal stripes [10].

Distribution & Range:
The distribution of Yellow-pine Chipmunk extends from southern British Columbia, across the northwestern United States, and south along the dry eastern edge of the Cascade and Sierra Nevada mountain ranges of California [8, 14]. In Wyoming, Yellow-pine Chipmunk is found in mountain ranges in the western and northwestern counties [10]. Confirmed or suspected breeding has been documented in 8 of 28 latitude/longitude degree blocks in the state [15].

Habitat:
Yellow-pine Chipmunk is typically associated with mixed shrub communities within semi-arid coniferous pine forests [16]. In Wyoming, Yellow-pine Chipmunk is found in open montane forests dominated by Lodgepole Pine (*Pinus contorta*), Quaking Aspen (*Populous tremuloides*), and juniper (*Juniperus* spp.), with shrubs and forbs as groundcover [10, 15]. This species may occasionally be found in willows, sagebrush, or grasslands, but always in close proximity to forested habitats [10, 15]. Yellow-pine Chipmunk nests are typically located in underground burrows [15, 17].

Phenology:
Yellow Pine-Chipmunk hibernates from November to March or April and breeds shortly after emergence [8, 10, 17, 18]. Females give birth to a single litter of approximately 4 or 5 young in May or June after a 28–30 day gestation period [8, 10]. Young begin to venture from the den site in late June [8].

Diet:
Yellow-pine Chipmunk is omnivorous and feeds on conifer, shrub and grass seeds; nuts; buds and flowers; foliage; fruits and berries; roots, bulbs, and tubers; fungi; larvae and insects; bird eggs; and even small vertebrates [8-10, 17, 18]. This species scatter-hoards seeds at numerous cache sites during the spring, summer, and early fall [17, 18]. Prior to entering hibernation in November, it moves cached seeds to a single larder within a den site, where it feeds on the contents throughout the winter months during brief periods of activity [17, 18].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: UNCOMMON
There are no robust estimates of abundance available for Yellow-pine Chipmunk in Wyoming. The species has an estimated statewide abundance rank of UNCOMMON and also appears to be uncommon within suitable environments in the occupied area [15].

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
Historic and recent population trends for Yellow-pine Chipmunk in Wyoming are unknown.

Intrinsic Vulnerability:
LOW VULNERABILITY

Yellow-pine Chipmunk has low intrinsic vulnerability in Wyoming because it is found in a variety of montane forest and shrubland habitats and does not have life history characteristics that would make it inherently sensitive to extrinsic stressors within its distribution.

Extrinsic Stressors:
SLIGHTLY STRESSED
Montane forests in Wyoming are vulnerable to fire suppression, loss or fragmentation from harvest and management practices, disease and insects, and drought and climate change [19]. As a species primarily associated with Lodgepole Pine forests in Wyoming, Yellow-pine Chipmunk has likely been exposed to tree mortality from the ongoing outbreak of Mountain Pine Beetle (*Dendroctonus ponderosae*) in the state; however, potential impacts have not been studied for this species [20].

KEY ACTIVITIES IN WYOMING

Yellow-pine Chipmunk is classified as a Species of Greatest Conservation Need by the Wyoming Game and Fish Department. There are currently no research projects designed specifically for Yellow-pine Chipmunk in Wyoming.

ECOLOGICAL INFORMATION NEEDS

Yellow-pine Chipmunk would benefit from research to determine its detailed distribution and abundance in Wyoming. Nothing is known about adult survival or reproductive success in the state. In addition, research is needed to examine if and how Yellow-pine Chipmunk is being affected by the Mountain Pine Beetle outbreak, and whether the species is potentially vulnerable to other natural or anthropogenic disturbances facing montane forests in Wyoming.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Little is known about Yellow-pine Chipmunks in Wyoming. Consequently, management priorities for the species in the short-term will focus on addressing these data deficiencies. Of particular importance are data on presence, distribution, population status and trends, and the impact of potential threats, including the current condition of montane forest habitat, which will ultimately be used to develop management and conservation recommendations.

CONTRIBUTORS

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Figure 1: A Yellow-pine Chipmunk in British Columbia, Canada. (Photo courtesy of Nichole L. Bjornlie)

Figure 2: North American range of *Tamias amoenus*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

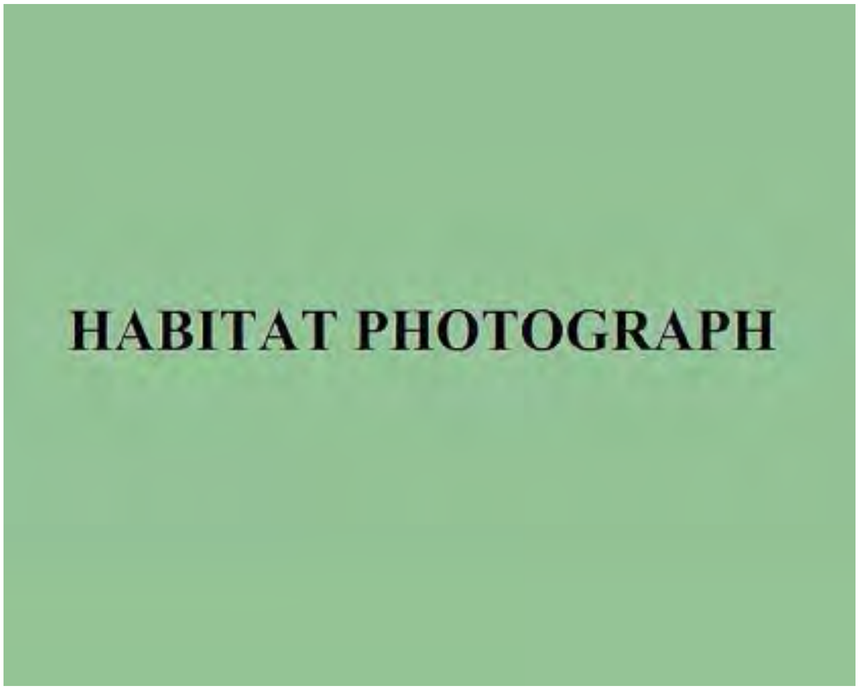

Figure 3: Photo not available.

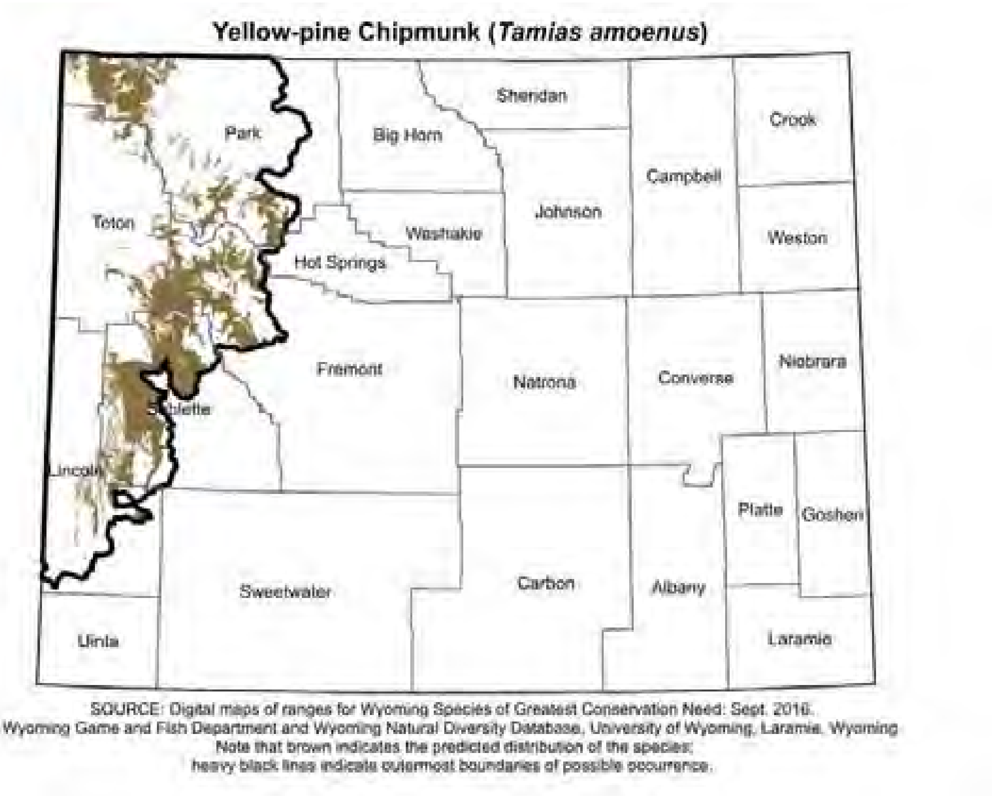

Figure 4: Range and predicted distribution of *Tamias amoenus* in Wyoming.

Yuma Myotis

Myotis yumanensis

REGULATORY STATUS

USFWS: No special status
USFS R2: No special status
USFS R4: No special status
Wyoming BLM: No special status
State of Wyoming: Nongame Wildlife

CONSERVATION RANKS

USFWS: No special status
WGFD: NSS4 (Cb), Tier III
WYNDD: G5, S1
Wyoming Contribution: LOW
IUCN: Least Concern

STATUS AND RANK COMMENTS

Yuma Myotis (*Myotis yumanensis*) has no additional regulatory status or conservation rank considerations beyond those listed above.

NATURAL HISTORY

Taxonomy:

There are six recognized subspecies of Yuma Myotis [1]. Because of distributional uncertainties, it is unclear which subspecies occur in Wyoming. In general, the subspecies *M. y. yumanensis* occurs in the southern Rocky Mountains, while *M. y. sociabilis* occurs in the northern Rocky Mountains [1, 2].

Description:

Yuma Myotis may be difficult to identify in the field, even by skilled observers. The species is a small vespertilionid bat, but medium in size among bats in the genus *Myotis*. Pelage color is variable across the species' range. Dorsal fur is short, dull, and varies from gray and brown to pale tan in color. Ventral fur is lighter in color, white or buffy. The ears, wing, and tail membranes are pale brown to gray [1]. Males and females are identical in appearance, but females may be significantly larger than males in some populations [1]. Juveniles are similar in appearance but can be differentiated from adults by the lack of ossified joints in the phalanges for the first summer [3, 4]. Yuma Myotis is similar in appearance to other co-occurring *Myotis* species. Yuma Myotis can be distinguished from Long-legged Myotis (*M. volans*), California Myotis (*M. californicus*), and Western Small-footed Myotis (*M. ciliolabrum*) by the lack of a keeled calcar and can be distinguished from Northern Long-eared Myotis (*M. septentrionalis*) by its short, blunt tragus. Yuma Myotis may be very difficult to distinguish from Little Brown Myotis (*M. lucifugus*) in the field. Several authors suggest using a combination of characteristics to accurately assign species identity where these two species are sympatric. Specifically, Yuma Myotis has dull pelage, pale ears, a steeply sloped forehead, and shorter forearms [5, 6]. Also, the characteristic frequency of echolocation calls of Yuma Myotis is usually higher (> 45 kHz) than that of Little Brown Myotis (< 45 kHz) [5].

Distribution & Range:
Yuma Myotis is widely distributed across western North America from central Mexico through the western United States and into far western Canada. Wyoming falls on the far eastern periphery of the continental distribution and comprises only a very small proportion of the range. In Wyoming, the distribution of the species is largely unknown. Yuma Myotis is known from far southcentral Wyoming near the town of Baggs and from southwestern Wyoming [7]. Additionally, the species is relatively common locally in portions of northcentral Wyoming in the vicinity of Bighorn Canyon National Recreation Area [8]. In 2011, the Wyoming Game and Fish Department (WGFD) captured one male Yuma Myotis in Weston County, southeast of Newcastle, representing the furthest east record of the species in the state [9]. It is unknown if this was a vagrant individual or if the species is more widely distributed across Wyoming than originally thought. In some areas, Yuma Myotis is considered a short-distance migrant, and seasonal changes in distribution have been noted as the species moves to winter hibernacula or warmer areas where it may remain active throughout the year [1].

Habitat:
Yuma Myotis occurs in a variety of ecosystems throughout its range. The species is closely associated with riparian habitats including both lentic and lotic systems [1, 10, 11]. These riparian systems are generally found within arid landscapes including desert and semi-arid shrublands. But in portions of its range, including the Pacific Northwest, Yuma Myotis is found in forested habitats [1]. Habitat associations of the species in Wyoming are largely unknown, but observations of the species in the state have generally been in riparian areas surrounded by sagebrush steppe or mixed-desert shrublands [7, 8]. During the summer, the species roosts in a variety of settings depending upon the local availability of roost structures. Yuma Myotis has been observed roosting in crevices within abandoned buildings, caves, cliffs, and in dead trees with crevices, hollow cores, or loose bark. Females often form large maternity colonies in attics, abandoned buildings, caves, mines, bridges, and in abandoned Cliff Swallow (*Petrochelidon pyrrhonota*) nests. Summer day roosts are always in close proximity to water [1]. Yuma Myotis hibernates in winter, but little is known about preferred hibernation site characteristics. There are no known Yuma Myotis hibernacula in Wyoming [4].

Phenology:
The phenology of Yuma Myotis is poorly understood and varies regionally. Yuma Myotis likely breeds in fall prior to entering hibernation. Sperm are stored overwinter, with fertilization of a single egg occurring in spring. A single altricial pup is born in late May or early June. It is thought that the species hibernates through the winter throughout much of its range but may experience only short duration hibernation events in warmer locations. It is unknown when the species enters or emerges from hibernation, and it is likely that the duration of hibernation varies locally and across its range depending upon local climatic conditions [1].

Diet:
Yuma Myotis is insectivorous, and diet composition is generally proportional to local prey availability. Evidence suggests it prefers to consume small insects such as midges. The species is known to consume insects from the orders Diptera, Neuroptera, Lepidoptera, and Hymenoptera, among others [1].

CONSERVATION CONCERNS

Abundance:
Continental: WIDESPREAD
Wyoming: VERY RARE
There are no estimates of abundance of Yuma Myotis in Wyoming. The species generally represents a small proportion of mist net captures and acoustic detections during surveys within the known range of Yuma Myotis in Wyoming [7-9]. Additionally, the species has a very limited distribution in the state. These two factors taken together suggest that species is very rare in Wyoming.

Population Trends:
Historic: UNKNOWN
Recent: UNKNOWN
There are no historic or recent population trend estimates for Yuma Myotis in Wyoming.

Intrinsic Vulnerability:
MODERATE VULNERABILITY
Yuma Myotis is moderately vulnerable to extrinsic stressors. Specifically, Yuma Myotis has low fecundity, giving birth to only one pup annually [1]. Yuma Myotis is gregarious, often aggregating in large numbers at night. Furthermore, female Yuma Myotis often forms large maternity colonies with up to 10,000 individuals observed in portions of the species' range [1]. Disturbance or destruction of these sites may negatively affect a large number of individuals. While Yuma Myotis occurs in a variety of habitat types, it is closely associated with riparian habitats within these broader landscapes [1]. Therefore, the species is likely to be negatively impacted by natural or anthropogenic disturbances to riparian habitats within its already limited Wyoming distribution.

Extrinsic Stressors:
MODERATELY STRESSED
White-nose Syndrome (WNS) is a fungal disease that affects hibernating bats. WNS has killed several million bats in North America [12, 13]. The pathogenic fungus *Pseudogymnoascus destructans* (formerly *Geomyces destructans*) that causes WNS has not been detected within the range of Yuma Myotis or in Wyoming to-date [14], but it is thought that the disease will continue to expand westward. It is unknown if Yuma Myotis will be affected by WNS, but similar species in the genus *Myotis* have experienced large population declines from the disease [12]. Like other insectivorous organisms, Yuma Myotis is affected by pesticide use. Effects come from both reduced food availability and acute and chronic toxicity from the pesticides themselves [4]. In California, a large spill of the pesticide metam sodium in the Sacramento River led to reduced survival of juvenile individuals, leading to a long-term decline in population growth rate compared to populations not exposed to the spill [11]. While large spills of this nature are rare, these findings suggest population level effects from pesticide exposure may stress bat populations. Disturbance from visitors to caves and abandoned mines used as hibernacula represents a significant threat to cave-roosting bats and bat habitat [4]. Even a small number of short duration disturbances lead to significant increases in arousal events and subsequent energy expenditures that may lead to increased mortality of bats [15]. Similarly, some authors have noted abandonment of roost structures supporting maternity colonies when they were disturbed [4]. Yuma Myotis is closely associated with riparian habitats across its range. Riparian habitats have been negatively affected by both natural processes and anthropogenic activities such as water

diversion and ground water extraction resulting in altered water flow regimes and aquifer draw-down, which may result in reduced water quality, reduced streamflow, and die-back of riparian vegetation. The effects of these changes to riparian systems have not been evaluated for bats. However, Yuma Myotis has been exposed to similar disturbances across its continental and Wyoming ranges, which may potentially harm the species.

KEY ACTIVITIES IN WYOMING

Bats have received increased research attention across North America and in Wyoming. To address concerns regarding potential WNS infection of bats in Wyoming, WGFD in cooperation with the Wyoming Bat Working Group authored "A strategic plan for white-nose syndrome in Wyoming" in 2011. This document presents a plan of action to minimize impacts of WNS if it is detected in Wyoming or adjacent states [16]. To facilitate early detection of the disease, WGFD requires researchers to use the Reichard Wing-Damage Index [17] to evaluate all bats captured during research activities for signs of WNS infection. Beginning in 2012, WGFD personnel placed temperature and humidity loggers in a number of known or suspected hibernacula across Wyoming to determine if climatic conditions at these sites are favorable for growth of *P. destructans*. Personnel have also begun collecting swabs of hibernating bats and hibernacula substrates in an effort to assist with early detection of *P. destructans*. Surveyors also searched for hibernating bats while placing loggers, but Yuma Myotis was not detected at any of these sites [18-20]. Both WGFD and the Wyoming Natural Diversity Database (WYNDD) have conducted numerous bat inventories across the state. In 2011, WGFD captured one adult male Yuma Myotis in northeastern Wyoming during a statewide forest bat inventory conducted from 2008 to 2011 [9, 21-25]. In 2012, WYNDD captured Yuma Myotis along the Little Snake River during a bat monitoring effort in southern Wyoming conducted from 2011 to 2013 [7, 26, 27]. During all years of these investigations, Yuma Myotis was infrequently captured or recorded, even where the species is known to occur. In 2015, WYNDD developed a bat monitoring plan and initiated survey activities at Bighorn Canyon National Recreation Area (BICA). The primary objective of this monitoring plan is to develop a baseline activity level or other index of abundance for Little Brown Myotis that can be used to detect changes in populations within BICA through time. Yuma Myotis was not captured during mist net surveys in 2015 but was detected acoustically at a small number of sites [28]. In addition to research activities, many conservation organizations and federal and state agencies, including WGFD, have developed outreach and education materials to inform the general public of the importance bats and concerns regarding the persistence of bats in the future.

ECOLOGICAL INFORMATION NEEDS

It is not currently known which subspecies of Yuma Myotis occur in Wyoming. The distribution of Yuma Myotis in the state is poorly understood, highlighted by the recent documentation of the species in northeastern Wyoming. Summer habitat and hibernacula preferences of Yuma Myotis in Wyoming remain largely unknown, but limited observations of the species in the state suggest summer habitat associations similar to those in other portions of its range.

MANAGEMENT IN WYOMING

This section authored solely by WGFD; Nichole L. Bjornlie. Very little is known about the current distribution or wintering locations of Yuma Myotis in Wyoming. Consequently, priorities will focus on further defining the distribution of the species in the state and monitoring hibernacula and other roost locations (e.g., maternity roosts) for Yuma Myotis to help direct management and conservation efforts. Mist-net surveys will continue to implement WNS protocols and assessment in an effort to assist with early detection should the disease reach the state. Habitat assessments will be incorporated with survey efforts to better understand what influences species presence and distribution at a finer scale. In addition to inventory projects, WGFD, in collaboration with the Wyoming Bat Working Group and other state-wide partners, will implement the North American Bat Monitoring Program that will use acoustic monitoring to assess state and region-wide bat trends. Additional priorities will include updating and revising the Conservation Plan for Bats in Wyoming and the Strategic Plan for WNS in Wyoming. Finally, outreach and collaboration with private landowners will remain a priority to ensure conservation of bats and bat habitat.

CONTRIBUTORS

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Figure 1: A Yuma Myotis in Wyoming. (Photo courtesy of Robert J. Luce, WGFD)

Figure 2: North American range of *Myotis yumanensis*. (Map from: Patterson, B. D., et al. (2007) Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0, NatureServe, Arlington, Virginia.)

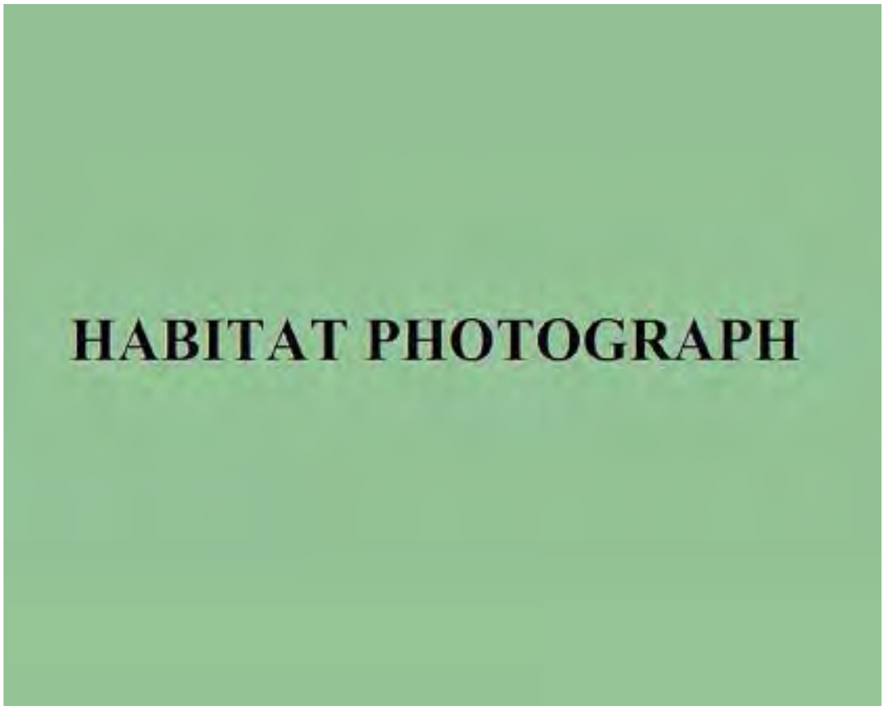

Figure 3: Photo not available.

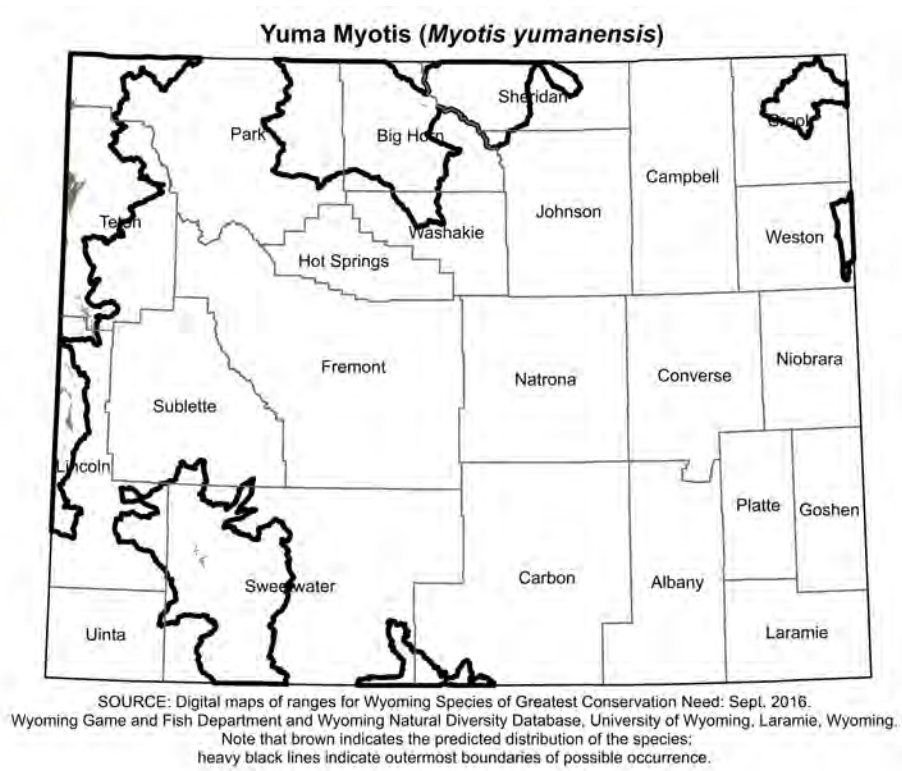

Figure 4: Range and predicted distribution of *Myotis yumanensis* in Wyoming.

Aquatic snails - Aquatic gastropods

Abundance: Unknown

Status: NSSU NatureServe: G5 SNR

Population Status: Unknown

Limiting Factor: Unknown

Comment: None

Introduction

Aquatic snails and limpets or class Gastropoda are soft bodied molluscs with a spiral, coiled disk-shaped (snails), or cone-shaped shell (limpets). Aquatic snails and limpets are composed of a muscular foot, head, visceral mass (contains organs), and a mantle (secretes shell). Shell length or width varies between 0.2 and 7 cm (0.1 to 2.8 inches). About 526 species of aquatic snails and limpets are known across North America (Brown and Lydeard 2010). According to NatureServe (2009), 54% of the snails and limpets in North America are considered critically imperiled or imperiled (G1/T1 or G2/T2). Aquatic snails and limpets are typically scrapers, eating algae, microbes, fungi, and detritus off of solid substrate such as rocks, logs, or macrophytes (Smith 2001). Freshwater snails and limpets tend to lay eggs in spring. Most snails and limpets lay eggs on substrate, but the families Viviparidae and Thiaridae are live-bearers. The families Physidae, Lymnaeidae, Planorbidae, Ancylidae, Valvatidae, Acroloxidae, and Lancidae are hermaphroditic, but females and males are separate in all other families of freshwater gastropods. Most snails and limpets live 9 to 15 months; however, some species can have 2 to 3 generation in one year especially in warmer climates and others may live up to 4 years. In Wyoming, 50 species and subspecies of freshwater snails and limpets are known (Beetle 1989)(NatureServe 2009). Of these gastropods, 16% are considered critically imperiled or imperiled (G1/T1 or G2/T2). Cave physa (Physa spelunca) is the only aquatic snail endemic to Wyoming. Green River pebblesnail (Fluminicola coloradoensis), ashy pebblesnail (Fluminicola fuscus), Utah physa (Physa gyrina utahensis), rotund physa (Physella columbiana), and Bear Lake springsnail (Pyrgulopsis pilsbryana) are all considered imperiled in Wyoming. Great Basin ramshorn (Helisoma newberryi), cave physa (Physa spelunca), and fat-whorled pondsnail (Stagnicola bonnevillensis) are considered critically imperiled in Wyoming.

Habitat

Aquatic snails and limpet live in both lentic and lotic ecosystems on substrate in the benthos or near the air-water interface on aquatic vegetation or other such substrate.

Problems

- A lack of basic knowledge, their distributions and ecology precludes status assessments for many species in Wyoming. Habitat alternations, dewatering, damming streams, groundwater withdrawals and invasive species have caused declines in freshwater snails and limpets in North America (Brown and Lydeard 2010).
- New Zealand mudsnails outcompete native aquatic snails.

Conservation Actions

- Effective means to control New Zealand Mudsnail are needed.
- A general description of aquatic snail distributions and ecology is needed in Wyoming.

Monitoring/Research

Monitoring plans for some species may be needed, but must be based on baseline distribution and ecology.

Recent Developments

A project lead by University of Wyoming researchers and supported by the Wyoming Game and Fish Department is underway to evaluate the distribution and ecology of Wyoming’s aquatic snails. One-hundred and twenty sites were sampled in the North Platte and Big Horn River drainages. At these sites, 5 families representing 12 different genera and subgenera were collected (C. Narr, in prep).

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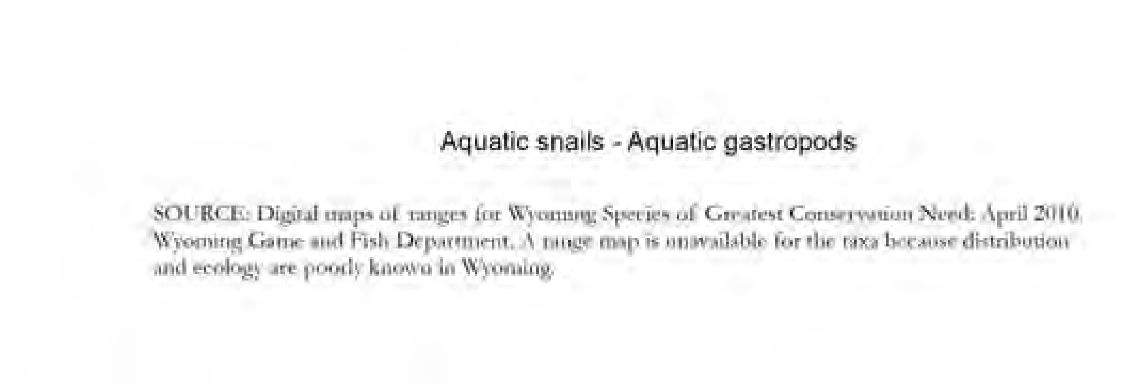

2017

Ash Gyro - Gyraulus parvus

Abundance: Unknown

Status: NSSU NatureServe: N5 S4

Population Status: Unknown

Limiting Factor: Unknown

Comment:

Introduction

The ash gyro is an aquatic snail in the family Planorbidae. These small snails have shells that are up to 0.7 cm in width and brown in color (Harrold and Guralnick 2010). Ash gyro occur across North America and are ranked from vulnerable (e.g., Utah) to secure (e.g., Oregon and New York; NatureServe 2016). These snails are considered secure across their range. Aquatic snails are scrapers that eat algae, microbes, fungi and detritus on solid surfaces such as logs, macrophytes and rocks (Smith 2001). The biology of the ash gyro has not been thoroughly studied (Dillon et al. 2006). Ash gyro are distributed across much of Wyoming.

Habitat

The ash gyro lives in ponds, lakes and slower waters of streams (Dillon et al. 2006).

Problems

Conservation Actions

Monitoring/Research

The Wyoming Game and Fish Department funded the Wyoming Natural Diversity Database to survey aquatic snails in the Snake and Green River drainages of Wyoming.

Recent Developments

None

References

Ash Gyro (*Gyraulus parvus*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

California Floater - Anodonta californiensis

Abundance: Unknown

Status: NSS1 (Aa) NatureServe: G3 S2

Population Status: Given the low numbers of California floater found in this survey and considering the impacts of water development (e.g., stream dewatering and the presence of barriers to fish movement); the California floater may be more imperiled in Wyoming than what was once thought. Only 13 live California floaters were found during systematic native mussel surveys.

Limiting Factor: The impoundments and irrigation diversions throughout the Bear River drainage prevent downstream populations of California floater from using the migration capabilities of their host fish (Watters 1996). Limited populations in downstream states and within Wyoming make the source populations sparse. If the isolated populations of California floater found in the Bear river drainage experience more severe drought years and increased anthropogenic disturbances, it may cause a rapid decline in their existing population numbers, making their recovery very difficult (Haag and Warren 2008). The short-lived nature of California floater reduces their chances of recolonization in the absence of immigration from downstream populations, (Haag and Warren 2008).

Comment: NSSU to NSS1 (Aa)

Introduction

North America hosts the world's highest diversity of freshwater mussels (over 300 species), but more than 70% of the mussels in North America are imperiled or critically imperiled (Williams et al. 1993). The shells of the California floater (Anodonta californiensis) are up to 12.7 cm (5 inches) in length and can be yellow-green, yellow-brown, olive, pale brown, red-brown, or black (Nedeau et al. 2009). These mussels do not display external sexual dimorphism. California floaters live in the western United States from Arizona to Washington and California to Wyoming (NatureServe 2015). These mussels have a wide range, but have sparse populations (Hovingh 2004). These bivalves are considered critically imperiled (Nevada and Arizona) to imperiled (California, Washington, Oregon, Wyoming, Montana, Idaho and Utah; NatureServe 2015). The number of individuals and sites occupied by the California floater are likely declining in the United States (NatureServe 2015). In Wyoming, California floaters are only known from the Bear River mainstem, the tributary Yellow Creek and the shoreline of Woodruff Narrows Reservoir (Beetle 1989; Hovingh 2004; Cvancara 2005). California floaters were first found near Cokeville in the Bear River in 2008 where this species co-occurs with the western pearlshell (Margaritifera falcata). Only two other drainages in the state are known to have two living mussel species co-occurring. Freshwater mussels are filter feeders that remove fine organic matter from the water column (Smith 2001). The life cycle of native mussels requires a host fish during the larval stage. Larval mussels (glochidia) disperse while attached to their host and develop into adults if released on suitable substrate (Cummings and Graf 2010). Natural hosts for the California floater are poorly known but introduced Mosquitofish (Gambusia affinis; d'Eliscu 1972), Speckled Dace (Rhinichthys osculus), Margined Sculpin (Cottus marginatus), Longnose Dace (Rhinichthys cataractae; O'Brien et al. 2013), and Chubs (Gila spp.; Hovingh 2004), Green Sunfish (Lepomis cyanellus) and Cutthroat Trout (Oncorhynchus clarkii spp.). Raccoons, muskrats, otters, fishes, turtles, and birds all feed on mussels (Grabarkiewicz and Davis 2008). Wyoming's native mussel diversity is naturally low (seven species known), owing to the generally high elevation, headwater character of Wyoming's aquatic ecosystems.

Habitat

The California floater prefers shallow habitats with sand and silt substrate in large rivers, lakes, and low gradient streams (Beetle 1989; Hovingh 2004; Whaley et al. 2004; Nedeau et al. 2009) with relatively stable water levels (Hovingh 2004). This mussel is found mostly in pools, near channel banks, and in sedge-occupied substrates (Cuffey 2002). The mussel prefers low velocity flow regimes and lakes.

Problems

- Water quality degradation, chemical pollution, silt, and interrupting glochidial host fish relationships.

Conservation Actions

h Baseline population data was collected from the Bear River drainage during the 2011 field season, but more data and continued monitoring is needed.

Monitoring / Research

More records of California floater from the Bear River drainage would be extremely valuable. If time allows and resources are available, thorough systematic surveys where live mussels are present should be performed. Surveying for California floater (average lifespan of 10-15 years) is recommended at sites with known live populations every five years to observe if their populations are increasing, decreasing, or stable. Any new sites in the Bear River drainage would be critical in determining a more refined NSS ranking.

Recent Developments

State Wildlife Grant funding was used during for fiscal years 2011 and 2012 in western Wyoming surveying the Bear River drainage. An administrative report is available that summarizes the data that were collected during systematic surveys (Mathias 2014).

Range expansion in Wyoming for California was noted in Yellow Creek, upstream of Woodruff Narrows Reservoir. This is the furthest upstream in Wyoming this species has been found to date.

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California Floater (*Anodonta californiensis*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Cave Physa - Physella spelunca

Abundance: Rare

Status: NSS4 (Bc) NatureServe: G1 S4

Population Status: Unknown

Limiting Factor: Unknown

Comment: NSSU to NSS4 (Bc)

Introduction

The cave physa (Physa speluna or Physella spelunca) is a small aquatic snail with a sinistral (shell opens on the left) spiral shell in the family Physidae. Their shells can reach 9 mm (0.3 in) in length and 4.5 mm (0.02 in) wide (Turner and Clench 1974). Turner and Clench (1974) discovered the cave physa in Lower Kane Cave near Lovell, Wyoming and the snail is not known from any other locations. The cave physa lives in the stream (21-22°C; 70-72°F) originating from a hot spring about 300 m (1000 ft) inside the cave entrance. The cave physa is endemic to Wyoming and considered critically imperiled across its range (NatureServe 2016). Wethington and Guralnick (2004) confirmed that the cave physa is a unique species from other snails living in hot springs. The snail feeds on bacteria growing in the cave (Turner and Clench 1974), but little is known about the life history of this unique species.

Habitat

The cave physa is only known from a stream originating from a hot spring in Lower Kane Cave in Wyoming.

Problems

Conservation Actions

- Lower Kane Cave is protected naturally (sulphuric gas in cave) as well as a locked gate at the entrance (Wethington and Guralnick 2004).

Monitoring/Research

Recent Developments

Wethington and Lydeard (2007) sequenced DNA and investigated internal morphology of snails in the family Physidae. The penial morphology and DNA both suggested that the cave physa falls into the type c group.

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Cave Physa (*Physa spelunca*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Cooper's Rocky Mountainsnail - Oreohelix strigosa cooperi

Abundance: Unknown

Status: NSS4 (Bc) NatureServe: G2G3 S1

Population Status: Cooper's Rocky Mountainsnail was monitored in 1991, 1992, 1999 (Frest and Johannes 2002) and 2010 (Tronstad and Andersen 2011). These studies suggest that the snails are persisting; live individuals were found at all but one location.

Limiting Factor: Unknown

Comment: NSSU to NSS4 (Bc)

Introduction

Cooper's Rocky Mountainsnail, (Oreohelix strigosa cooperi or Oreohelix cooperi), are land snails in the order Stylommatophora. Mountainsnails have depressed, heliciform shells with an umbilicus and 4 to 6 whorls (Pilsbry 1939). Shell diameter is up to 22 mm (0.9 in) and shell height can be up to 17 mm (0.7 in). Cooper's Rocky Mountainsnails are located Wyoming and South Dakota and as fossil in Iowa and Illinois (Pilsbry 1939; NatureServe 2016). Other states listed are Kansas (NatureServe 2016) and Alberta (Pilsbry 1939) but these populations likely need to be evaluated further. Cooper's Rocky Mountainsnail are listed as critically imperiled in Wyoming and imperiled in South Dakota, and vulnerable across their range (NatureServe 2016). Mountain snails eat leaf litter, detritus and microorganisms growing on surfaces, such as rocks, logs or soil (Speiser 2001, Anderson 2005). Little is known about the life history of mountain snails, including how long these snails live and how often they reproduce. Mountain snails are live bearers, meaning they raise their young within their shell until the young reach about 2.5 whorls (Anderson et al. 2007). Cooper's Rocky Mountainsnails are active during spring and early summer during wet, cool conditions but may be active in the fall or winter depending on conditions (Anderson 2005; Tronstad, personal observation). Cooper's Rocky Mountainsnails are located in the Black Hills and Bear Lodge Mountains of Wyoming.

Habitat

Cooper's Rocky Mountainsnails live in areas with canopy cover and leaf or needle litter. Mountain snails are generally found in moist, cool areas such as north facing slopes or near streams (Anderson 2005; Tronstad and Andersen 2011).

Problems

- The taxonomy of Oreohelix is questionable and is in need of revision.

Conservation Actions

- Concerns over the effects of habitat disturbance, such as logging, forest thinning, fire and grazing in association with the limited dispersal ability of land snails (Anderson 2005).

Monitoring/Research

Tronstad and Andersen (2011) monitored Cooper's Rocky Mountainsnails in the Black Hills and Bear Lodge Mountains and predicted suitable habitat using predictive distribution models. They found the mountainsnails at all but one of the previously visited sites. Models predicted the best habitat was in the northwest area of the Black Hills. Anderson (2007) investigated movement and growth of Cooper's Rocky Mountainsnails in the Black Hills. Snails moved up to 7.2 m in a two week span and shell diameter increased by about 0.1 mm during June.

Recent Developments

Frest and Johannes (2002) suggested that Oreohelix strigosa cooperi be split into three distinct species based on morphology. They split O. s. cooperi in the Black Hills into two species based on shell size. The third proposed species was the Oreohelix in the Bear Lodge Mountains. Molecular and morphological work on Oreohelix sp. in the Black Hills and Bear Lodge Mountains of Wyoming and South Dakota came to two conclusion using different techniques (Weaver et al. 2006; Chak 2007). Chak (2007) found that Oreohelix in the Bear Lodge Mountains were different than those in the Black Hills, whereas Weaver's et al. (2006) evidence suggested that Oreohelix in the Bear Lodge Mountains and the Black Hills were the same species. Anderson et al. (2007) discovered that temperature strongly correlated with shell size for Oreohelix in the Black Hills suggesting that the difference in shell size were not attributed to different species. Anderson (2010) investigated Oreohelix in the Bighorn Mountains and suggested that Oreohelix pygmaea and Oreohelix strigosa cooperi are the same species because of little genetic difference.

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Cooper's Rocky Mountain Mountainsnail (*Oreohelix strigosa cooperi*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Cylindrical Papershell - Anodontoides ferussacianus

Abundance: Unknown

Status: NSS2 (Ab) NatureServe: G5 SNR

Population Status: The short lifespan of the cylindrical papershell requires them to experience suitable spawning conditions more frequently than longer-lived species (Haag and Warren 2008). Given the low numbers of cylindrical papershell found during systematic surveys and considering the impacts of water development (e.g., stream dewatering and the presence of barriers to fish movement); the cylindrical papershell may be more imperiled in Wyoming than previously thought. A total of 17 cylindrical papershell were found during focused surveys (Mathias 2015).

Limiting Factor: Water development in the form of impoundments and irrigation diversions throughout cylindrical papershell's range present even more challenges for native mussels to complete their life history and maintain stable populations, especially in a headwaters state. Not only do these barriers prevent downstream populations of cylindrical papershell from using the dispersal capabilities of their host fish (Watters 1996), they also cause the streams to dry and cease flow by impounding or diverting valuable water. In Wyoming, cylindrical papershell are only native to the North and South Platte drainages. Limited populations in downstream states and within Wyoming make the source populations sparse.

Comment: NSSU to NSS2 (Ab)

Introduction

North America hosts the world's highest diversity of freshwater mussels (over 300 species), but more than 70% of the mussels in North America are imperiled or critically imperiled (Williams et al. 1993). Shells of the cyclindrical papershell (Anodontoides ferussacianus) are up to 7.5 cm (3 inches) in length and can be light-green to yellow-brown. These mussels do not display external sexual dimorphism. Cylindrical papershell live in the Mississippi, Ohio, Cumberland and St. Lawrence River drainages from Arkansas to Manitoba and Wyoming to Vermont (NatureServe 2015). These bivalves are considered critically imperiled (Vermont, Kansas and Missouri) to secure (Indiana and Ohio) and presumed extirpated in Tennessee (NatureServe 2015). Cylindrical papershell are ranked as vulnerable in Wyoming. The cylindrical papershell is widespread and common throughout most of the range with a few exceptions (Cummings and Mayer 1992, NatureServe 2015). In Wyoming, cylindrical papershell are known from tributaries of the North and South Platte River drainages (Hoke 1979; Beetle 1989; Cvancara 2005; Mathias 2015). The cylindrical papershell were found in the lower Laramie River and Horse Creek and evidence of the mussel were found in Crow Creek and Lodgepole Creek in the South Platte River drainage. This mussel co-occurs with the plain pocketbook (Lampsilis cardium) in the lower Laramie River, one of only three known locations with co-occurring, live mussel populations. Freshwater mussels are filter feeders that remove fine organic matter from the water column (Smith 2001). The life cycle of aquatic mussels requires a host fish during the larval stage. Larval mussels (glochidia) disperse while attached to their host and develop into adults if released on suitable substrate (Cummings and Graf 2010). Cylindrical papershells are host fish generalist and known hosts for theses mussels that are found in Wyoming include White Sucker (Catostomus commersonii), Iowa Darter (Etheostoma exile), Common Shiner (Luxilus cornutus), Mottled Sculpin (Cottus bairdi), Bluegill (Lepomis macrochirus), Largemouth Bass (Micropterus salmoides), Black Crappie (Pomoxis nigromaculatus), Brook Stickleback (Culaea inconstans), and Fathead Minnow (Pimephales promelas; OSUMD 2010; Watters et al. 2009). Raccoons, muskrats, otters, fishes, turtles, and birds all feed on mussels (Grabarkiewicz and Davis 2008). Wyoming's native mussel diversity is naturally low (seven species known), owing to the generally high elevation, headwater character of Wyoming's aquatic ecosystems.

Habitat

The cylindrical papershell mussel inhabits small streams and low gradient headwater streams, and they have been observed in mud and sand substrate (Hoke 1979; Beetle 1989; Cummings and Mayer 1992; Whaley et al. 2004)

Problems

h Pollution, changes in flow regime, extremely low flows, siltation, changes in substrate, and interrupting glochidial host fish relationships.

Conservation Actions

h Baseline population data was collected from the North and South Platte river drainages during the 2013-2014 field seasons. Continued surveys to document new occurrences and monitor existing populations is crucial to a more refined NSS. Potential reintroductions of CPM from populations in Wyoming (Horse Creek and Laramie River) and/or neighboring states could augment existing populations and help establish new populations.

Monitoring/Research

More records of cylindrical papershell from the North and South Platte River drainages would be extremely valuable. If time allows and resources are available, thorough systematic surveys where live mussels are present should be performed. Surveying for cylindrical papershell (average lifespan of seven years) is recommended at sites with known live populations every five years to observe if their populations are increasing, decreasing, or stable. Any new sites within their Wyoming range would be critical in determining a more refined NSS ranking.

Recent Developments

State Wildlife Grant and Governor's ESA funding were used to during the 2013 and 2014 field seasons using systematic surveys techniques developed in 2011. Live individuals were extremely rare. An administrative report is available that summarizes the data that were collected during systematic surveys (Mathias 2015).

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Cylindrical Papershell (*Anodontoides ferussacianus*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Giant Floater - Pyganodon grandis

Abundance: Unknown

Status: NSSU NatureServe: G5 S3

Population Status: More research and surveys are needed to determine the NSS Rank of GFM in Wyoming. It is recommended that GFM remain a rank of NSSU until more field work can be performed above Keyhole Reservoir in the Belle Fourche River, in the Cheyenne River drainage, and in the Little Powder River and Little Missouri River drainages.

Limiting Factor: Unknown

Comment: None

Introduction

North America hosts the world's highest diversity of freshwater mussels (over 300 species), but more than 70% of the mussels in North America are imperiled or critically imperiled (Williams et al. 1993). Shells of the giant floater (Pyganodon grandis) are up to 25.4 cm (10 inches) in length and color is light yellow or yellow-green with green or brown rays. These mussels do not display external sexual dimorphism. Giant floaters live in much of Canada and United States in the Great Lakes, Mississippi and Gulf of Mexico drainages, and are not found in the Atlantic Slope drainages or peninsular Florida (NatureServe 2015). These bivalves are considered imperiled (Colorado, Iowa and Vermont) to secure (13 states and provinces), but exotic in North Carolina and Arizona (NatureServe 2015). The giant floater is widespread and common throughout nearly all of its range (Cummings and Mayer 1992). In Wyoming, giant floaters were first discovered in the Belle Fourche and Little Missouri River drainages (Cvancara 2005), and subsequently found in the Little Powder and Cheyenne River drainages. Giant floaters appear to be common where the species is found in Wyoming. Freshwater mussels are filter feeders that remove fine organic matter from the water column (Smith 2001). The life cycle of aquatic mussels requires a host fish during the larval stage. Larval mussels (glochidia) disperse while attached to their host and develop into adults if released on suitable substrate. Giant floaters are a habitat and host-generalist, which make the species fairly adaptable to ecological disturbances (Cummings and Mayer 1992). Natural hosts that are known for the giant floater and found in Wyoming include River Carpsucker (Carpiodes carpio), White Sucker (Catostomus commersoni), Central Stoneroller (Campostoma anomalum), Pearl Dace (Margariscus margarita), Common Shiner (Luxilus cornutus), Creek Chub (Semotilus atromaculatus), Iowa Darter (Etheostoma exile), Johnny Darter (Etheostoma nigrum), Channel Catfish (Ictalurus punctatus), Rock Bass (Ambloplites rupestris), Green Sunfish (Lepomis cyanellus), Pumpkinseed (Lepomis gibbosus), Bluegill (Lepomis macrochirus), Largemouth Bass (Macropterus salmoides), Yellow Perch (Perca flavescens), Black Crappie (Pomoxis nigromaculatus), White Crappie (Pomoxis annularis), Freshwater Drum (Aplodinotus grunniens), Brook Stickleback (Culaea inconstans), Goldfish (Carassius auratus), Common Carp (Cyprinus carpio), Gizzard Shad (Dorosoma cepedianum) and Golden Shiner (Notemigonus crysoleucas; OSUMD 2010). Raccoons, muskrats, otters, fishes, turtles, and birds all feed on mussels (Grabarkiewicz and Davis 2008). Wyoming's native mussel diversity is naturally low (seven species known), owing to the generally high elevation, headwater character of Wyoming's aquatic ecosystems.

Habitat

The giant floater mussel inhabits low velocity habitats in streams, rivers, lakes and reservoirs, and is most often found in fine substrates such as silt and sand (Cummings and Mayer 1992; Downing et al. 2000; Whaley et al. 2004; NatureServe 2015). This species is tolerant of lower oxygen concentrations than most other mussels (NatureServe 2015).

Problems

- Water quality degradation, chemical pollution, silt, and interrupting glochidial host fish relationships.

Conservation Actions

- Baseline population distribution, abundance, and structure data for the giant floater are needed throughout its range in Wyoming to evaluate the need for and to help guide potential conservation actions. The viability of populations of this mussel in Wyoming is unknown.

Monitoring / Research

A population monitoring plan needs to be developed following a thorough baseline inventory of abundance and population structure. Surveys for live individuals throughout the giant floater's range are crucial to determine an NSS rank. This species lives around 10 years, so monitoring known populations at least every five years would help determine a more refined population status and rank.

Recent Developments

State Wildlife Grant funded survey efforts during the 2014 and 2015 field seasons using survey designs from 2011 returned very little data on the giant floater in Wyoming. Very few individuals were found and those that were found were below Keyhole Reservoir in the Belle Fourche River. These records are considered a range expansion since giant flaoters had not been documented in the Belle Fourche River below Keyhole Dam. Weathered shells were found during shoreline snorkel surveys at Keyhole Reservoir in 2015. An administrative report is in review that summarizes the data that were collected during systematic surveys.

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Giant Floater (*Pyganodon grandis*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Green River Pebblesnail - Fluminicola coloradoensis

Abundance: Unknown

Status: NSSU NatureServe: G3G4 S4

Population Status: Unknown

Limiting Factor: Unknown

Comment:

Introduction

The Green River pebblesnail is an aquatic snail in the family Hydrobiidae. This snail is small (shell is up to 1.2 cm in height), has gills and carries an operculum that can cover the opening of its shell (Liu et al. 2013). The Green River pebblesnail is known from Wyoming, Idaho and Utah; however, Lui et al. (2013) investigated the morphology and DNA of this snail and other closely related taxa and they lumped them together. The range of the Green River pebblesnail now includes Oregon and Washington in addition to Wyoming, Idaho and Utah. The snail was previously ranked as imperiled (Idaho and Utah) and apparently secure (Wyoming) within states, and imperiled across its range (NatureServe 2016); however, the recent taxonomic change may alter these rankings. Aquatic snails are scrapers that eat algae, microbes, fungi and detritus on solid surfaces such as logs, macrophytes and rocks (Smith 2001). In Wyoming, the Green River pebblesnail is known from streams in the Green, Snake and Bear River drainages (Liu et al. 2013).

Habitat

The Green River pebblesnail lives in large springs and streams (Hershler 1999).

Problems

Conservation Actions

Monitoring/Research

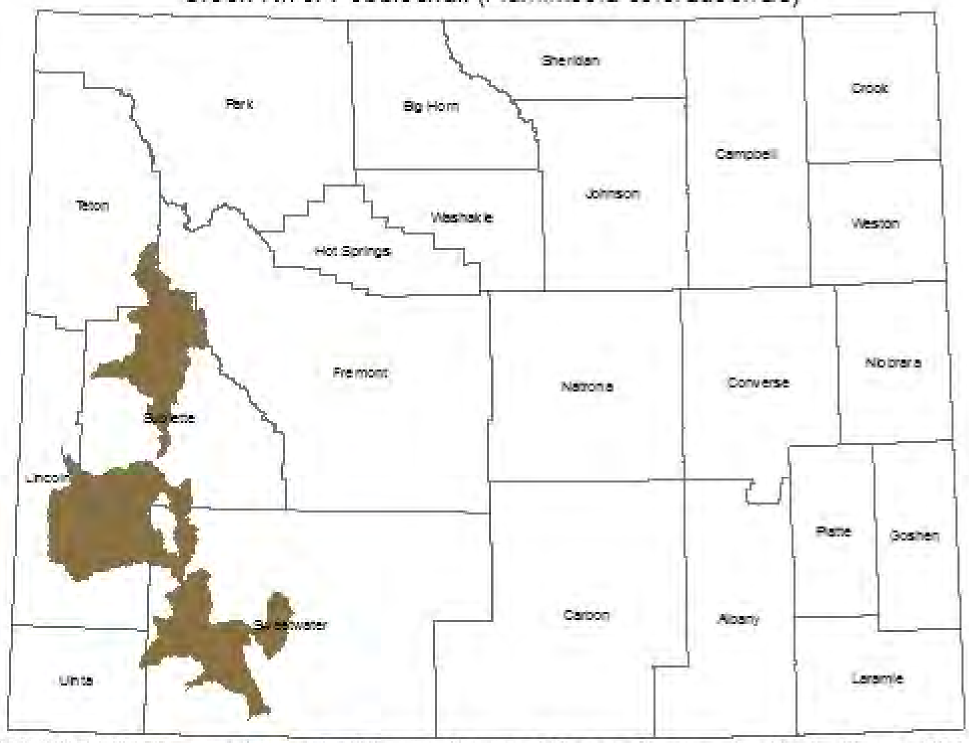
The Wyoming Game and Fish Department funded the Wyoming Natural Diversity Database to survey aquatic snails in the Snake and Green River drainages of Wyoming.

Recent Developments

Liu et al. (2013) revised the taxonomy of Fluminicola, and lumped F. fuscus and unassigned taxa from the Snake River drainage with F. coloradensis. Therefore, the Green River pebblesnail is more widely distributed than according to previous taxonomy.

References

Green River Pebblesnail (*Fluminicola coloradoensis*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Jackson Lake Springsnail - Pyrgulopsis robusta

Abundance: Unknown

Status: NSS2 (Ba) NatureServe: G5 S2

Population Status: Unknown

Limiting Factor: The invasive New Zealand mudsnail outcompete native Jackson Lake springsnails in Polecat Creek, Wyoming.

Comment: NSS4 (Bc) to NSS2 (Ba)

Introduction

The Jackson Lake springsnail (Pyrgulopsis robusta) is an aquatic snail in the family Hydrobiidae. These snails have a gill and operculum, and their dextral (opening to the right) shell has an elongate spiral. The length of an individual can reach 6.3 mm (0.25 in; Hershler 1994). The Jackson Lake springsnail is known from Washington, Oregon, Idaho and Wyoming (Hershler and Liu 2004; NatureServe 2016). The snail is considered critically imperiled in Oregon and Idaho, imperiled in Wyoming and not ranked in Washington (NatureServe 2016). The Jackson Lake springsnail scrapes algae, microbes, fungi and detritus from solid substrates in aquatic habitats (Lysne et al. 2007). These snails may reproduce throughout the year, but peak reproduction likely occurs in summer. The average life span of an individual is between 11 and 14 months. In Wyoming, individual length does not exceed 5 mm (0.2 in). Jackson Lake springsnails are currently known from two sites in Wyoming, Polecat Creek and Marmot Spring in the Snake River drainage of Grand Teton and Yellowstone National Parks (Riley et al. 2008). The Jackson Lake springsnail was once considered common in Jackson Lake, Grand Teton National Park, but is now thought extirpated from this location, possibly as a result of the dam and shoreline modifications made to improve water storage (USFWS 2006, NatureServe 2016).

Habitat

Jackson Lake springsnails can live in lakes, reservoirs, streams and springs under a wide range of temperatures (Lysne et al. 2007). These snails can survive in habitats with sand, gravel or cobble substrates.

Problems

- The taxonomy of Oreohelix is questionable and is in need of revision.

Conservation Actions

- Concerns over the effects of habitat disturbance, such as logging, forest thinning, fire and grazing in association with the limited dispersal ability of land snails (Anderson 2005).

Monitoring/Research

None by the Wyoming Game and Fish Department.

Recent Developments

This species was considered recently extirpated from Jackson Lake (USFWS 2006).

This snail now has a wider distribution since found synonymous with three other previously distinct species (USFWS 2006).

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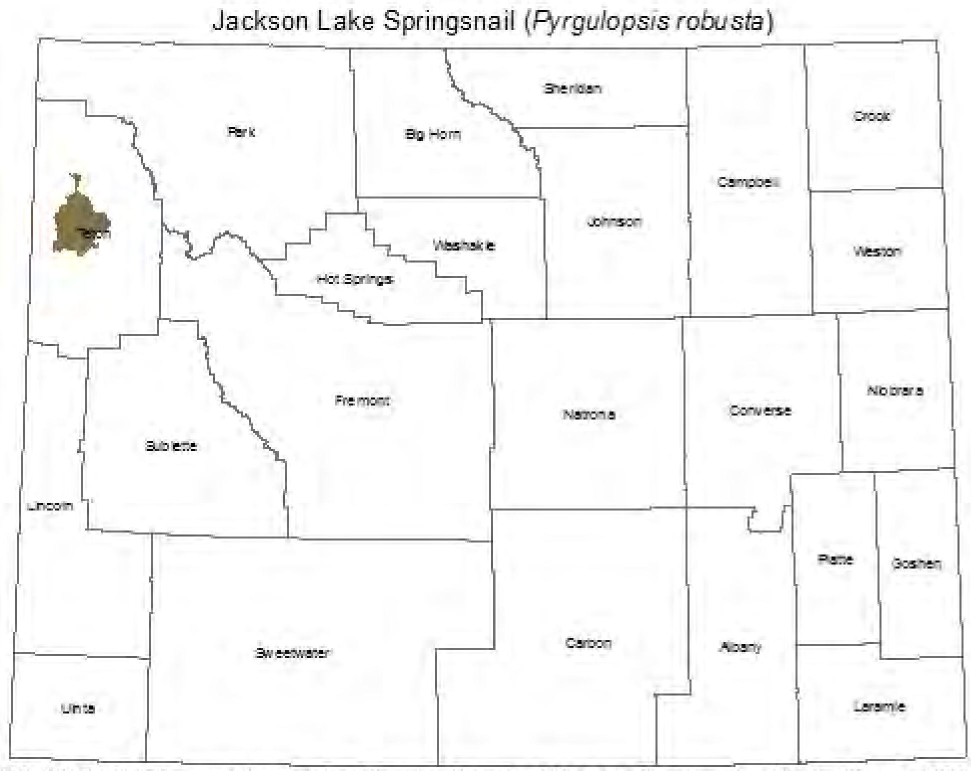

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Land snails and slugs - Order Stylommatophora

Abundance: Unknown

Status: NSSU NatureServe: G5 SNR

Population Status: Unknown

Limiting Factor: Unknown

Comment: None

Introduction

Land snails and slugs are molluscs in the Order Stylommatophora. Snails have a calcareous shell that spiral in characteristic ways used to identify gastropod families (Burch and Pearce 1990). The shell protects the soft tissues of snails, which consist of the foot, head, visceral mass and mantle. Slugs are gastropods where the shell is reduced, absent or internal. About 1,000 land snails and slugs inhabit most terrestrial habitats across North America north of Mexico. NatureServe (2016) lists 2,091 species and subspecies of terrestrial mollusks in the United States and Canada. Of these terrestrial mollusks, 35% are considered critically imperiled or imperiled (G1/T1 or G2/T2). Land snails and slugs eat plants (living and dead), litter, wood and dead animals (Speiser 2001). Terrestrial gastropods typically mate and reproduce during wet, cool periods of the year when they are seasonally active (Burch and Pearce 1990). During unsuitable times, land snails and slugs aestivate, a time of inactivity where they seal their shell (snails) or use other methods to retain moisture. In Wyoming, most land snails are active during late spring and early summer, and aestivate the rest of the year depending on conditions. Fifty-four terrestrial gastropod species and subspecies are known from Wyoming (NatureServe 2016). Of these, 13% are considered critically imperiled or imperiled (G1/T1 or G2/T2). Catinella wandae, Oreohelix strigosa berryi, and Oreohelix strigosa cooperi are considered imperiled and Oreohelix pygmaea, Vertigo idahoensis and Vertigo binneyana are considered critically imperiled. Oreohelix strigosa cooperi, Oreohelix pygmaea, and Oreohelix carinifera were petitioned for listed under the Endangered Species Act and received negative 90-day findings. Oreohelix strigosa cooperi, Discus shimeki, Vertigo arthuri, and Vertigo paradoxa are Forest Service Region 2 species of local concern.

Habitat

Land snails and slugs live in most terrestrial habitats, including soils, caves, litter, vegetation, rocks, epiphytes and tree canopies (Heller 2001). However, terrestrial gastropods need shelter, moisture, food, and calcium carbonate (to make shells) to survive (Burch and Pearce 1990). Microhabitats for land snails and slugs can be found near water (springs, streams, or lakes), on north-facing hillsides or under vegetation.

Problems

- Lack of basic knowledge of land snails and slugs in Wyoming including what species live in the state, how they are distributed and their ecology.

Conservation Actions

- Conservation concerns for some land snails have grown due to habitat disturbances such as logging and grazing, coupled with limited dispersal abilities of these animals (Anderson 2004, Anderson 2005, Natureserve 2016).
- A general description of land snail distributions and ecology is needed in Wyoming.

Monitoring/Research

Monitoring plans for some species may be needed, but must be based on baseline distribution and ecology.

Recent Developments

None.

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Land snails and slugs - Order Stylommatophora

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: April 2010. Wyoming Game and Fish Department. A range map is unavailable for the taxa because distribution and ecology are poorly known in Wyoming.

2017

Mountain Snails - Oreohelix sp.

Abundance: Unknown

Status: NSSU NatureServe: G5 SNR

Population Status:

Limiting Factor:

Comment:

Introduction

Mountain snails, genus Oreohelix, are land snails in the order Stylommatophora. Mountain snails typically have depressed, heliciform shells with an umbilicus and 4 to 6 whorls (Pilsbry 1939). Shell diameter varies between 0.7 and 2.1 cm (0.3 to 0.8 inches). Mountain snails are located in western North America from Saskatchewan and British Columbia to Mexico and California to South Dakota (Pilsbry 1939). Nearly 91% of mountain snail species and subspecies are considered critically imperiled or imperiled (G1/T1 or G2/T2) by NatureServe (2009). In fact, a few species and subspecies have been petitioned for listing under the Endangered Species Act. Mountain snails eat leaf litter, detritus, and microorganisms growing on surfaces, such as rocks, logs, or soil (Speiser 2001). Little is known about the life history of mountain snails, including how long these snails live, and how often they reproduce. Mountain snails are live bearers, meaning they raise their young within their shell until the young reach a certain size. Seven species of mountain snails are recorded from the state: O. carinifera, O. pilsbryi, O. pygmaea, O. strigosa, O. subrudis, O. yavapai, and O. swopei (NatureServe 2009). Several subspecies have also been collected in Wyoming, including O. strigosa berryi, O. strigosa cooperi, O. strigosa spp. 1, O. strigosa spp. 2, O. yavapai magnicornu, O. yavapai extremitatis, O. pygmaea maculate, O. strigosa depressa, and O. subrudis obscura. Of these snails, O. pygmaea is endemic to the Bighorn Mountains of Wyoming, O. yavapai occurs in Wyoming and 5 other western states, and O. carinifera is located in one area of Montana and possibly the Bighorn Mountains and Shoshone National Forest of Wyoming. O. strigosa and O. subrudis are thought to be widespread throughout the mountains of Wyoming.

Habitat

Mountainsnails live in the mountains in areas with canopy cover and leaf or needle litter. Mountainsnails are generally found in moist, cool areas such as north facing slopes or near streams.

Problems

- Lack of basic information on the species present, their distribution, and ecology in Wyoming
- The taxonomy of species within the genus Oreohelix is in question

Conservation Actions

- Concerns over the effects of habitat disturbance, such as logging, forest thinning, and grazing in association with the limited disbursal ability of land snails.
- The unknown affects of climate change on the distribution of Oreohelix.

Monitoring / Research

Tronstad (unpublished data) has an on-going study of Oreohelix in the Snowy Mountains of Wyoming and individuals in her study have lived for four years. Tronstad et al. (2014) collected snails from four areas of Grand Teton National Park and identified them as Oreohelix subrudis. Additionally, snails collected from the Tensleep and Heart Mountain Preserves were identified as O. subrudis (Tronstad et al. 2011).

Recent Developments

Molecular and morphological work on Oreohelix strigosa cooperi in the Black Hills of Wyoming and South Dakota came to two conclusion using different techniques (Weaver et al. 2006; Chak 2007). Chak (2007) found that Oreohelix in the Bear Lodge Mountains were different than those in the Black Hills, whereas Weaver's et al. (2006) evidence suggested that Oreohelix in the Bear Lodge Mountains and the Black Hills were the same species. Anderson (2010) suggested that Oreohelix pygmaea and Oreohelix strigosa cooperi are the same species because of little genetic difference.

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Mountain snails - *Oreohelix* sp.

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: April 2010, Wyoming Game and Fish Department. A range map is unavailable for the taxa because distribution and ecology are poorly known in Wyoming.

2017

Multirib Vallonia - Vallonia gracilicosta

Abundance: Unknown

Status: NSSU NatureServe: G5 SNR

Population Status: Unknown

Limiting Factor: Unknown

Comment:

Introduction

The multirib vallonia is a terrestrial snail in the family Valloniidae. Their shell has a low spire, a thickened lip at the shell opening, 45-50 distinct ribs and the shell diameter is up to 2.8 mm (Forsyth 2004, Tronstad 2011). The multirib vallonia is found across much of North America from Nunavut Territory to Texas and California to New York (NatureServe 2016). The snail is considered critically imperiled (Ontario and New Mexico) to secure (British Columbia) and presumed extirpated in Kentucky. The snail is considered secure across its range. Land snails eat plants (living and dead), litter and wood (Speiser 2001).

Habitat

Multirib vallonia live in leaf litter, under rocks or under wood in moist to dry habitats (Forsyth 2004).

Problems

Conservation Actions

Monitoring / Research

Dorothy Beetle (1989) published a checklist of mollusks in Wyoming. Surveys have been done at Devils Tower National Monument (Tronstad 2011a), the Black Hills (Tronstad and Andersen 2011), and the North Fork of the Powder River Wilderness Study Area (Tronstad 2016).

Recent Developments

None

References

Multirib Vallonia (*Vallonia gracilicosta*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Pewter Physa - Physa acuta

Abundance: Unknown

Status: NSSU NatureServe: N5 S4

Population Status: Unknown

Limiting Factor: Unknown

Comment:

Introduction

The pewter physa is an aquatic snail in the family Physidae. These snails have shells that are up to 1.9 cm in length and yellow to brown in color (Harrold and Guralnick 2010). Pewter physa occur across North America and are ranked from imperiled (British Columbia and Colorado) to secure (e.g., Texas, Florida and Ontario; NatureServe 2016). These snails are considered secure across their range. Pewter physa live on many continents raising questions as to whether or not they are native to North America. Dillon et al. (2002) speculated that pewter physa were native to North America and spread to Europe and other counties after the New World was settled after studies individuals from both continents. Aquatic snails are scrapers that eat algae, microbes, fungi and detritus on solid surfaces such as logs, macrophytes and rocks (Smith 2001). The biology of the pewter physa has been thoroughly studied. These hermaphroditic snails lay 50-100 eggs and juveniles mature after 6-8 weeks in a laboratory settling (Wethington and Dillon 1993). Pewter physa are distributed across much of Wyoming.

Habitat

Pewter physa live in many aquatic habitats and they can reach high densities in ponds and lakes (Dillon et al. 2006).

Problems

Conservation Actions

Monitoring/Research

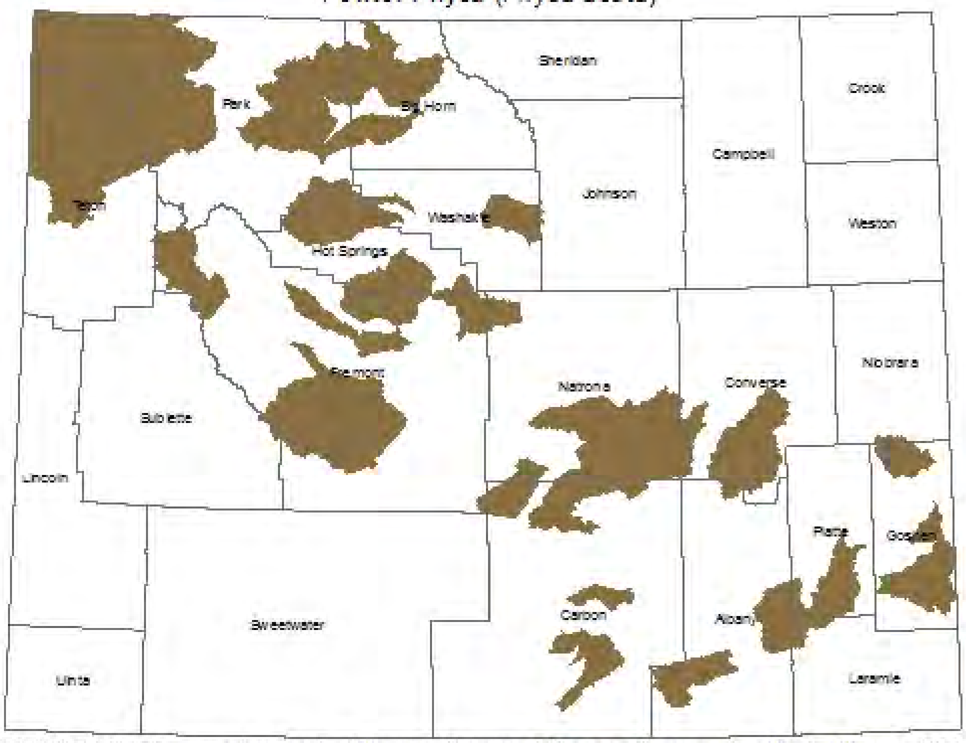
The Wyoming Game and Fish Department funded the Wyoming Natural Diversity Database to survey aquatic snails in the Snake and Green River drainages of Wyoming.

Recent Developments

Wethington and Lydreard (2007) published a revised taxonomy of the family Physidae and found that the species Physa acuta includes P. acuta, P. cubensis, P. heterostropha, P. integra and P. virgate.

References

Pewter Physa (*Physa acuta*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Pill clams - Family Sphaeriidae

Abundance: Unknown

Status: NSSU NatureServe: G5 SNR

Population Status: Unknown

Limiting Factor: Unknown

Comment: None

Introduction

Pill clams or fingernail clams are mollusks in the class Bivalvia (two shells). These clams are small (up to 1 cm wide) and live in the sediment of streams, rivers, ponds and lakes (Thorp and Rogers 2011). Fingernail clams are usually yellow, brown, orange, green or blue in color with growth lives on their shells. Four genera of fingernail clams are known from North America (Pisidium, Musculum, Sphaerium and Eupera) and are distributed across the continent. Forty-one species of fingernail clams are known in the United States and four are ranked as imperiled or critically imperiled (NatureServe 2016). Thirteen species are currently known from Wyoming in the genera Musculium, Pisidium and Sphaerium and they are all ranked as secure across their range. Fingernail clams are water-column filter feeders and do not require a host for reproduction and dispersal (Cummings and Graf 2010).

Habitat

Pill Clams or fingernail clams are generally found in sand to gravel-sized substrate of streams and rivers, and in fine sediments of ponds and lakes often with vegetation (Thorp and Rogers 2011).

Problems

- Lack of basic knowledge about the distribution and species present in Wyoming.

Conservation Actions

- None.

Monitoring/Research

The Wyoming Game and Fish Department funded the Wyoming Natural Diversity Database to survey aquatic molluscs in the Snake River drainage of Wyoming.

Recent Developments

None.

References

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Pill clams - Family Sphaeriidae

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: April 2010. Wyoming Game and Fish Department. A range map is unavailable for the taxa because distribution and ecology are poorly known in Wyoming.

2017

Plain Pocketbook - Lampsilis cardium

Abundance: Unknown

Status: NSS1 (Aa) NatureServe: G5 SNR

Population Status: In Wyoming, plain pocketbook are only native to the North Platte River drainage. No live plain pocketbook have been found since 2008, even after extensive surveys near the site of the last known live individual. It is assumed that the plain pocketbook has been extirpated from the mainstem North Platte River (Mathias 2015).

Limiting Factor: Installation of bottom release dam, historically unregulated flows that caused portions of the river to go completely dry, and numerous oil and gasoline spills have been detrimental to plain pocketbook populations. Populations may still exist in tributaries such as Deer Creek near Glenrock, WY. The Laramie River has potential for a surviving population, but the Arapaho Fire in the Laramie Range in 2012 may have caused plain pocketbook's extirpation above Grayrocks Reservoir. In addition, no recently dead plain pocketbook shells were found downstream of Grayrocks Reservoir and flash flooding and persistent drought may have negatively impacted these populations (Mathias 2015).

Comment: NSSU to NSS1(Aa)

Introduction

North America hosts the world's highest diversity of freshwater mussels (over 300 species but more than 70% of the mussels in North America are imperiled or critically imperiled (Williams et al. 1993). Shells of the plain pocketbook (Lampsilis cardium) are up to 17.8 cm (7 inches) in length, smooth with yellow or yellow-green color, and dark green rays. These mussels display external sexual dimorphism (Cummings and Mayer 1992). Plain pocketbook lives in the upper Mississippi River drainage, St. Lawrence River, and Great Lakes region of the United States, and the Winnipeg, Red and Nelson River drainages of Canada (NatureServe 2015). These bivalves are considered critically imperiled (South Dakota and Louisiana) to secure (Indiana and Ohio) and critically imperiled in Wyoming, but exotic in Virginia and Maryland (NatureServe 2015). In general, plain pocketbook is widespread and fairly common throughout most of its range (Cummings and Mayer 1992). In Wyoming, the native range of the plain pocketbook includes the North Platte River drainage downstream of Grey Reef Reservoir and the lower Laramie River drainage (Cvancara 2005). Live plain pocketbook is extremely rare in Wyoming. Empty shells are common in the North Platte River below Grey Reef Dam, but live specimens have never been collected there. Empty shells are also common in the Lower Laramie River above Grayrocks Reservoir, where a live mussel was found in 1917 (Henderson 1924) and 2008 (Mathias 2015). Freshwater mussels are filter feeders that remove fine organic matter from the water column (Smith 2001). The life cycle of aquatic mussels requires a host fish or amphibian during the larval stage. Female plain pocketbooks attract potential hosts with an extension of the mantle that acts as a lure (Cummings and Mayer 1992). Larval mussels (glochidia) disperse while attached to their host and develop into adults if released on suitable substrate. Natural hosts that are known for the plain pocketbook and found in Wyoming include Sauger (Sander canadensis) and Tiger Salamander (Ambystoma tigrinum), Walleye (Sander vitreus), Pumpkinseed (Lepomis gibbosus), Black crappie (Pomoxis nigromaculatus), White Crappie (Pomoxis annularis), Green Sunfish (Lepomis cyanellus), Bluegill (Lepomis macrochirus), Largemouth Bass (Macropterus salmoides), Smallmouth Bass (Micropterus dolomieu) and Yellow Perch (Perca flavescens; Watters 1997,Watters et al. 2009, OSUMD 2010). Raccoons, muskrats, otters, fishes, turtles, and birds all feed on mussels (Grabarkiewicz and Davis 2008). Wyoming's native mussel diversity is naturally low (seven species known), owing to the generally high elevation, headwater character of Wyoming's aquatic ecosystems.

Habitat

Plain pocketbook inhabits small streams to large rivers, and prefers mud, sand and gravel substrates (Cummings and Mayer 1992; Whaley et al. 2004).

Problems

- Pollution, changes in flow regime, extremely low flows, siltation, changes in substrate, and interrupting glochidial host fish relationships.

Conservation Actions

h Baseline population data was collected using Governor's ESA and State Wildlife Grant funding during the 2013 and 2014 field seasons in the North Platte River drainage. Using WGFD's 2010 SWAP NSS Matrix and with the current populations surveyed in the North Platte River drainage plain pocketbook has been assigned a rank of NSS1. Continued surveys throughout the North Platte River drainage, especially in the Laramie River drainage, would help determine a more refined NSS rank. Mussel surveys should be done every several years with more intensive surveys for PPM occurring more often to document its existence or possible extirpation.

Monitoring / Research

More live records of the plain pocketbook in the North Platter River drainage would be extremely valuable. If time allows and resources are available, additional thorough systematic surveys should be performed. Any new sites within their Wyoming range would be critical in determining a more refined NSS ranking. Live individuals appear to be rare in Wyoming. Stable populations of this mussel were once common in the North Platte drainage, given that empty shells are common in certain locations. Fossil specimens of this species were also documented in relatively recent strata of the North Platte River's floodplain. Mussel surveys should be done every several years with more intensive surveys for PPM occurring more often to document its existence or possible extirpation.

Recent Developments

Governor's ESA and State Wildlife Grant funded systematic surveys using techniques developed in 2011 were performed in southeastern Wyoming during the 2013 and 2014 field seasons. No live individuals were found. An administrative report is available that summarizes the data that were collected during systematic surveys (Mathias 2015).

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Plain Pocketbook (*Lampsilis cardium*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Pond Snails - Stagnicola sp.

Abundance:

Status: NatureServe:

Population Status:

Limiting Factor:

Comment:

Introduction

Pond snails, genus Stagnicola, is a genus of air-breathing freshwater snails in the family Lymnaeidae. These snails have a spiral shell that is up to 5 cm in length with a dextral (left-opening) shell (Thorp and Rogers 2011). Pond snails are distributed across North America (NatureServe 2016). Of the 28 species and subspecies known from North America, 9 (32%) are considered critically imperiled or imperiled (G1/T1 or G2/T2). Aquatic snails are scrapers that eat algae, microbes, fungi and detritus on solid surfaces such as logs, macrophytes and rocks (Smith 2001). Eight species of pond snails are known from Wyoming: S. apicina, S. bonnevillensis, S. caperata, S. catascopium, S. elodes, S. hinkleyi, S. montanensis and S. traski (NatureServe 2016). Of these species, S. hinkleyi was listed as imperiled and S. bonnevillensis, S. montanensis and S. traski were listed as vulnerable (NatureServe 2016). S. traski was recorded from one location in Wyoming (Oliver and Bosworth 1999). S. bonnevillenis is thought to be extirpated from southwest Wyoming and was a candidate species under the Endangered Species Act (NatureServe 2016).

Habitat

Pond snails live in ponds or slow moving streams. These snails may live on the bottom of ponds or streams on fine sediment or on aquatic vegetation (Thorp and Rogers 2011).

Problems

- Lack of basic information on the species present, their distribution, and ecology in Wyoming

Conservation Actions

- Concerns over the effects of habitat disturbance, such as dewatering, pollution, and invasive animals

Monitoring/Research

Monitoring plans for some species may be desirable, but baseline information is first needed.

Recent Developments

Aquatic snail surveys are currently being conducted in some areas of Wyoming.

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Pond Snails - *Stagnicola* sp.

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: April 2010. Wyoming Game and Fish Department. A range map is unavailable for the taxa because distribution and ecology are poorly known in Wyoming.

2017

Pygmy Mountainsnail - Oreohelix pygmaea

Abundance:

Status: NatureServe:

Population Status:

Limiting Factor:

Comment:

Introduction

Pygmy mountainsnail are land snails in the order Stylommatophora. Mountainsnails have depressed, heliciform shells with an umbilicus and 4 to 6 whorls (Pilsbry 1939). Shell diameter is about 11 mm (0.45 in) and shell height can be up to 9 mm (0.35 in). Pygmy mountainsnails are located Wyoming and Montana (Pilsbry 1939; NatureServe 2016). Pygmy mountainsnail are listed as critically imperiled in Montana and vulnerable in Wyoming, and critically imperiled across their range (NatureServe 2016). Mountainsnails eat leaf litter, detritus and microorganisms growing on surfaces, such as rocks, logs or soil (Speiser 2001). Little is known about the life history of mountainsnails, including how long these snails live and how often they reproduce. Mountain snails are live bearers, meaning they raise their young within their shell until the young reach about 2.5 whorls (Anderson et al. 2007). Pygmy mountainsnails are active during spring and early summer during wet, cool conditions but may be active in the fall or winter depending on conditions (Anderson 2005; Tronstad, personal observation). Pygmy Mountainsnails are located in the Bighorn Mountains of Wyoming.

Habitat

Pygmy mountainsnails live in the Bighorn Mountains in areas with canopy cover and leaf or needle litter. Mountainsnails are generally found in moist, cool areas such as north facing slopes or near streams.

Problems

Conservation Actions

Monitoring / Research

Anderson (2010) surveyed for Oreohelix at 15 sites and found live individuals at 13 sites. She identified Oreohelix subrudis, O. pygmaea and O. yavapai in the Bighorn Mountains.

Recent Developments

Anderson (2010) investigated Oreohelix in the Bighorn Mountains and suggested that Oreohelix pygmaea and Oreohelix strigosa cooperi are the same species because of little genetic difference.

References

Pygmy Mountainsnail (*Oreohelix pygmaea*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Tadpole Physa - Physa gyrina

Abundance: Unknown

Status: NSSU NatureServe: N5 S4

Population Status: Unknown

Limiting Factor: Unknown

Comment:

Introduction

The tadpole physa is an aquatic snail in the family Physidae. These snails have shells that are up to 2 cm in length and brown in color (Harrold and Guralnick 2010). Tadpole physa occur across North America and are ranked from apparently secure (e.g., Wyoming and Washington) to secure (e.g., Georgia, Wisconsin and Alberta; NatureServe 2016). These snails are considered secure across their range. Aquatic snails are scrapers that eat algae, microbes, fungi and detritus on solid surfaces such as logs, macrophytes and rocks (Smith 2001). The biology of the tadpole physa has been thoroughly studied (Dillon et al. 2006). These snails mature at 11 to 12 weeks in a laboratory settling and exhibit a variety of life history strategies (Dillon et al. 2004). Tadpole physa are distributed across much of Wyoming.

Habitat

Tadpole physa live in permanent and intermittent waterbodies including streams, rivers, ponds and lakes (Dillon et al. 2006). They can be found on a variety of substrate types from fine sediment, sand, cobble and aquatic plants.

Problems

Conservation Actions

Monitoring/Research

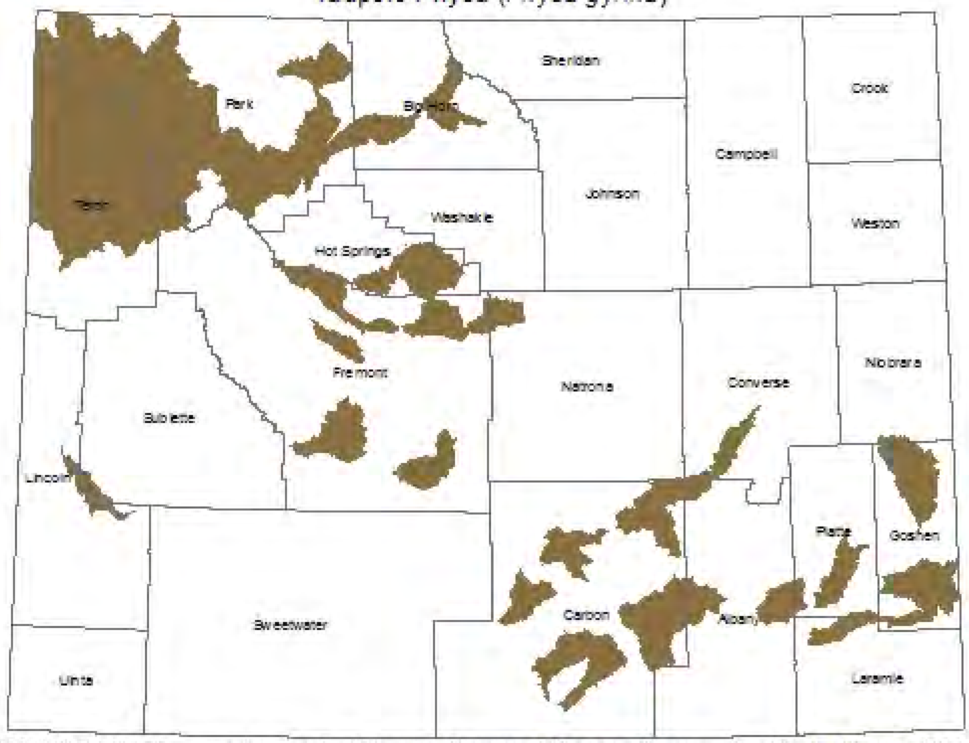
The Wyoming Game and Fish Department funded the Wyoming Natural Diversity Database to survey aquatic snails in the Snake and Green River drainages of Wyoming.

Recent Developments

Wethington and Lydreard (2007) published a revised taxonomy of the family Physidae and found that the species Physa gyrina includes P. johnsoni, P. microstriata, P. utahensis and P. wrighti.

References

Tadpole Physa (*Physa gyrina*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Yavapai Mountainsnail - Oreohelix yavapai

Abundance: Unknown

Status: NSSU NatureServe: G5 SNR

Population Status: Unknown

Limiting Factor: Unknown

Comment:

Introduction

Yavapai mountainsnail are land snails in the order Stylommatophora. Mountainsnails have depressed, heliciform shells with an umbilicus and 4 to 6 whorls (Pilsbry 1939). Shell diameter is about 17 mm (0.7 in) and shell height can be 10 mm (0.4 in). Yavapai mountainsnails are located Wyoming, Montana, Utah, Arizona and New Mexico (Pilsbry 1939; NatureServe 2016). Yavapai mountainsnail are listed as critically imperiled in Utah and Arizona, and secure across their range (NatureServe 2016). Mountainsnails eat leaf litter, detritus and microorganisms growing on surfaces, such as rocks, logs or soil (Speiser 2001). Little is known about the life history of mountainsnails, including how long these snails live and how often they reproduce. Mountain snails are live bearers, meaning they raise their young within their shell until the young reach about 2.5 whorls (Anderson et al. 2007). Yavapai mountainsnails are active during spring and early summer during wet, cool conditions but may be active in the fall or winter depending on conditions (Anderson 2005; Tronstad, personal observation). Yavapai mountainsnails are located in the Bighorn Mountains of Wyoming.

Habitat

Yavapai mountainsnails live in the Bighorn Mountains in areas with canopy cover and leaf or needle litter. Mountainsnails are generally found in moist, cool areas such as north facing slopes or near streams.

Problems

Conservation Actions

Monitoring/Research

Anderson (2010) surveyed for Oreohelix at 15 sites and found live individuals at 13 sites. She identified Oreohelix subrudis, O. pygmaea and O. yavapai in the Bighorn Mountains.

Recent Developments

Anderson (2010) investigated Oreohelix in the Bighorn Mountains and suggested that Oreohelix yavapai is a unique species.

References

Yavapai Mountainsnail (*Oreohelix yavapai*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Species Accounts for other Wyoming SGCN Mollusks

While survey information has revealed that the following mollusks are present in Wyoming and have therefore been identified as SGCN in Wyoming's 2017 SWAP, not enough data exists to create individual species accounts: Creeping Ancylid, Dusky Fossaria, Forest Disc, Marsh Rams-horn, Prairie Fossaria, Quick Gloss, Rocky Mountain Mountainsnail, Subalpine Mountainsnail, Umbilicate Sprite, and Western Glass-snail.

Black Hills Red-bellied Snake - Storeria occipitomaculata pahasapae

Abundance: Unknown

Status: NSSU NatureServe: G5T4Q S1

Population Status: Greatly restricted distribution, population numbers are unknown.

Limiting Factor: Habitat: severely limited habitat. Species found in moist areas along riparian corridors. Degree of habitat loss is unknown.

Comment: Little is known regarding the status of this species. Habitat and range are greatly restricted within the state, but threats to this species are unknown.

Introduction

The Black Hills Red-bellied Snake can be found in Crook and Weston Counties of the Black Hills (Baxter and Stone 1985). The active period for this snake is likely May through September. Breeding may occur in the spring, summer, or fall (Ernst and Ernst 2003). After late summer or fall mating, sperm may be stored in the oviducts over the winter. This species is ovoviviparous and bear their young live. One to thirteen neonates are typically born in late summer (Baxter and Stone 1985). Prey items for this species include slugs, earthworms, and other small invertebrates. Black Hills Red-bellied Snakes are often described as secretive and spend most of their time in moist environments under cover. These snakes overwinter below the frost line in soil, gravel, ant mounds, rock crevices, and mammal burrows (Ernst and Ernst 2003).

Habitat

In Wyoming, the Black Hills Red-bellied Snake inhabits woodland communities of the Black Hills (Baxter and Stone 1985). They may occur in moist woodlands, open fields, bogs, or along the borders of marshes and swamps (Ernst and Ernst 2003). Some populations may also be observed in dry conditions.

Problems

- Little is known about this species in Wyoming. Lack of information regarding populations, distribution, and habitat associations directly impact the ability to manage for this species.
- Lack of basic information on the species presence, distribution, and ecology in Wyoming.
- This species has restricted habitats in the state, therefore disturbance to these areas may affect the range of the species in Wyoming.

Conservation Actions

- Develop management recommendations based on resulting data.
- Survey and monitor population distribution, status, and habitat assocations.

Monitoring / Research

Conduct baseline surveys to gain better understanding of species distribution within the state.

Recent Developments

Baseline reptile and amphibian surveys were conducted in northern Wyoming in 2013 and 2014. However, no Black Hills Red-bellied Snakes were documented during these surveys. Surveys for Black Hills Red-bellied Snakes were conducted, and several individuals observed during these survesy, near a new mine site in the Black Hills. Reptiles have received increased attention within Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

Baxter, G.T. and M.D. Stone. 1985. Amphibians and Reptiles of Wyoming. Second Edition. Wyoming Game and Fish Department, Cheyenne. 137pp.

Ernst, C.H., and E.M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Books, Washington and London. 668pp.

Black Hills Red-bellied Snake (*Storeria occipitomaculata pahasapae*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Desert Striped Whipsnake - Coluber taeniatus taeniatus

Abundance: Unknown

Status: NSSU NatureServe: G5 S1

Population Status: Population numbers are unknown. Only three documented sightings of the species in the state.

Limiting Factor: Habitat: habitat and range likely restricted in range within the state. Degree of habitat loss is unknown.

Comment: New species documented in the state since 2010 SWAP.

Introduction

In Wyoming, Desert Striped Whipsnakes only occur in the far southwest region of the state, near the southern part of Flaming Gorge. The Desert Striped Whipsnake's opportunistic diet consists of lizards, other small vertebrates, and insects such as grasshoppers and beetles (Hammerson 1999). They use their fast speed to capture prey as well as to escape predation (Hammerson 1999). Desert Striped Whipsnakes lay 3 to 10 eggs in June or July (Hammerson 1999). Males defend small mating territories around adult females; adult females reproduce annually (Hammerson 1999). Desert Striped Whipsnakes are generally active during warm daylight hours from April to October, depending on the weather. They overwinter in crevices of rock outcroppings and sometimes share these dens with other snake species (Hammerson 1999). Desert Striped Whipsnakes were first officially documented in the state in 2010.

Habitat

Desert Striped Whipsnakes can be found in semidesert shrublands, woodlands, rocky slopes, and the bottoms of canyons (Hammerson 1999). They are usually on the ground, but may climb vegetation; when inactive, they burrow underground or under cover such as rocks (Hammerson 1999).

Problems

- Little is known about this species in Wyoming. Lack of information regarding populations, distribution, and habitat associations directly impact the ability to manage for this species.
- This species may have limited habitat in Wyoming and degree of this habitat loss is unknown.

Conservation Actions

- Survey and monitor population distribution, status, and habitat assocations.

Monitoring / Research

Conduct baseline surveys to gain a better understanding of Desert Striped Whipsnake distribution in Wyoming.

Recent Developments

Surveys were conducted for Desert Striped Whipsnakes near Flaming Gorge in 2014. One additional individual was documented during these surveys. Reptiles have received increased attention in Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

Hammerson, G.A. 1999. Amphibians and Reptiles in Colorado: A Colorado Field Guide, Second Edition. University Press of Colorado and Colorado Division of Wildlife. 484 pp.

Stebbins, R.C. 2003. A Field Guide to Western Reptiles and Amphibians. Third Edition. Houghton Mifflin Company, Boston. 336 pp.

Hubbard, K. A. 2011. Geographic Distribution: Coluber (=Masticophus) taeniatus (Striped Whipsnake). Herpetological Review 42:113.

Desert Striped Whipsnake (*Coluber taeniatus taeniatus*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Eastern Spiny Softshell - Apalone spinifera spinifera

Abundance: Rare

Status: NSS2 (Ba) NatureServe: G5 S4

Population Status: Vulnerable, restricted habitat and range. Habitat is severely decreasing and populations have dramatically declined in areas.

Limiting Factor: Habitat: Restricted to low elevation habitats within the Missouri River drainage.

Comment: NSS status changed from NSS4 to NSS2 due to declining populations and increasing threats. Scientific name changed from Apalone spiniferus hartwegi. Common name changed from Western Spiny Softshell to Eastern Spiny Softshell.

Introduction

The Eastern Spiny Softshell can be found at lower elevations in the eastern and northern counties including the Bighorn Basin (Baxter and Stone 1985). Wyoming Game and Fish personnel have observed this species in all major river drainages within these regions. The Eastern Spiny Softshell typically becomes active in April or May. Nesting season for this species may last from May-August, but most nesting behavior occurs in June and July (Ernst et al 1994). In Wyoming, hatchlings appear in August and September (Baxter and Stone 1985). Females typically lay 20 eggs in loose sand near water. Eggs are often deposited in full sun in sand or gravel bars. Eastern Spiny Softshells are primarily carnivorous and feed on fish, amphibians, and invertebrates. This species is highly aquatic and spends its daylight hours foraging, floating on the surface, or buried in soft aquatic substrates with only its head and neck protruding (Ernst et al 1994). Riverine and open water habitats are preferred. Eastern Spiny Softshells may also be observed basking on sand bars, gravel bars, floating debris, and mud banks. These turtles typically enter hibernation by the end of October and overwinter in soft substrates in deep pools.

Habitat

Eastern Spiny Softshells prefer permanent lakes, rivers, and larger streams below 6000 feet.

Problems

- Lack of basic information on the species presence, distribution, and ecology in Wyoming.
- Reductions in permanent water availability are likely to impact populations of this species.

Conservation Actions

- Develop management recommendations based on resulting data.
- Survey and monitor population distribution, status, and habitat assocations.

Monitoring/Research

Conduct baseline surveys to gain better understanding of species distribution within the state.

Recent Developments

Baseline reptile and amphibian surveys were conducted in southeast Wyoming in 2011 and 2012 (Snoberger and Walker 2013, 2014) and in northern Wyoming in 2013 and 2014. Several Eastern Spiny Softshells were documented during these surveys in southeast Wyoming and detailed habitat data was collected at these locations (Snoberger and Walker 2013, 2014). Reptiles have received increased attention within Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

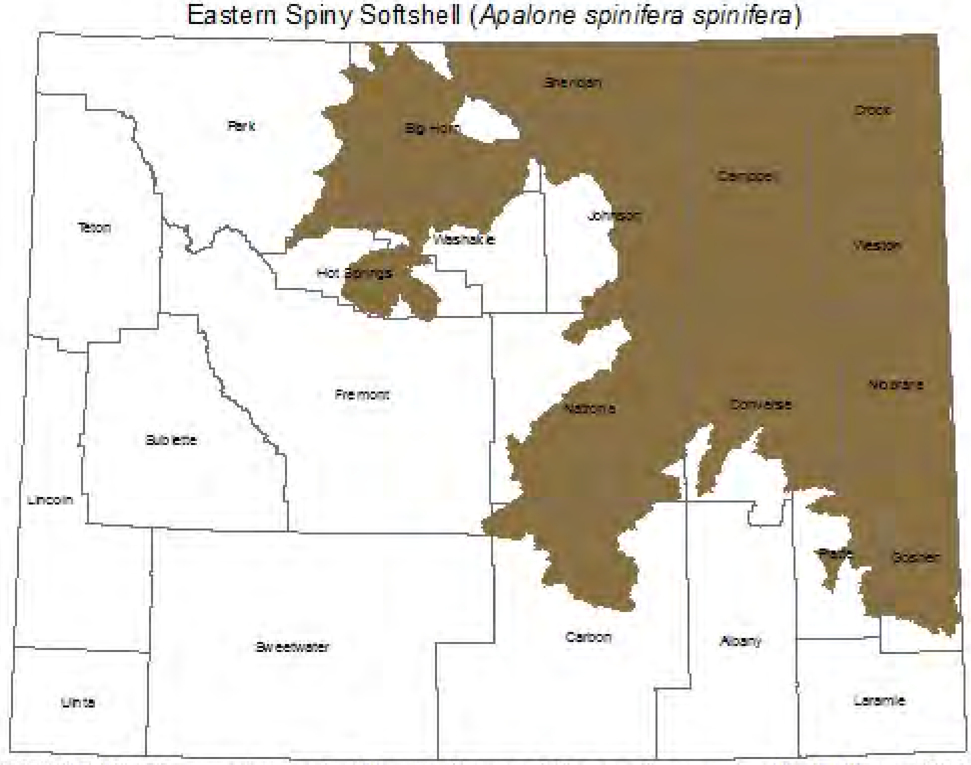
Ernst, C.H., J.E. Lovich, and R.W. Barbour. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington and London. 578pp.

Baxter, G.T. and M.D. Stone. 1985. Amphibians and Reptiles of Wyoming. Second Edition. Wyoming Game and Fish Department, Cheyenne. 137pp.

Snoberger, C.E. and Z.J. Walker. 2013. Southeast Wyoming reptile and amphibian surveys 2011-2012. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Snoberger, C.E. and Z.J. Walker. 2014. Reptile and amphibian habitat associations in southeast Wyoming. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Eastern Spiny Softshell (*Apalone spinifera spinifera*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Great Basin Gophersnake - Pituophis catenifer deserticola

Abundance: Rare

Status: NSS2 (Ba) NatureServe: G5T5 S3

Population Status: Vulnerable populations are restricted in numbers and distribution, extirpation is not eminent.

Limiting Factor: Habitat: the habitat for this species is experiencing severe and ongoing loss due to energy development.

Comment: None.

Introduction

In Wyoming, Great Basin Gophersnakes can be found in the south-central counties at lower elevations and in the Wyoming Basin west of the Continental Divide (Baxter and Stone 1985). Gophersnakes are typically active from April to October. They are mostly diurnal, but may be more nocturnal during hot, dry periods. Gophersnakes burrow frequently to make retreats, nests, and to excavate rodents (Ernst and Ernst 2003). Great Basin Gophersnakes primarily feed upon mice, gophers, chipmunks, and rabbits (Baxter and Stone 1985). Breeding takes place after snakes leave their winter dens. During June and July, females deposit 2-24 eggs in animal burrows, under rocks or logs, and in excavations dug in loose soil by the female (Ernst and Ernst 2003). Eggs probably hatch in August or September (Baxter and Stone 1985). When disturbed, a gophersnake may hiss loudly, puff its body, vibrate its tail, coil, and strike repeatedly. Gophernakes hibernate in mammal burrows or rock crevices and may share dens with other species of snakes, including rattlesnakes (Ernst and Ernst 2003).

Habitat

Great Basin Gophersnakes inhabit sagebrush and desert habitats in the plains zone (Baxter and Stone 1985). Gophersnakes need deep, loose soil and animal burrows for shelter (Ernst and Ernst 2003). Little is known about this species' habits in Wyoming.

Problems

- Ongoing human activities throughout the state will likely result in habitat loss for this species.
- Lack of basic information on the species presence, distribution, and ecology in Wyoming.

Conservation Actions

- Develop management recommendations based on resulting data.
- Survey and monitor population distribution, status, and habitat assocations.

Monitoring / Research

Conduct baseline surveys to gain a better understanding of Great Basin Gophersnake distribution in Wyoming.

Recent Developments

Baseline reptile and amphibian surveys were conducted in southwest Wyoming in 2009 and 2010 (Snoberger and Walker 2012). One Great Basin Gophersnake was documented during these surveys and detailed habitat data was collected at this locations (Snoberger and Walker 2012). In 2009, a graduate project was implemented through the University of Wyoming to look at the effects of roads on reptile species within the lower Green River valley (Hubbard 2011). In 2015, the Bureau of Land Management funded a project looking at Great Basin Gophersnake distribution and comparing that information to predictive distribution models. Results of this project are still being compiled. Reptiles have received increased attention in Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

Ernst, C.H., and E.M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Books, Washington and London. 668pp.

Baxter, G.T. and M.D. Stone. 1985. Amphibians and Reptiles of Wyoming. Second Edition. Wyoming Game and Fish Department, Cheyenne. 137pp.

Snoberger, C.E. and Z.J. Walker. 2012. Reptile and amphibian habitat associations in southwest Wyoming. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Snoberger, C.E. and Z.J. Walker . 2012. Southwest Wyoming reptile and amphibian surveys 2009-2010 . Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Hubbard, K.A. 2011. The relative influence of adjacent road characteristics and habitat on lizard populations in arid shrublands. Master's thesis. University of Wyoming. Laramie, Wyoming.

Great Basin Gophersnake (*Pituophis catenifer deserticola*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Great Basin Skink - Plestiodon skiltonianus utahensis

Abundance: Unknown

Status: NSSU NatureServe: G5T5 S1

Population Status: Population numbers and threats unknown. Discovered in 2010 in the Bear River drainage. Only two individuals documented in the state.

Limiting Factor: Habitat: habitat and range restricted in range within the state. Threats unknown.

Comment: Species recently documented in the state (2010).

Introduction

The Great Basin Skink was first documented in Wyoming during the spring of 2010 near Cokeville (Matthews et al. 2011, Snoberger and Walker 2012). Following initial discovery, another Great Basin Skink was documented along the Smith's Fork of the Bear River (Matthews et al. 2011, Snoberger and Walker 2012). Great Basin Skinks are active during the day, but usually stay out of sight under rocks, logs, bark, boards, scrap metal, or burrowed underground (Stebbins 2003, Snoberger and Walker 2012, St. John 2002). This species is likely active from late April through October. Great Basin Skinks feed on insects, spiders, earthworms, and sowbugs (Stebbins 2003, St. John 2002). On average, females lay 2-10 eggs from June to July (Stebbins 2003). Females remain with the nest, and have been known to fend off predators and repair damaged nests (Werner et al. 2004). Eggs typically hatch in late July and August. Skinks can burrow in loose soil, but tend to use existing burrows for nesting and cover (Werner et al. 2004). This species is very cryptic and may easily be overlooked.

Habitat

In Wyoming, the Great Basin Skink has only been documented in Lincoln County (Snoberger and Walker 2012). Great Basin Skinks inhabit areas with rocks or logs in scrub oak, sagebrush, juniper, and grassland habitats from around 4,500 to 8,300 feet (Stebbins 2003, Tanner 1957). They may prefer rocky habitats near streams, but can also be found on hillsides farther from water (Stebbins 2003, Snoberger and Walker 2012a, Snoberger and Walker 2012b).

Problems

- Lack of basic information on the species presence, distribution, and ecology in Wyoming.
- This species has restricted habitats in the state, therefore disturbance to these areas may affect the range of the species in Wyoming.
- Little is known about this species in Wyoming. Lack of information regarding populations, distribution, and habitat associations directly impact the ability to manage for this species.

Conservation Actions

- Research critical life history and habitat information needs
- Survey and monitor population distribution, status, and habitat assocations.

Monitoring/Research

Conduct baseline surveys to gain better understanding of species distribution within the state.

Recent Developments

Baseline reptile and amphibian surveys were conducted in southwest Wyoming in 2009 and 2010 (Snoberger and Walker 2012). Great Basin Skinks were first documented in the state during these surveys (Matthews et al. 2011, Snoberger and Walker 2012). Two Great Basin Skinks were observed and detailed habitat data was collected at these locations (Snoberger and Walker 2012). Reptiles have received increased attention in Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

Stebbins, R.C. 2003. A Field Guide to Western Reptiles and Amphibians. Third Edition. Houghton Mifflin Company, Boston. 336 pp.

Werner, J.K., B.A. Maxwell, P. Hendricks, and D.L. Flath. 2004. Amphibians and Reptiles of Montana. Mountain Press Publishing Company, Missoula. 262pp.

St. John, A. 2002. Reptiles of the Northwest. Lone Pine Publishing. 272 pp.

Snoberger, C.E. and Z.J. Walker . 2012. Southwest Wyoming reptile and amphibian surveys 2009-2010 . Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Snoberger, C.E. and Z.J. Walker. 2012. Reptile and amphibian habitat associations in southwest Wyoming. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Matthews, C.E., H.J. Vogel, and L.A. Schreiber. 2011. Great Basin Skink (Plestiodon skiltonianus utahensis) geographic distribution. Herpetological Review 42:113.

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Great Plains Earless Lizard - Holbrookia maculata maculata

Abundance: Unknown

Status: NSSU NatureServe: G5TNR S2

Population Status: Restricted distribution, population numbers and threats are unknown.

Limiting Factor: Habitat: limited habitat. Species found in southeastern Wyoming in sandy areas. Degree of habitat loss is unknown.

Comment: None.

Introduction

The Great Plains Earless Lizard may be found in Goshen and Laramie Counties. This lizard is commonly active from April to October. However, juveniles and hatchlings are more active in the fall than adults (Hammerson 1999). When temperatures exceed preferred conditions, this species will retreat into vegetation or burrows. Breeding begins in April. Adult females will deposit 3-6 eggs in June or July. Large females can lay 2 clutches per year (Hammerson 1999). Hatchlings commonly begin to appear in August. The Great Plains Earless Lizard primarily feeds upon insects and other small invertebrates.

Habitat

In Wyoming, the Great Plains Earless Lizard inhabits grassland communities in the plains zone (Baxter and Stone 1985). Within these habitats, this lizard prefers yucca and exposed sandy habitats. This species may also be found along streams, prairie-dog towns, and other flat open expanses of ground (Hammerson 1999).

Problems

- Lack of basic information on the species presence, distribution, and ecology in Wyoming.
- This species may have limited habitat in Wyoming and degree of this habitat loss is unknown.

Conservation Actions

- Develop management recommendations based on resulting data.
- Survey and monitor population distribution, status, and habitat assocations.

Monitoring/Research

Conduct baseline surveys to gain better understanding of species distribution within the state.

Recent Developments

Baseline reptile and amphibian surveys were conducted in southeast Wyoming in 2011 and 2012 (Snoberger and Walker 2013, 2014). Several Great Plains Earless Lizards were documented during these surveys and detailed habitat data was collected at these locations (Snoberger and Walker 2013, 2014). Reptiles have received increased attention within Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

Hammerson, G.A. 1999. Amphibians and Reptiles in Colorado: A Colorado Field Guide, Second Edition. University Press of Colorado and Colorado Division of Wildlife. 484 pp.

Baxter, G.T. and M.D. Stone. 1985. Amphibians and Reptiles of Wyoming. Second Edition. Wyoming Game and Fish Department, Cheyenne. 137pp.

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Snoberger, C.E. and Z.J. Walker. 2014. Reptile and amphibian habitat associations in southeast Wyoming. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Great Plains Earless Lizard (*Holbrookia maculata maculata*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Greater Short-horned Lizard - Phrynosoma hernandesi

Abundance: Rare

Status: NSS4 (Bc) NatureServe: G5 S4

Population Status: Widely distributed, but vulnerable due to range-wide population declines.

Limiting Factor: Habitat: although habitat is not restricted, ongoing human activities will likely result in habitat loss.

Comment: None. Formerly Phrynosoma hernandesi hernandesi.

Introduction

Greater Short-horned Lizards range throughout Wyoming. Although identified as common, anecdotal evidence indicates many populations are in decline throughout this species' range. Greater Short-horned Lizards are active from May to September or October. They forage diurnally on insects (beetles, termites, grasshoppers, caterpillars, etc.) and prefer ants (Baxter and Stone 1985, Stebbins 2003). Greater Short-horned Lizards bear live young from June to August, with litters ranging in size from 5 to 48 (Baxter and Stone 1985, Stebbins 2003). They overwinter in the banks of washes with relatively steep slopes at specific sites with bare and penetrable substrate. They probably overwinter around 1m under the soil and do not show a tendency to aggregate for the winter (Mathies and Martin 2008).

Habitat

Greater Short-horned Lizards range from semiarid plains to the mountains; they can be found in shortgrass prairie and sagebrush habitats, and open pine-spruce, pinon-juniper, and spruce-fir forests. The ground may be stony, sandy, or firm, but usually has fine loose soil present, in which the lizards burrow (Stebbins 2003).

Problems

- Ongoing human activities throughout the state will likely result in habitat loss for this species.
- Lack of basic information on the species presence, distribution, and ecology in Wyoming.

Conservation Actions

- Survey and monitor population distribution, status, and habitat assocations.
- Develop management recommendations based on resulting data.

Monitoring / Research

Conduct baseline surveys to gain a better understanding of Greater Short-horned Lizard distribution in Wyoming.

Recent Developments

Baseline reptile and amphibian surveys were conducted in southwest Wyoming in 2009 and 2010 (Snoberger and Walker 2012), in southeast Wyoming in 2011 and 2012 (Snoberger and Walker 2013, 2014) and in northern Wyoming in 2013 and 2014. Several Greater Short-horned Lizards were documented during these surveys and detailed habitat data was collected at these locations (Snoberger and Walker 2012, 2013, 2014). In 2009, a graduate project was implemented through the University of Wyoming to look at the effects of roads on reptile species, including Greater Short-horned Lizards, within the lower Green River valley (Hubbard 2011). A graduate project was conducted through the University of Wyoming from 2011 to 2015 on Greater Short-horned Lizards across the state. This project attempted to identify factors limiting the distribution and abundance of Greater Short-horned Lizards. Many new observations of Greater Short-horned Lizards were made during this study and the diet of the species was examined. Another ongoing project through the University of Wyoming is examining preferred body temperature and microhabitat selection in Greater Short-horned Lizard. Reptiles have received increased attention in Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

Stebbins, R.C. 2003. A Field Guide to Western Reptiles and Amphibians. Third Edition. Houghton Mifflin Company, Boston. 533pp.

Mathies, T., and D.J. Martin. 2008. Overwintering site selection by short-horned lizards (Phrynosoma hernandesi) in northeastern Colorado. Journal of Herpetology 42:163-171.

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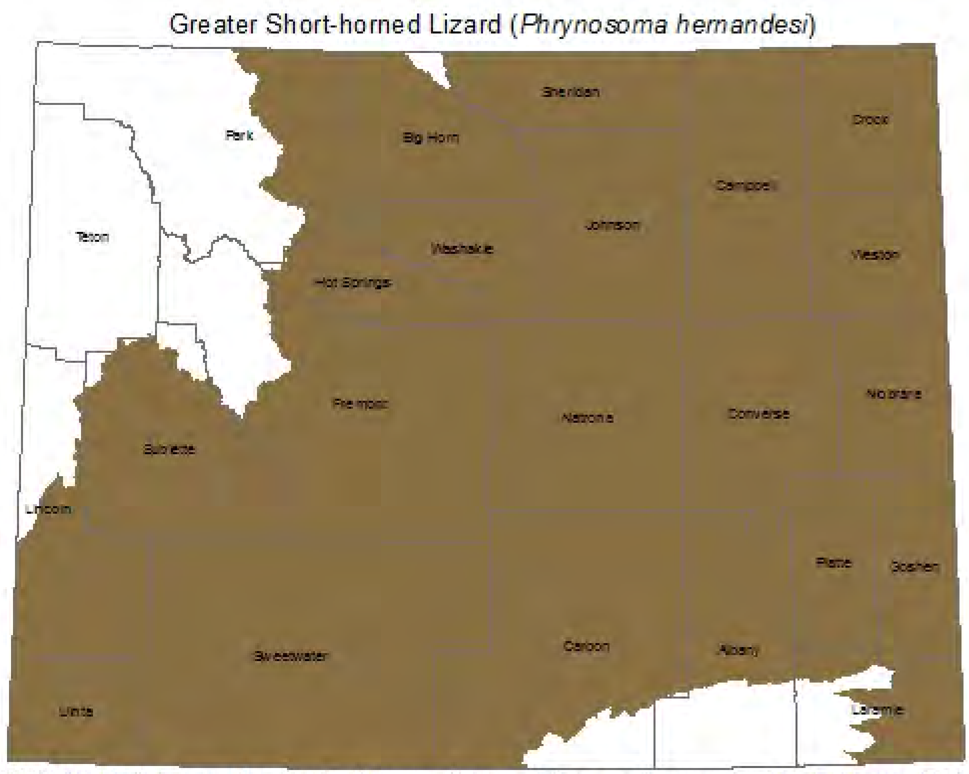
Snoberger, C.E. and Z.J. Walker. 2013. Southeast Wyoming reptile and amphibian surveys 2011-2012. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Snoberger, C.E. and Z.J. Walker. 2014. Reptile and amphibian habitat associations in southeast Wyoming. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Hubbard, K.A. 2011. The relative influence of adjacent road characteristics and habitat on lizard populations in arid shrublands. Master's thesis. University of Wyoming. Laramie, Wyoming.



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Midget Faded Rattlesnake - Crotalus oreganus concolor

Abundance: Extremely rare

Status: NSS1 (Aa) NatureServe: G5T4 S1

Population Status: Imperiled due to greatly restricted numbers and distribution, extirpation is possible.

Limiting Factor: Habitat: species is only found in the Flaming Gorge Region. Habitat has undergone significant loss. Additional habitat loss is ongoing due to energy development.

Comment: None.

Introduction

In Wyoming, the Midget Faded Rattlesnake can be found in the Lower Green River Valley (Baxter and Stone 1985). The majority of this species' range extends southward from the cities of Rock Springs and Green River. The active period for this snake is typically from late April through September. Breeding occurs in July and August (Travsky and Beauvais 2004). Gravid females will give ovoviviparous birth to 3-7 neonates the year following breeding, from August to September. During gestation, gravid females are typically found near hibernacula at thermally preferred communal rookeries (Duvall et al. 1985). It is estimated that females do not become sexually mature until at least five years of age (Travsky and Beauvais 2004). Maturity may not be attained until ten years of age. Females probably breed every 2-4 years. After general emergence, Midget Faded Rattlesnakes typically move to shedding habitat (Parker 2003). Rattlesnakes often use the same locations for ecdysis in successive years (Redder 1994). Following ecdysis, non gravid snakes will travel extensive distances to summer activity ranges. In Wyoming, this species has been documented preying upon lizards, small mammals, and birds (Parker 2003). Midget Faded Rattlesnakes hibernate in rock outcroppings alone or in small aggregations. Venom of this species is considered more potent than other closely related species (Baxter and Stone 1985).

Habitat

The Midget Faded Rattlesnake is found in sagebrush communities in the plains zone (Baxter and Stone 1985). This species requires an abundance of south-facing rock outcroppings and exposed canyon walls (Travsky and Beauvais 2004). Rocky outcrops are essential for cover, variable thermal conditions, and hibernation.

Problems

- Human disturbances (deliberate killing and hibernacula destruction) may be causing declines in the population or will cause declines in the future.
- In some parts of the country, this species has been the target of collection for the pet trade.
- Little is known about this species in Wyoming. Lack of information regarding populations, distribution, and habitat associations directly impact the ability to manage for this species.
- Increased oil and gas development will likely lead to habitat alteration or loss.

Conservation Actions

- Develop management recommendations based on resulting data.
- Survey and monitor population distribution, status, and habitat assocations.
- Bring increased attention to this species when planning future energy development within its range.

Monitoring / Research

Conduct baseline surveys to gain better understanding of species distribution within the state. Monitor known populations and begin to assess population trends.

Recent Developments

In 2006, baseline studies were conducted to look at reptile distribution and abundance in the lower Green River Valley south of the cities of Green River and Rock Springs (Walker and Turner 2010). In 2009, a study was implemented to model Midget Faded Rattlesnake habitat, gene flow, and possible impacts of ongoing energy development (Spear et al. 2011). In 2009, a graduate project was implemented through the University of Wyoming to look at the effects of roads on reptile species within the lower Green River valley (Hubbard 2011). Baseline surveys were conducted to look at reptile distribution and abundance in southwest Wyoming in 2009 and 2010 (Snoberger and Walker 2012). Several Midget Faded Rattlesnakes were documented during these surveys and detailed habitat data was collected at each of these locations (Snoberger and Walker 2012). This project focused on better defining the Midget Faded Rattlesnake range north of Interstate 80, in the White Mountain area (Snoberger and Walker 2012). A Midget Faded Rattlesnake sampling protocol was created for energy companies working in the lower Green River Valley. Reptiles have received increased attention within Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

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Redder, A. J.. 1994. Daily and seasonal activity patterns of prairie rattlesnakes (Crotalus viridis viridis) in Wyoming. M.S Thesis, University of Wyoming Dept of Zoology and Physiology.

Spear, S.F., J.M. Parker, C.R. Peterson, and C.L. Jenkins. 2011. Conservation and Management of Midget Faded Rattlesnakes. Wyoming Game and Fish Department Administrative Report, Cheyenne, Wyoming.

Hubbard, K.A. 2011. The relative influence of adjacent road characteristics and habitat on lizard populations in arid shrublands. Master's thesis. University of Wyoming. Laramie, Wyoming.

Midget Faded Rattlesnake (*Crotalus oreganus concolor*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Northern Many-lined Skink - Plestiodon multivirgatus multivirgatus

Abundance: Unknown

Status: NSSU NatureServe: G5T5 S1

Population Status: Restricted distribution, population numbers and threats are unknown.

Limiting Factor: Habitat: limited habitat. Species found in southeastern Wyoming in prairie habitat. Degree of habitat loss is unknown.

Comment: None. Formerly Eumeces multivirgatus multivirgatus.

Introduction

The Northern Many-lined Skink can be found in Goshen, Platte, and Laramie Counties. This species is usually active from April to October. The breeding habits of this species are not well documented. Breeding is thought to occur in late spring and early summer. Adult females may produce 5-7 eggs in a clutch, but may not breed in consecutive years (Hammerson 1999). Hatchlings can be observed as early as mid July. The food habits for the Northern Many-lined Skink are unknown, but it is assumed that this species feeds upon small invertebrates. This species overwinters underground.

Habitat

The Northern Many-lined Skink prefers grassland communities in the plains zones, including prairies and scarp woodlands (Baxter and Stone 1985). Skinks prefer loose soil that is good for burrowing. This species is typically observed close to cover such as logs, cow dung, trash, and rocks.

Problems

- Lack of basic information on the species presence, distribution, and ecology in Wyoming.
- This species may have limited habitat in Wyoming and degree of this habitat loss is unknown.

Conservation Actions

- Develop management recommendations based on resulting data.
- Survey and monitor population distribution, status, and habitat assocations.

Monitoring / Research

Conduct baseline surveys to gain better understanding of species distribution within the state.

Recent Developments

Baseline reptile and amphibian surveys were conducted in southeast Wyoming in 2011 and 2012 (Snoberger and Walker 2013, 2014). One Many-lined Skink was documented during these surveys and detailed habitat data was collected at this location (Snoberger and Walker 2013, 2014). Reptiles have received increased attention within Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

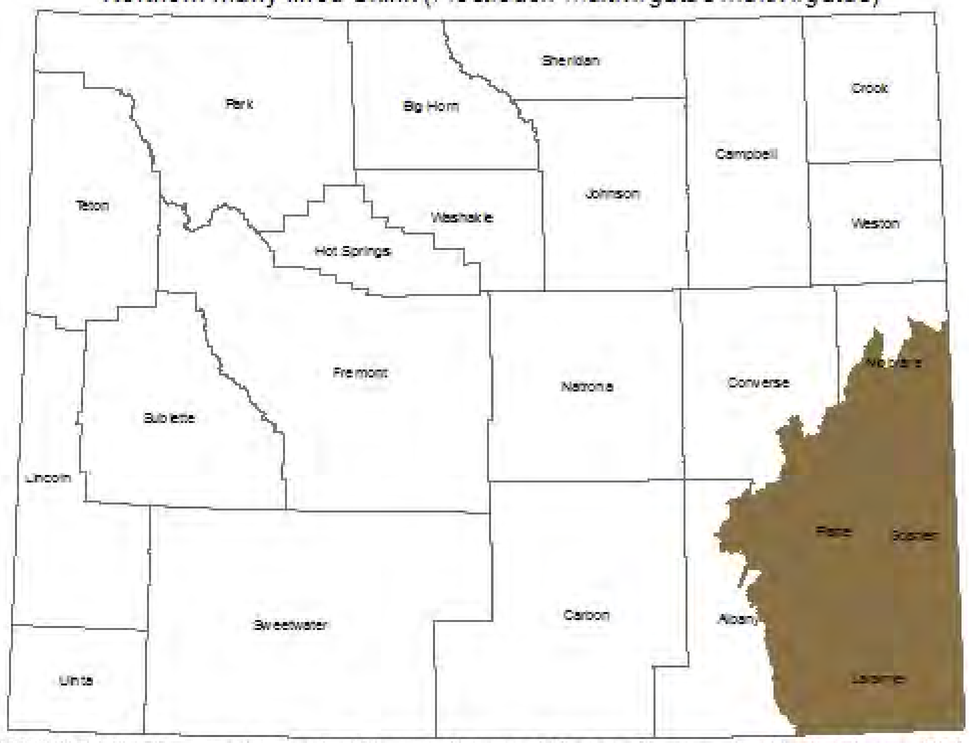
Baxter, G.T. and M.D. Stone. 1985. Amphibians and Reptiles of Wyoming. Second Edition. Wyoming Game and Fish Department, Cheyenne. 137pp.

Snoberger, C.E. and Z.J. Walker. 2013. Southeast Wyoming reptile and amphibian surveys 2011-2012. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Snoberger, C.E. and Z.J. Walker. 2014. Reptile and amphibian habitat associations in southeast Wyoming. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Hammerson, G.A. 1999. Amphibians and Reptiles in Colorado: A Colorado Field Guide, Second Edition. University Press of Colorado and Colorado Division of Wildlife. 484 pp.

Northern Many-lined Skink (*Plestiodon multivirgatus multivirgatus*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Northern Rubber Boa - *Charina bottae*

Abundance: Rare

Status: NSS3 (Bb) NatureServe: G5 S2

Population Status: Vulnerable. Restricted in numbers and distribution, extirpation is not eminent.

Limiting Factor: Habitat: the low elevation forested habitat for this species is limited, but loss is not increasing significantly.

Comment: None.

Introduction

In Wyoming, Northern Rubber Boas inhabit the northwest corner of the state, south into Star Valley and east to the Bighorn Mountains. A secretive and mostly nocturnal snake, it often spends its time beneath logs, flat rocks, tree bark, and in stumps and rodent burrows (Baxter and Stone 1985, Ernst and Ernst 2003). They are usually active from dusk and throughout the night, from April to November (Ernst and Ernst 2003). Northern Rubber Boas may only emerge nocturnally once every eight days (Dorcas and Peterson 1998). They hibernate during the winter in talus slopes, deep rock crevices, rodent burrows, and logs (Ernst and Ernst 2003). Northern Rubber Boas can swim, burrow, and climb well (Stebbins 2003). They feed on small mammals (shrews, mice, voles, moles, and pocket gophers), lizards, birds, salamanders, and reptile eggs (Baxter and Stone 1985, Ernst and Ernst 2003, Stebbins 2003). Northern Rubber Boas bear 1 to 10 live young, born from August to November, and may live up to 40 or 50 years in the field (Ernst and Ernst 2003, Stebbins 2003). They are highly prized by the pet industry due to their calm nature.

Habitat

Northern Rubber Boas are found in the foothills and lower montane zone of Wyoming and prefer areas with nearby water and an abundance of flat rocks, logs, stumps, and boulders (Baxter and Stone 1985, Ernst and Ernst 2003). They are not found in the more arid regions of the state (Baxter and Stone 1985).

Problems

- Lack of basic information on the species presence, distribution, and ecology in Wyoming.
- In some parts of the country, this species has been the target of collection for the pet trade.

Conservation Actions

- Survey and monitor population distribution, status, and habitat assocations.
- Develop management recommendations based on resulting data.

Monitoring / Research

Conduct baseline surveys to gain a better understanding of Northern Rubber Boa distribution in Wyoming.

Recent Developments

Baseline reptile and amphibian surveys were conducted in southwest Wyoming in 2009 and 2010 (Snoberger and Walker 2012). Two Northern Rubber Boas were documented during these surveys and detailed habitat data was collected at these locations (Snoberger and Walker 2012). Reptiles have received increased attention in Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

Ernst, C.H., and E.M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Books, Washington and London. 668pp.

Stebbins, R.C. 2003. A Field Guide to Western Reptiles and Amphibians. Third Edition. Houghton Mifflin Company, Boston. 336 pp.

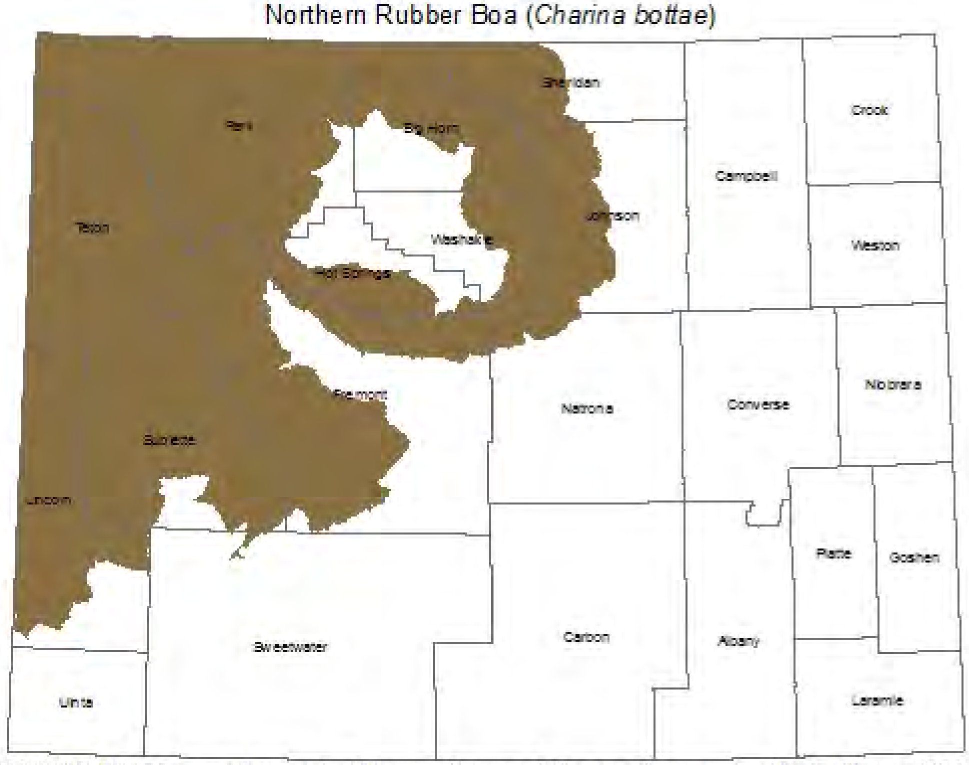
Baxter, G.T. and M.D. Stone. 1985. Amphibians and Reptiles of Wyoming. Second Edition. Wyoming Game and Fish Department, Cheyenne. 137pp.

Dorcas, M.E., and C.R. Peterson. 1998. Daily body temperature variation in free-ranging rubber boas. Herpetologica 54:88-103.

Snoberger, C.E. and Z.J. Walker. 2012. Reptile and amphibian habitat associations in southwest Wyoming. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Snoberger, C.E. and Z.J. Walker . 2012. Southwest Wyoming reptile and amphibian surveys 2009-2010 . Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Northern Rubber Boa (*Charina bottae*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Northern Tree Lizard - *Urosaurus ornatus wrighti*

Abundance: Extremely rare

Status: NSS1 (Aa) NatureServe: G5TNR S2

Population Status: Imperiled due to greatly restricted numbers and distribution, extirpation is possible.

Limiting Factor: Habitat: species is only found in the Flaming Gorge region. Habitat has undergone significant loss. Additional habitat loss is ongoing due to energy development.

Comment: None.

Introduction

In Wyoming, Northern Tree Lizards occur only in southwestern Sweetwater County near the state line (Baxter and Stone 1985). Their diet consists of spiders and a variety of insects, including aphids, beetles, flies, ants, termites, and grasshoppers (Stebbins 2003). Northern Tree Lizards are active from April through October. They bask in the sun throughout most of the day. However, shaded perches are used during the hottest parts of the afternoon. Females lay 1 to 2 clutches of 2 to 16 eggs in July; hatchlings emerge in August (Hammerson 1999, Stebbins 2003). Winters are presumably spent underground and may be spent with aggregations of tree lizards (Hammerson 1999).

Habitat

Northern Tree Lizards inhabit rocky cliffs, canyon walls, steep exposures of bedrock, and large boulders in sagebrush and juniper habitats (Baxter and Stone 1985, Hammerson 1999).

Problems

- Increased oil and gas development will likely lead to habitat alteration or loss.
- Lack of basic information on the species presence, distribution, and ecology in Wyoming.

Conservation Actions

- Survey and monitor population distribution, status, and habitat assocations.
- Develop management recommendations based on resulting data.

Monitoring/Research

Conduct baseline surveys to gain a better understanding of Northern Tree Lizard distribution in Wyoming.

Recent Developments

Baseline reptile and amphibian surveys were conducted in southwest Wyoming in 2009 and 2010 (Snoberger and Walker 2012). Several Northern Tree Lizards were documented during these surveys and detailed habitat data was collected at these locations (Snoberger and Walker 2012). During these surveys, a small range expansion was documented for Northern Tree Lizards, in the White Mountain area north of Green River (Snoberger and Walker 2012). Reptiles have received increased attention in Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

Stebbins, R.C. 2003. A Field Guide to Western Reptiles and Amphibians. Third Edition. Houghton Mifflin Company, Boston. 336 pp.

Baxter, G.T. and M.D. Stone. 1985. Amphibians and Reptiles of Wyoming. Second Edition. Wyoming Game and Fish Department, Cheyenne. 137pp.

Hammerson, G.A. 1999. Amphibians and Reptiles in Colorado: A Colorado Field Guide, Second Edition. University Press of Colorado and Colorado Division of Wildlife. 484 pp.

Snoberger, C.E. and Z.J. Walker. 2012. Reptile and amphibian habitat associations in southwest Wyoming. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Snoberger, C.E. and Z.J. Walker . 2012. Southwest Wyoming reptile and amphibian surveys 2009-2010 . Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Northern Tree Lizard (*Urosaurus ornatus wrighti*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Pale Milksnake - Lampropeltis triangulum multistriata

Abundance: Rare

Status: NSS3 (Bb) NatureServe: G5TNR S3

Population Status: Vulnerable due to restricted numbers, but extirpation is not eminent.

Limiting Factor: Habitat: the woodland and riparian habitats of this species are limited, but loss is not increasing significantly.

Comment: None.

Introduction

In Wyoming, the Pale Milksnake can be found within counties east of the Continental Divide. This species is often found below 8000 feet in elevation (Hammerson 1999). Pale Milksnakes are active from April to October. Breeding occurs shortly after emergence from hibernacula (Werner et al. 2004). Females lay 4-13 eggs from June to July under rocks, logs, or within old mammal burrows. Hatchlings typically emerge in late August and September. Prey items for this species include lizards, small snakes, mammals, and birds. In Wyoming, it is believed that mammals make up the majority of the milksnake's diet (Baxter and Stone 1985). Pale Milksnakes are primarily nocturnal, and are very secretive. During the day, this species is often hidden under cover. Milksnakes are usually observed in the open on humid nights or after rains. This species may hibernate communally with other species of snakes.

Habitat

In Wyoming, the Pale Milksnake prefers scarp woodlands of the plains and foothills zones (Baxter and Stone 1985). However, this species may also be found in dry conifer forests in montane areas. Milksnakes have been found at approximately 7000 feet in the Seminoe Mountains. This species can be found in shortgrass prairies, sandhills, shrubby hillsides, canyons, juniper woodlands, and arid river valleys (Hammerson 1999).

Problems

- In some parts of the country, this species has been the target of collection for the pet trade.
- Lack of basic information on the species presence, distribution, and ecology in Wyoming.

Conservation Actions

- Develop management recommendations based on resulting data.
- Survey and monitor population distribution, status, and habitat assocations.

Monitoring/Research

Conduct baseline surveys to gain better understanding of species distribution within the state.

Recent Developments

Baseline reptile and amphibian surveys were conducted in southeast Wyoming in 2011 and 2012 (Snoberger and Walker 2013, 2014). One Pale Milksnake was documented during these surveys and detailed habitat data was collected at this location (Snoberger and Walker 2013, 2014). Reptiles have received increased attention within Wyoming. Incidental observations are encouraged to be reported to the herpetology program. Incidental observations have extended the known distribution of the Pale Milksnake in Wyoming westward into higher elevations.

References

Hammerson, G.A. 1999. Amphibians and Reptiles in Colorado: A Colorado Field Guide, Second Edition. University Press of Colorado and Colorado Division of Wildlife. 484 pp.

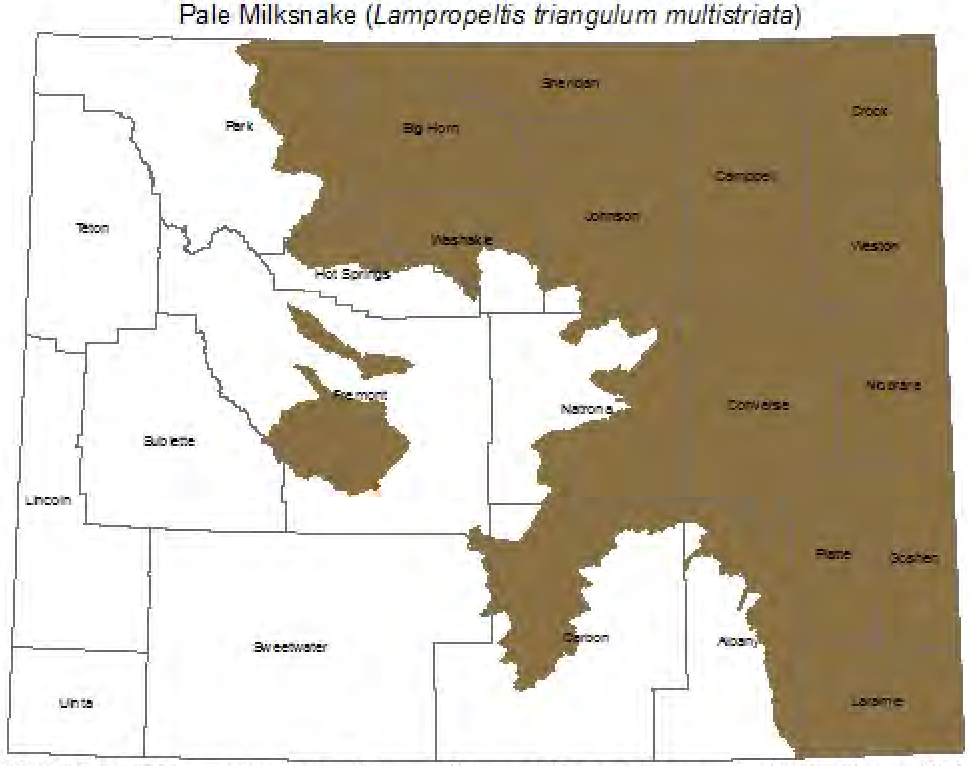
Werner, J.K., B.A. Maxwell, P. Hendricks, and D.L. Flath. 2004. Amphibians and Reptiles of Montana. Mountain Press Publishing Company, Missoula. 262pp.

Baxter, G.T. and M.D. Stone. 1985. Amphibians and Reptiles of Wyoming. Second Edition. Wyoming Game and Fish Department, Cheyenne. 137pp.

Snoberger, C.E. and Z.J. Walker. 2013. Southeast Wyoming reptile and amphibian surveys 2011-2012. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Snoberger, C.E. and Z.J. Walker. 2014. Reptile and amphibian habitat associations in southeast Wyoming. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Pale Milksnake (*Lampropeltis triangulum multistriata*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Plains Black-headed Snake - Tantilla nigriceps

Abundance: Unknown

Status: NSSU NatureServe: G5 SNR

Population Status: Restricted distribution, population numbers are unknown.

Limiting Factor: Habitat: limited habitat distribution, habitat utilization in Wyoming is unknown.

Comment: None. Although this species is thought to be rare, no information is available on population status. Other species of this secretive genus can exist in large numbers without detection.

Introduction

Within Wyoming, the Plains Black-headed Snake has been found in Platte and Carbon Counties. This species is likely active from April to September. Reproductive habits of this species are not well known. It is thought that mating probably takes place in the spring, followed by egg laying in June or July (Ernst and Ernst 2003). Females on average will lay 1-3 eggs per clutch. Hatchlings appear in late July and August. Plains Black-headed Snakes primarily prey upon insects, earthworms, and other small invertebrates. This secretive species spends most of its time underground or under cover. Foraging is often performed at night after rains. These snakes overwinter underground in the soil.

Habitat

The Plains Black-headed Snake is often observed in plains, grasslands, scrub brush, and woodlands (Ernst and Ernst 2003). This species prefers those habitats with loose soil, rock outcroppings, or other structures suitable for cover.

Problems

h Lack of basic information on the species presence, distribution, and ecology in Wyoming.

h This species may have limited habitat in Wyoming and degree of this habitat loss is unknown.

Conservation Actions

h Develop management recommendations based on resulting data.

h Survey and monitor population distribution, status, and habitat assocations.

Monitoring/Research

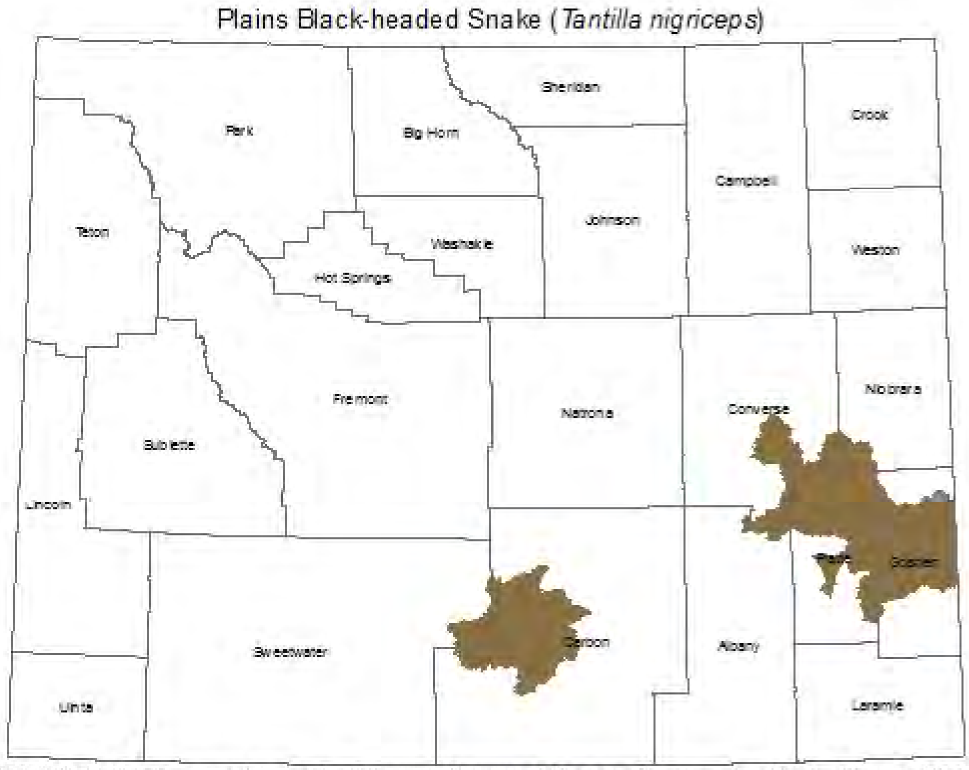
Conduct baseline surveys to gain better understanding of species distribution within the state.

Recent Developments

Reptiles have received increased attention within Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

Ernst, C.H., and E.M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Books, Washington and London. 668pp.



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Plains Box Turtle - Terrapene ornata ornata

Abundance: Unknown

Status: NSSU NatureServe: G5T5 S1

Population Status: Restricted distribution, population numbers and threats are unknown. It has been suggested that this species is already extirpated from the state (Redder et al. 2006).

Limiting Factor: Habitat: limited habitat. This species only inhabits vegetated sandhills.

Comment: Common name changed from Ornate Box Turtle to Plains Box Turtle.

Introduction

The native distribution of Plains Box Turtles in Wyoming is probably confined to the Sandhill region in Goshen County near the state line and near the North Platte River as far west as Fort Laramie (Baxter and Stone 1985). However, the species has also been introduced throughout the state as a result of the pet trade (Baxter and Stone 1985). Plains Box Turtles are primarily terrestrial and have hinged plastrons that close completely. Plains Box Turtles are usually active from April to mid-October (Ernst et al. 1994); they lay eggs in clutches of 2 to 8 eggs from May to June or July (Baxter and Stone 1985). Eggs usually hatch in 59 to 70 days with hatchlings emerging in August and September. Some hatchlings may overwinter in the nest. Plains Box Turtles are primarily carnivorous, though captives eat vegetable matter (Ernst et al. 1994). They feed on insects (grasshoppers, dung beetles, caterpillars, etc.), earthworms, crayfish, eggs, carrion, cactus, fruits, and leaves (Baxter and Stone 1985, Stebbins 2003). Plains Box Turtles construct burrows in deep sandy soils to escape mid-day heat and for hibernation (Redder et al. 2006). This species usually hibernates alone (Ernst et al. 1994). Plains Box Turtles may be declining in numbers and extent in their North American range (Redder et al.2006).

Habitat

Plains Box Turtles favor prairies and sandy, treeless grasslands, but also occur in open woodlands (Baxter and Stone 1985, Ernst et al. 1994, Stebbins 2003). They will seek areas with loose soils suitable for burrowing (Stebbins 2003). Plains Box Turtles usually construct their own burrows or forms (Ernst et al. 1994); they also may be found under larger cover objects (Stebbins 2003). Preferred nesting sites are open, well-drained, and have a soft substrate (Ernst et al. 1994).

Problems

- This species has restricted habitats in the state, therefore disturbance to these areas may affect the range of the species in Wyoming.
- In some areas, this species may have been over harvested for the pet trade (Ernst et al. 1994).
- Automobile mortality may also be a significant threat for this species (Baxter and Stone 1985, Ernst et al. 1994).
- There is some debate on the possible extirpation of this species in the state.
- Lack of basic information on the species presence, distribution, and ecology in Wyoming.
- Due to their long lives and low reproductive output, Ornate Box Turtle populations are especially threatened by the loss of reproductive-age females (Redder et al.2006).

Conservation Actions

- Survey and monitor population distribution, status, and habitat assocations.
- Develop management recommendations based on resulting data.

Monitoring / Research

Conduct baseline surveys to gain a better understanding of Plains Box Turtle distribution in Wyoming.

Recent Developments

Baseline reptile and amphibian surveys were conducted in southeast Wyoming in 2011 and 2012 (Snoberger and Walker 2013). Unfortunately, no Plains Box Turtles were documented during these surveys. Reptiles have received increased attention in Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

Stebbins, R.C. 2003. A Field Guide to Western Reptiles and Amphibians. Third Edition. Houghton Mifflin Company, Boston. 336 pp.

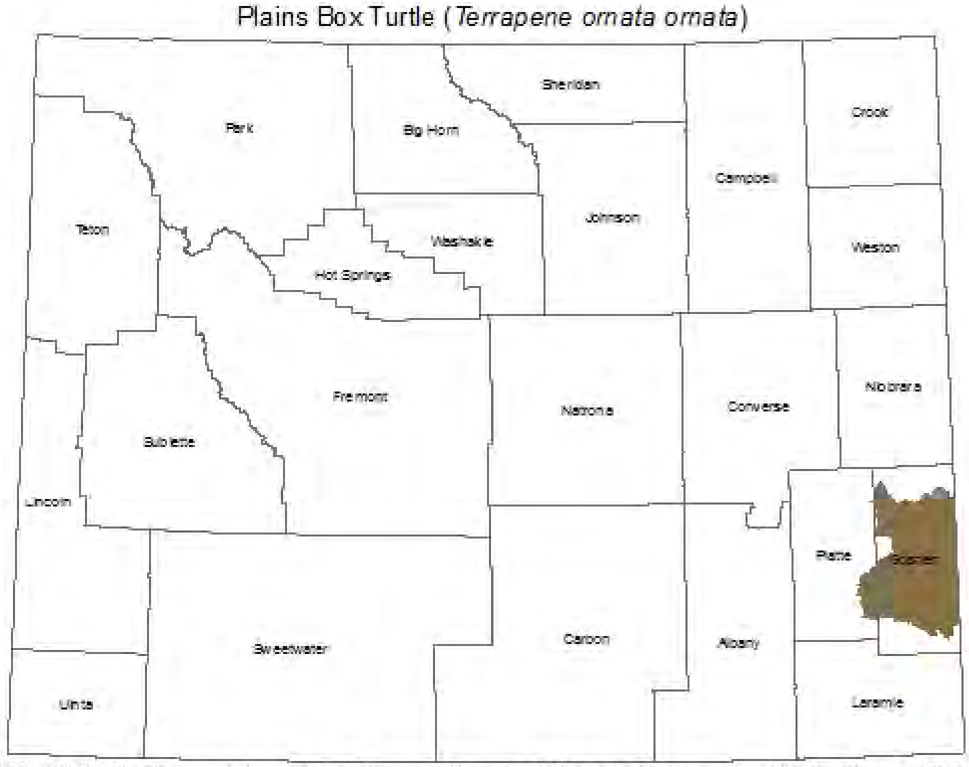
Redder, A.J., C.K. Dodd, Jr., and D. Keinath. 2006. Ornate Box Turtle (Terrapene ornata ornata): a technical conservation assessment. USDA Forest Service, Rocky Mountain Region.

Baxter, G.T. and M.D. Stone. 1985. Amphibians and Reptiles of Wyoming. Second Edition. Wyoming Game and Fish Department, Cheyenne. 137pp.

Ernst, C.H., J.E. Lovich, and R.W. Barbour. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington and London. 578pp.

Snoberger, C.E. and Z.J. Walker. 2013. Southeast Wyoming reptile and amphibian surveys 2011-2012. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Plains Box Turtle (*Terrapene ornata ornata*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Plains Gartersnake - Thamnophis radix

Abundance: Unknown

Status: NSSU NatureServe: G5 S5

Population Status: Restricted distribution, population numbers and threats are unknown.

Limiting Factor: Habitat: limited habitat. This species inhabits riparian areas in plains communities.

Comment: None.

Introduction

Within Wyoming, the Plains Gartersnake may be found east of the Continental Divide below about 6,500 feet in elevation (Baxter and Stone 1985). Plains Gartersnakes are primarily active from April to September. Breeding typically occurs in the spring, but may occur in the fall. Sperm from autumn breeding will remain viable inside the female until spring fertilization. Plains Gartersnakes are ovoviviparous. Nine to twenty-one neonates are birthed in late June to September. Prey items for this species include aquatic vertebrates, amphibians, insects, small mammals, and invertebrates. Activity is usually limited to daylight hours. Plains Gartersnakes exhibit a wide variety of anti-predatory behaviors, but will commonly expel musk or feces onto antagonists. This species hibernates underground in abandoned rodent burrows, anthills, crawfish holes, old wells, and rock crevices (Ernst and Ernst 2003).

Habitat

In Wyoming, the Plains Gartersnake is found along small streams, sloughs, and ponds in the grassland communities of the plains zone (Baxter and Stone 1985). This species hibernates underground in abandoned rodent burrows, anthills, crawfish holes, old wells, and rock crevices (Ernst and Ernst 2003).

Problems

- Lack of basic information on the species presence, distribution, and ecology in Wyoming.

Conservation Actions

- Develop management recommendations based on resulting data.
- Survey and monitor population distribution, status, and habitat assocations.

Monitoring / Research

Conduct baseline surveys to gain better understanding of species distribution within the state.

Recent Developments

Baseline reptile and amphibian surveys were conducted in southeast Wyoming in 2011 and 2012 (Snoberger and Walker 2013, 2014) and in northern Wyoming in 2013 and 2014. Several Plains Gartersnakes were documented during these surveys and detailed habitat data was collected at these locations (Snoberger and Walker 2013, 2014). Reptiles have received increased attention within Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

Ernst, C.H., and E.M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Books, Washington and London. 668pp.

Baxter, G.T. and M.D. Stone. 1985. Amphibians and Reptiles of Wyoming. Second Edition. Wyoming Game and Fish Department, Cheyenne. 137pp.

Snoberger, C.E. and Z.J. Walker. 2013. Southeast Wyoming reptile and amphibian surveys 2011-2012. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Snoberger, C.E. and Z.J. Walker. 2014. Reptile and amphibian habitat associations in southeast Wyoming. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Plains Gartersnake (*Thamnophis radix*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Plains Hog-nosed Snake - Heterodon nasicus

Abundance: Unknown

Status: NSSU NatureServe: G5 S4

Population Status: Appears widely distributed, population numbers and threats are unknown.

Limiting Factor: Habitat - threats to habitat are unknown.

Comment: None.

Introduction

In Wyoming, Plains Hog-nosed Snakes are found in the eastern counties, mostly in the plains. They are a burrowing, diurnal species. If threatened, a Plains Hog-nosed Snake may spread its head and hiss loudly, and if harassed further, may roll on its back and play dead. They are not considered a dangerous species, but sometimes have a reputation for being harmful because of their defensive behavior (Baxter and Stone 1985). Plains Hog-nosed Snakes are active during the day, probably from April to October in Wyoming. They spend the night in temporary burrows constructed in loose soil. Hibernation occurs in burrows the snake digs itself or in abandoned mammal burrows (Ernst and Ernst 2003). Plains Hog-nosed Snakes preferentially feed on toads, but also eat lizards, small mammals, frogs, birds, salamanders, snakes, turtle eggs, and invertebrates (Baxter and Stone 1985, Ernst and Ernst 2003, Stebbins 2003). Females deposit 2 to 24 eggs in soft soil or sand from June to August (Ernst and Ernst 2003, Stebbins 2003). Hatchlings emerge after 50 or 60 days, usually in August or September (Baxter and Stone 1985, Ernst and Ernst 2003).

Habitat

Plains Hog-nosed Snakes prefer grasslands with sandy or gravelly areas where they can burrow, but can also inhabit open brushland and woodland, farmlands, canyon bottoms, scrub brush, and floodplains, (Baxter and Stone 1985, Ernst and Ernst 2003). They may show a preference for areas close to water (Baxter and Stone 1985).

Problems

- Lack of basic information on the species presence, distribution, and ecology in Wyoming.
- Increased oil and gas development will likely lead to habitat alteration or loss.
- The threatening behavior of this snake and its resemblance to the rattlesnake may cause it to be killed needlessly by those thinking it to be harmful (Baxter and Stone 1985).

Conservation Actions

- Survey and monitor population distribution, status, and habitat assocations.
- Develop management recommendations based on resulting data.

Monitoring/Research

Conduct baseline surveys to gain a better understanding of Plains Hog-nosed Snake distribution in Wyoming.

Recent Developments

Baseline reptile and amphibian surveys were conducted in southeast Wyoming in 2011 and 2012 (Snoberger and Walker 2013, 2014) and in northern Wyoming in 2013 and 2014. Several Plains Hog-nosed Snakes were documented during these surveys and detailed habitat data was collected at these locations (Snoberger and Walker 2013, 2014). Reptiles have received increased attention in Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

Baxter, G.T. and M.D. Stone. 1985. Amphibians and Reptiles of Wyoming. Second Edition. Wyoming Game and Fish Department, Cheyenne. 137pp.

Ernst, C.H., and E.M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Books, Washington and London. 668pp.

Stebbins, R.C. 2003. A Field Guide to Western Reptiles and Amphibians. Third Edition. Houghton Mifflin Company, Boston. 336 pp.

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Snoberger, C.E. and Z.J. Walker. 2014. Reptile and amphibian habitat associations in southeast Wyoming. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Plains Hog-nosed Snake (*Heterodon nasicus*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Plateau Fence Lizard - Sceloporus tristichus

Abundance: Rare

Status: NSS4 (Bc) NatureServe: G5 S1

Population Status: Vulnerable due to restricted distribution, but extirpation is not eminent.

Limiting Factor: Habitat: limited habitat. Degree of habitat loss is moderate, but may be increasing.

Comment: Updated to an SGCN species. NSS status changed from NSSU to NSS4(Bc).

Introduction

In Wyoming, Plateau Fence Lizards occur at low elevations in the lower Green River valley in Sweetwater County and along a narrow corridor (hogback) at the east edge of the Laramie Mountains in Laramie, Platte, and Converse Counties. Plateau Fence Lizards feed on flies, grasshoppers, crickets, leaf hoppers, ants, moths and other insects, as well as spiders, ticks, millipedes, and snails (Baxter and Stone 1985, Hammerson 1999, Stebbins 2003). In Wyoming, they are usually active from May to early October (Baxter and Stone 1985). Plateau Fence Lizards seek sunny, open areas during cooler temperatures and shady areas during warmer temperatures. Females lay one to three clutches of eggs, with four to 17 eggs per clutch in June or July (Hammerson 1999, Stebbins 2003). Hatchlings usually appear in August (Hammerson 1999). This species was previously classified as two subspecies in Wyoming, the Red-lipped Plateau Lizard, Sceloporus undulatus erythrocheilus, and the Northern Plateau Lizard, Sceloporus undulatus elongates.

Habitat

Plateau Fence Lizards inhabit sunny rock outcrops, boulders, sandstone cliffs, hogbacks, and canyon walls in sagebrush and shrubland communities (Baxter and Stone 1985, Hammerson 1999). They may sometimes be found near abandoned buildings (Baxter and Stone 1985).

Problems

- Lack of basic information on the species presence, distribution, and ecology in Wyoming.
- Increased oil and gas development will likely lead to habitat alteration or loss.
- This species has restricted habitats in the state, therefore disturbance to these areas may affect the range of the species in Wyoming.

Conservation Actions

- Survey and monitor population distribution, status, and habitat assocations.
- Develop management recommendations based on resulting data.

Monitoring / Research

Conduct baseline surveys to gain a better understanding of Plateau Fence Lizard distribution in Wyoming.

Recent Developments

Baseline reptile and amphibian surveys were conducted in southwest Wyoming in 2009 and 2010 (Snoberger and Walker 2012) and in southeast Wyoming in 2011 and 2012 (Snoberger and Walker 2013, 2014). Several Plateau Fence Lizards were documented during these surveys and detailed habitat data was collected at these locations (Snoberger and Walker 2012, 2013, 2014). During these surveys, a range expansion was documented for Plateau Fence Lizards in Natrona County, in the North Laramie Mountains (Weber and Leuenberger 2012). Reptiles have received increased attention in Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

Hammerson, G.A. 1999. Amphibians and Reptiles in Colorado: A Colorado Field Guide, Second Edition. University Press of Colorado and Colorado Division of Wildlife. 484 pp.

Stebbins, R.C. 2003. A Field Guide to Western Reptiles and Amphibians. Third Edition. Houghton Mifflin Company, Boston. 336 pp.

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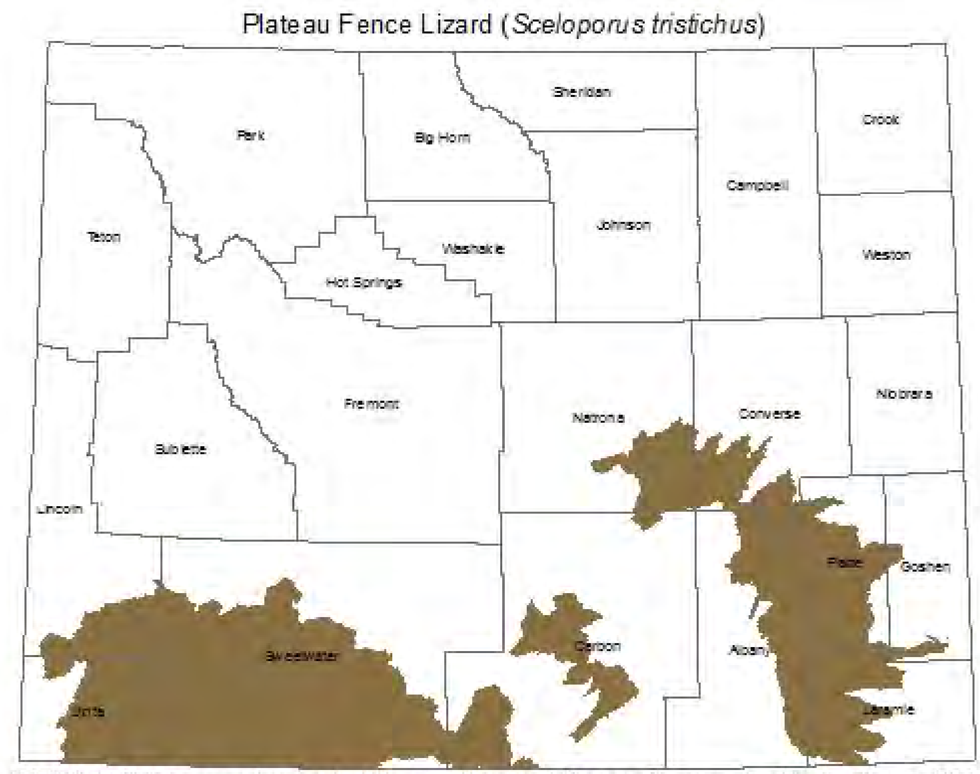
Snoberger, C.E. and Z.J. Walker. 2013. Southeast Wyoming reptile and amphibian surveys 2011-2012. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Snoberger, C.E. and Z.J. Walker. 2014. Reptile and amphibian habitat associations in southeast Wyoming. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Weber, K.J. and K.P. Leuenberger. 2012. Sceloporus tristichus (Plateau Fence Lizard) geographic distribuation. Herpetological Review 43:104.



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Prairie Lizard - *Sceloporus consobrinus*

Abundance: Unknown

Status: NSSU NatureServe: G5 S1

Population Status: Restricted distribution, population numbers are unknown. Although historic reports state this species can commonly be found in SE Wyoming, little information is available for the Prairie Lizard's distribution, population, or threats.

Limiting Factor: Habitat: limited habitat. Degree of habitat loss is unknown.

Comment: None.

Introduction

This is a rough scaled lizard of the prairie, closely related to the Eastern Fence Lizard. Prairie Lizards have blue and black markings on their bellies and chins. They engage in courtship behaviors included doing "push ups". They are generally less than three inches in size. The diet of Prairie Lizards probably consists of small invertebrates including grasshoppers and small beetles. They lay eggs in clutches of one to 17 from April to August. A female was collected in May near Wheatland, WY that had eggs measuring about a half inch in width. There is some evidence to indicate that Prairie Lizards may lay two clutches of eggs per breeding season.

Habitat

The Prairie Lizard prefers grassland and scarp woodlands in the plains zone of Wyoming (Baxter and Stone 1985). Specific habitats for this species include grassland hillsides, sandy areas, sandstone outcrops, limestone outcrops, cliffs, talus, and other various outcroppings.

Problems

- Lack of basic information on the species presence, distribution, and ecology in Wyoming.
- This species may have limited habitat in Wyoming and degree of this habitat loss is unknown.

Conservation Actions

- Develop management recommendations based on resulting data.
- Survey and monitor population distribution, status, and habitat assocations.

Monitoring / Research

Conduct baseline surveys to gain better understanding of species distribution within the state.

Recent Developments

Baseline reptile and amphibian surveys were conducted in southeast Wyoming in 2011 and 2012 (Snoberger and Walker 2013, 2014). Several Prairie Lizards were documented during these surveys and detailed habitat data was collected at these locations (Snoberger and Walker 2013, 2014). Reptiles have received increased attention within Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

Baxter, G.T. and M.D. Stone. 1985. Amphibians and Reptiles of Wyoming. Second Edition. Wyoming Game and Fish Department, Cheyenne. 137pp.

Snoberger, C.E. and Z.J. Walker. 2013. Southeast Wyoming reptile and amphibian surveys 2011-2012. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Snoberger, C.E. and Z.J. Walker. 2014. Reptile and amphibian habitat associations in southeast Wyoming. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Prairie Racerunner - Aspidoscelis sexlineatus viridis

Abundance: Unknown

Status: NSSU NatureServe: G5T5 S2

Population Status: Restricted distribution, population numbers and threats are unknown.

Limiting Factor: Habitat: limited habitat. This species inhabits sandy prairies along the North Platte River.

Comment: None.

Introduction

In Wyoming, Prairie Racerunners have only been documented from Platte County near Wheatland. However, this species is thought to occur in Goshen County (Baxter and Stone 1985). In Colorado, this species is found adjacent to Laramie County, Wyoming (Hammerson 1999). The Prairie Racerunner is primarily active from May to September. However, adults begin to become less active after July (Hammerson 1999). Juveniles are typically active later in the year, with hatchlings being observed in September to October. Breeding occurs in late spring and early summer. Females deposit 1-6 eggs in sandy soil. Larger females are believed to lay two clutches per year (Hammerson 1999). Prairie Racerunners feed primarily on invertebrates. During daylight hours, this species is constantly on the move. Nocturnally, this species finds refuge beneath cover or underground. Prairie Racerunners may dig their own burrows in loose or sandy soils.

Habitat

In Wyoming, the Prairie Racerunner prefers floodplains and yucca covered grasslands (Baxter and Stone 1985). This species may also be found on rocky outcrops, roadsides, sandhills, sand or gravel stream banks, and grassy openings (Hammerson 1999). All habitats require an unvegetated or sparsely vegetated opening.

Problems

- Lack of basic information on the species presence, distribution, and ecology in Wyoming.
- This species may have limited habitat in Wyoming and degree of this habitat loss is unknown.

Conservation Actions

- Develop management recommendations based on resulting data.
- Survey and monitor population distribution, status, and habitat assocations.

Monitoring / Research

Conduct baseline surveys to gain better understanding of species distribution within the state.

Recent Developments

Baseline reptile and amphibian surveys were conducted in southeast Wyoming in 2011 and 2012 (Snoberger and Walker 2013, 2014). Several Prairie Racerunners were documented during these surveys and detailed habitat data was collected at these locations (Snoberger and Walker 2013, 2014). Reptiles have received increased attention within Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

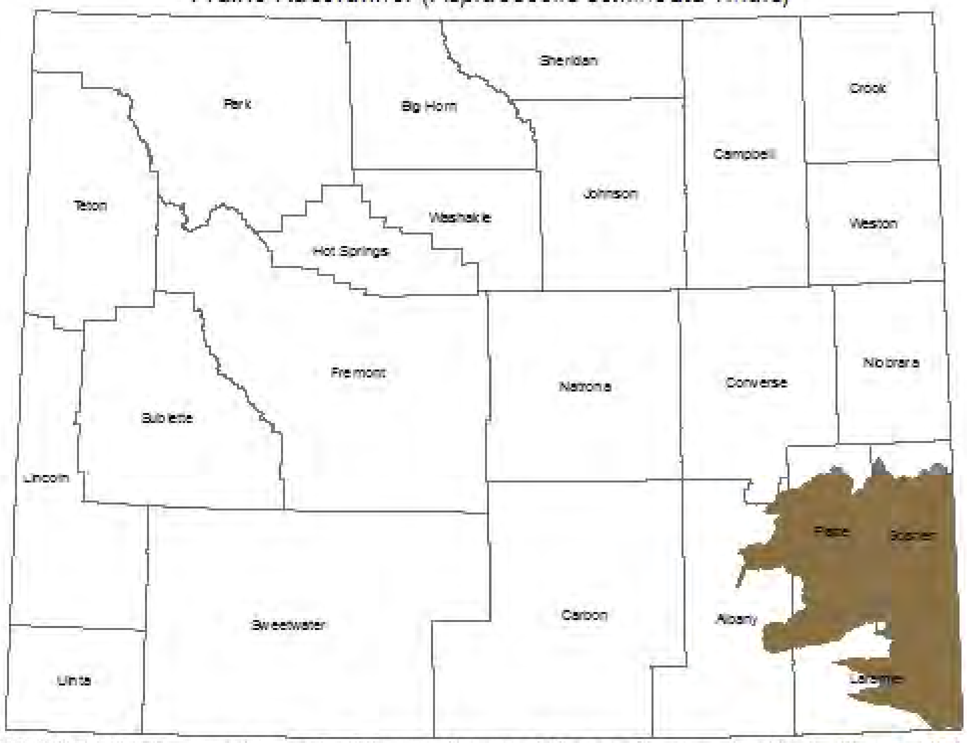
Hammerson, G.A. 1999. Amphibians and Reptiles in Colorado: A Colorado Field Guide, Second Edition. University Press of Colorado and Colorado Division of Wildlife. 484 pp.

Baxter, G.T. and M.D. Stone. 1985. Amphibians and Reptiles of Wyoming. Second Edition. Wyoming Game and Fish Department, Cheyenne. 137pp.

Snoberger, C.E. and Z.J. Walker. 2013. Southeast Wyoming reptile and amphibian surveys 2011-2012. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Snoberger, C.E. and Z.J. Walker. 2014. Reptile and amphibian habitat associations in southeast Wyoming. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Prairie Racerunner (*Aspidoscelis sexlineata viridis*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Prairie Rattlesnake - Crotalus viridis

Abundance: Vulnerable

Status: NSS4 (Bc)   NatureServe: G5 S5

Population Status: Widely distributed, populations appear stable, but are known declines due to humans directly killing.

Limiting Factor: Human: disturbances and direct killing continue to result in additional loss.

Comment: Changed to SGCN species. Classification changed to NSS4 (Bc). Due to increasing threats. Most populations appear stable, but individuals typically killed upon sight and have led to population declines. Increasing human population will likely result in additional Prairie Rattlesnake population declines.

Introduction

In Wyoming, Prairie Rattlesnakes occur in all counties east of the Continental Divide and in Carbon County west of the Divide. The Prairie Rattlesnake's diet consists of rodents such as ground squirrels, prairie dogs, chipmunks and cottontail rabbits, as well as amphibians, lizards, other snakes, and birds. They hunt during the cooler parts of the day (Baxter and Stone 1985). Prairie Rattlesnakes bear 4 to 21 live young in August or September (Baxter and Stone 1985). Females generally reproduce biennially, but some may reproduce annually or triennially (Ernst and Ernst 2003). They overwinter in large aggregations in deep underground crevices, prairie dog burrows, or other abandoned mammal burrows and usually emerge in April or May. Not averse to water, Prairie Rattlesnakes are occasionally found swimming in large reservoirs (Baxter and Stone 1985).

Habitat

Prairie Rattlesnakes can be found in the plains, foothills, scarp woodlands, and near granite or limestone outcrops (Baxter and Stone 1985). They are often found near rocky outcrops, talus slopes, rocky stream courses, and ledges (Stebbins 2003). They were formerly abundant in shortgrass plains, where they favor black-tailed prairie dog towns, though populations in these areas have declined (Baxter and Stone 1985).

Problems

- Lack of basic information on the species presence, distribution, and ecology in Wyoming.
- Human disturbances (deliberate killing and hibernacula destruction) may be causing declines in the population or will cause declines in the future.

Conservation Actions

- Survey and monitor population distribution, status, and habitat assocations.
- Develop management recommendations based on resulting data.

Monitoring / Research

Conduct baseline surveys to gain a better understanding of Prairie Rattlesnake distribution in Wyoming.

Recent Developments

Baseline reptile and amphibian surveys were conducted in southwest Wyoming in 2009 and 2010 (Snoberger and Walker 2012), in southeast Wyoming in 2011 and 2012 (Snoberger and Walker 2013, 2014) and in northern Wyoming in 2013 and 2014. Several Prairie Rattlesnakes were documented during these surveys and detailed habitat data was collected at these locations (Snoberger and Walker 2012, 2013, 2014). Reptiles have received increased attention in Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

Ernst, C.H., and E.M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Books, Washington and London. 668pp.

Stebbins, R.C. 2003. A Field Guide to Western Reptiles and Amphibians. Third Edition. Houghton Mifflin Company, Boston. 336 pp.

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Snoberger, C.E. and Z.J. Walker. 2012. Reptile and amphibian habitat associations in southwest Wyoming. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Snoberger, C.E. and Z.J. Walker . 2012. Southwest Wyoming reptile and amphibian surveys 2009-2010 . Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Snoberger, C.E. and Z.J. Walker. 2014. Reptile and amphibian habitat associations in southeast Wyoming. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Prairie Rattlesnake (*Crotalus viridis*)

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Red-Sided Gartersnake - Thamnophis sirtalis parietalis

Abundance: Unknown

Status: NSSU NatureServe: G5T5 S5

Population Status: Restricted distribution, population numbers and threats are unknown.

Limiting Factor: Species found near permanent water along riparian corridors. Degree of habitat loss is unknown.

Comment: None.

Introduction

In Wyoming, the Red-sided Gartersnake is found east of the Continental Divide in lower elevations (Baxter and Stone 1985). It is considered common in the Sheridan, Wheatland, and Torrington areas. It may also be found in the Black Hills. The Common Gartersnake (Thamnophis sirtalis) is considered more cold tolerant than any other snake (Ernst and Ernst 2003). Its activity period may extend from March to November. Mating for this species typically occurs in the spring following general emergence from hibernacula. However, autumn breeding may occur with sperm stored inside the oviducts until spring. Red-sided Gartersnakes are ovoviviparous, with an average of 27 neonates born in late summer. Prey items for this species include aquatic vertebrates, amphibians, small mammals, and invertebrates. Carrion may also make up a portion of the diet. This species often dens communally in rock crevices, gravel banks, rock and earth dams, old wells, ant mounds, crawfish burrows, beaver and muskrat lodges, and rotting logs or stumps (Ernst and Ernst 2003). This species is normally not found in association with the Plains Gartersnake.

Habitat

The Red-sided Gartersnake is usually found near permanent water at lower elevations in the plains zone of Wyoming (Baxter and Stone 1985). It can be found in a variety of habitats including forest edges, drainage ditches, sloughs, canals, streams, rivers, ponds, marshes, meadows, pastures, old fields, fence rows, cemeteries, and other suburban habitats (Ernst and Ernst 2003). This species often dens communally in rock crevices, gravel banks, rock and earth dams, old wells, ant mounds, crawfish burrows, beaver and muskrat lodges, and rotting logs or stumps (Ernst and Ernst 2003).

Problems

- Lack of basic information on the species presence, distribution, and ecology in Wyoming.

Conservation Actions

- Develop management recommendations based on resulting data.
- Survey and monitor population distribution, status, and habitat assocations.

Monitoring / Research

Conduct baseline surveys to gain better understanding of species distribution within the state.

Recent Developments

Baseline reptile and amphibian surveys were conducted in southeast Wyoming in 2011 and 2012 (Snoberger and Walker 2013, 2014) and in northern Wyoming in 2013 and 2014. Several Red-sided Gartersnakes were documented during these surveys and detailed habitat data was collected at these locations (Snoberger and Walker 2013, 2014). Reptiles have received increased attention within Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

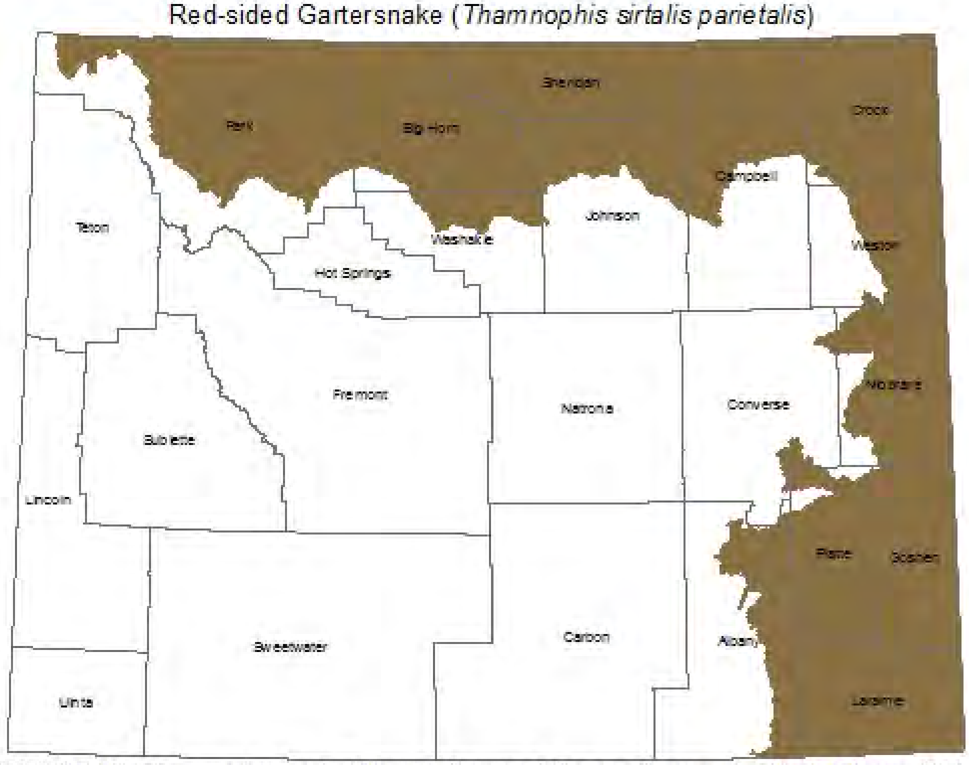
Ernst, C.H., and E.M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Books, Washington and London. 668pp.

Baxter, G.T. and M.D. Stone. 1985. Amphibians and Reptiles of Wyoming. Second Edition. Wyoming Game and Fish Department, Cheyenne. 137pp.

Snoberger, C.E. and Z.J. Walker. 2013. Southeast Wyoming reptile and amphibian surveys 2011-2012. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Snoberger, C.E. and Z.J. Walker. 2014. Reptile and amphibian habitat associations in southeast Wyoming. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Red-sided Gartersnake (*Thamnophis sirtalis parietalis*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Smooth Greensnake - Opheodrys vernalis

Abundance: Rare

Status: NSS3 (Bb) NatureServe: G5 S2

Population Status: Vulnerable due to restricted numbers and distribution, but extirpation is not eminent.

Limiting Factor: Habitat - the habitat for this species is restricted. Additionally habitat loss will result in loss of localized scattered populations.

Comment: None.

Introduction

Smooth Greensnakes occur in southeast and south-central Wyoming, as well as the Black Hills. Smooth Greensnakes may be active from April to October (Ernst and Ernst 2003). This species is primarily ground-dwelling, but will occasionally climb bushes. They can be secretive and difficult to find due to their camouflaged color when near green plants (Stebbins 2003). Smooth Greensnakes are most active during the warmer parts of the day and feed on insects and spiders (Baxter and Stone 1985, Ernst and Ernst 2003, Stebbins 2003). They hibernate underground, usually in aggregations. Ant mounds may occasionally be utilized for hibernacula (Ernst and Ernst 2003). Female greensnakes lay 2 to 12 eggs from June to September, sometimes hatching within a few days (Stebbins 2003). Oviposition may be communal and could occur in the same location in successive years (Redder et al. 2006). Hatchlings usually emerge from August to October. Preferred nest sites are piles of rotting vegetation, rotting logs and stumps, mammal burrows, and sawdust piles (Ernst and Ernst 2003).

Habitat

Smooth Greensnakes occupy habitats from prairies to open damp grassy areas. Populations can occur at lower elevations of the foothills and montane zones (Baxter and Stone 1985, Stebbins 2003). They can inhabit meadows, marsh and stream borders, open woodlands, and rocky habitats interspersed with grass (Ernst and Ernst 2003, Stebbins 2003). Smooth Greensnakes are rarely seen far from riparian areas and are often found under rocks, logs and other objects (Baxter and Stone 1985, Redder et al 2006).

Problems

- Lack of basic information on the species presence, distribution, and ecology in Wyoming. Because of their small reproductive output and short life span, loss of reproductive females (> age 3) could adversely affect population size and persistence (Redder et al. 2006).
- This species has restricted habitats in the state, therefore disturbance to these areas may affect the range of the species in Wyoming.
- Insecticides may be a threat to this species (Ernst and Ernst 2003).

Conservation Actions

- Survey and monitor population distribution, status, and habitat assocations.
- Develop management recommendations based on resulting data.

Monitoring / Research

Conduct baseline surveys to gain a better understanding of Smooth Greensnake distribution in Wyoming.

Recent Developments

Baseline reptile and amphibian surveys were conducted in southwest Wyoming and in the Smooth Greensnake's range near Savery and Baggs during the summers of 2009 and 2010 (Snoberger and Walker 2012). Unfortunately, no individuals were found during these surveys, but several local landowners and biologists began reporting their incidental observations of Smooth Greensnakes in the area. Baseline reptile and amphibian surveys were conducted in northern Wyoming in 2013 and 2014. Several Smooth Greensnakes were documented during these surveys and detailed habitat data was collected at these locations. Reptiles have received increased attention in Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

Ernst, C.H., and E.M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Books, Washington and London. 668pp.

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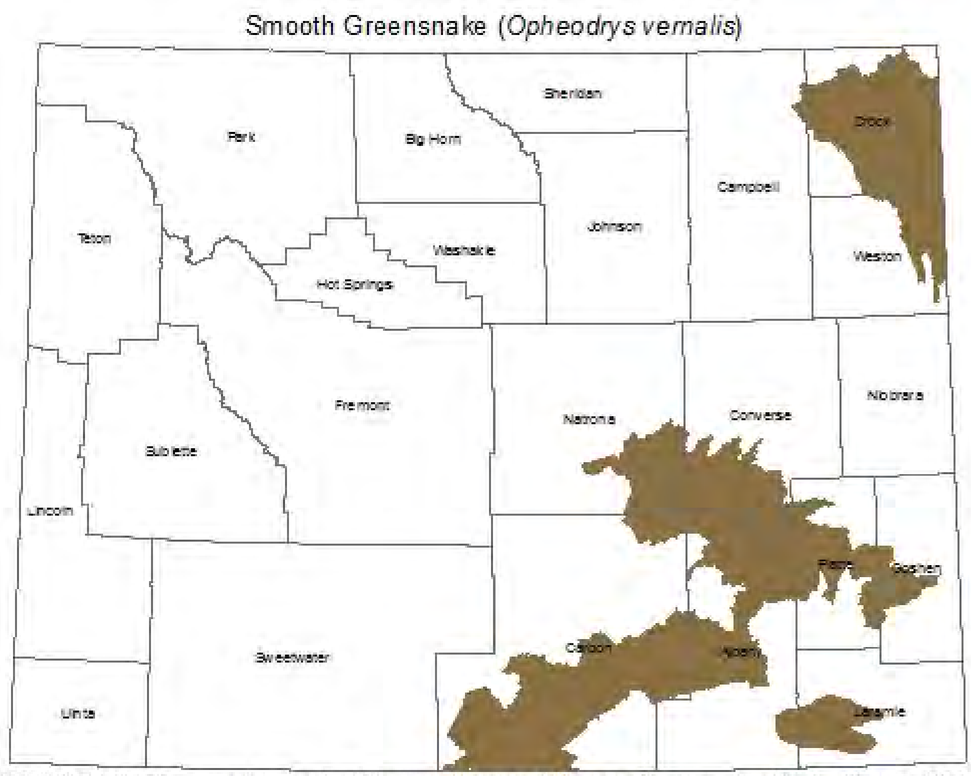

SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Valley Gartersnake - *Thamnophis sirtalis fitchi*

Abundance: Unknown

Status: NSSU NatureServe: G5TNR S2

Population Status: Restricted distribution, population numbers and threats are unknown.

Limiting Factor: Habitat - limited habitat. Species found near permanent water along corridors. Degree of habitat loss is unknown.

Comment: None.

Introduction

Valley Gartersnakes are found west of the Continental Divide, in Lincoln and Teton Counties. They may also intergrade with Red-sided Gartersnakes (a related subspecies) in the Black Hills (Baxter and Stone 1985). Valley Gartersnakes overwinter in dens that may contain hundreds of individuals and may overwinter with other species of snakes. They utilize rock and earth dams, gravel banks, rock crevices, stone causeways, old wells, ant mounds, beaver lodges, and rotting logs as hibernacula. Valley Gartersnakes may travel several kilometers between hibernacula and feeding ranges. They are primarily diurnal snakes, but can be active nocturnally to feed on breeding anurans. These snakes become active in March or April in Wyoming (Ernst and Ernst 2003). Valley Gartersnakes bear 3 to 85 live young between May and November. Valley Gartersnakes eat frogs, toads, fish, tadpoles, salamanders, birds, small mammals, reptiles, slugs, and earthworms (Stebbins 2003). They are good swimmers and climbers and may be found in the water (Ernst and Ernst 2003).

Habitat

Valley Gartersnakes inhabit lower elevation grasslands, woodlands, shrub brush, chaparral, forests, riparian areas, marshes, swamps, meadows, pastures, old fields, cemeteries, and vacant lots, usually near water or wet vegetation (Ernst and Ernst 2003, Baxter and Stone 1985). They utilize rock and earth dams, gravel banks, rock crevices, stone causeways, old wells, ant mounds, beaver lodges, and rotting logs as hibernacula.

Problems

- Lack of basic information on the species presence, distribution, and ecology in Wyoming.
- This species may have limited habitat in Wyoming and degree of this habitat loss is unknown.
- Human disturbances (deliberate killing and hibernacula destruction) may be causing declines in the population or will cause declines in the future.

Conservation Actions

- Survey and monitor population distribution, status, and habitat assocations.
- Develop management recommendations based on resulting data.

Monitoring / Research

Conduct baseline surveys to gain a better understanding of Valley Gartersnake distribution in Wyoming.

Recent Developments

Baseline surveys were conducted in southwest Wyoming in 2009 and 2010 to better understand herpetofaunal assemblages and distribution (Snoberger and Walker 2012). Many Valley Gartersnakes were documented during these surveys and detailed habitat data was collected at these locations (Snoberger and Walker 2012). During these surveys, a range extension for Valley Gartersnakes was documented in Lincoln County (Matthews et al. 2010). Reptiles have received increased attention in Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

Ernst, C.H., and E.M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Books, Washington and London. 668pp.

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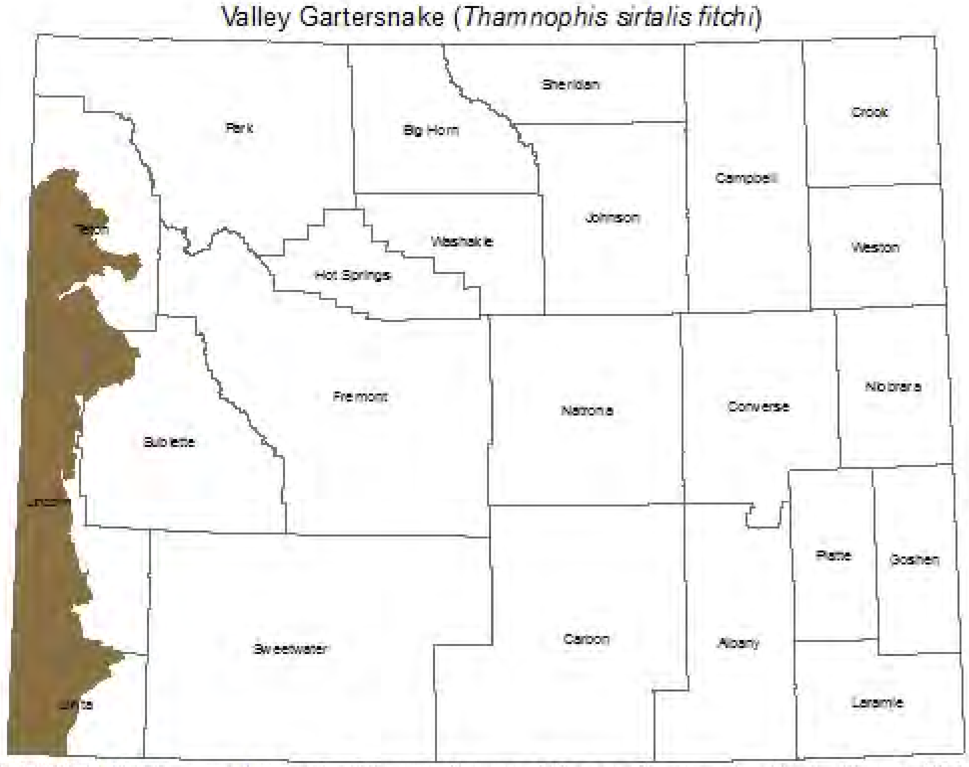
Matthews, C.E., H.J. Vogel, and L.A. Schreiber. 2011. Valley Gartersnake (Thamnophis sirtalis fitchi) geographic distribution. Herpetological Review 42:116.

Valley Gartersnake (*Thamnophis sirtalis fitchi*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Western Painted Turtle - *Chrysemys picta bellii*

Abundance: Rare

Status: NSS4 (Bc) NatureServe: G5T5 S4

Population Status: Vulnerable due to restricted distribution, but extirpation is not eminent.

Limiting Factor: Habitat: restricted to low elevation habitats within the Missouri River drainage.

Comment: None.

Introduction

In Wyoming, Western Painted Turtles range in the eastern counties below 6,000 feet and are abundant near Wheatland, the Powder River, and Muddy Creek in Laramie County. Western Painted Turtles forage in water and feed on fish, aquatic plants, insects, crayfish, mollusks, and amphibians (Baxter and Stone 1985, Stebbins 2003). They are most active from March through October. Western Painted Turtles are diurnal and spend the night at the bottom of a water body or on a partially submerged object (Ernst et al. 1994). They often are found sunning themselves on banks or logs at the edge of the water (Baxter and Stone 1985, Stebbins 2003). Western Painted Turtles overwinter in the soft bottoms of waterbodies, in muskrat lodges or burrows, underneath overhanging dirt banks, or on land in floodplain woods or pastures (Ernst et a. 1994). Females deposit 1 to 22 eggs in soft soil (Stebbins 2003); nesting usually occurs from late May to July (Ernst et al. 1994). In Wyoming, hatchlings may overwinter in the nest and emerge in April or May (Baxter and Stone 1985, Ernst et al. 1994). Western Painted Turtles have been common in the pet trade, but have become less common because they sometimes carry salmonella (Baxter and Stone 1985).

Habitat

Western Painted Turtles live in swampy habitats, marshes, small lakes, ponds, ditches, and muddy streams (Baxter and Stone 1985, Stebbins 2003). They prefer areas with slow-moving shallow water, soft bottoms, basking sites, and aquatic vegetation (Ernst et al. 1994).

Problems

- Lack of basic information on the species presence, distribution, and ecology in Wyoming.
- This species has restricted habitats in the state, therefore disturbance to these areas may affect the range of the species in Wyoming.

Conservation Actions

- Survey and monitor population distribution, status, and habitat assocations.
- Develop management recommendations based on resulting data.

Monitoring/Research

Conduct baseline surveys to gain a better understanding of Western Painted Turtle distribution in Wyoming.

Recent Developments

Baseline reptile and amphibian surveys were conducted in southeast Wyoming in 2011 and 2012 (Snoberger and Walker 2013, 2014) and in northern Wyoming in 2013 and 2014. Several Western Painted Turtles were documented during these surveys and detailed habitat data was collected at these locations (Snoberger and Walker 2013, 2014). Reptiles have received increased attention in Wyoming. Incidental observations are encouraged to be reported to the herpetology program.

References

Ernst, C.H., J.E. Lovich, and R.W. Barbour. 1994. Turtles of the United States and Canada. Smithsonian Institution Press, Washington and London. 578pp.

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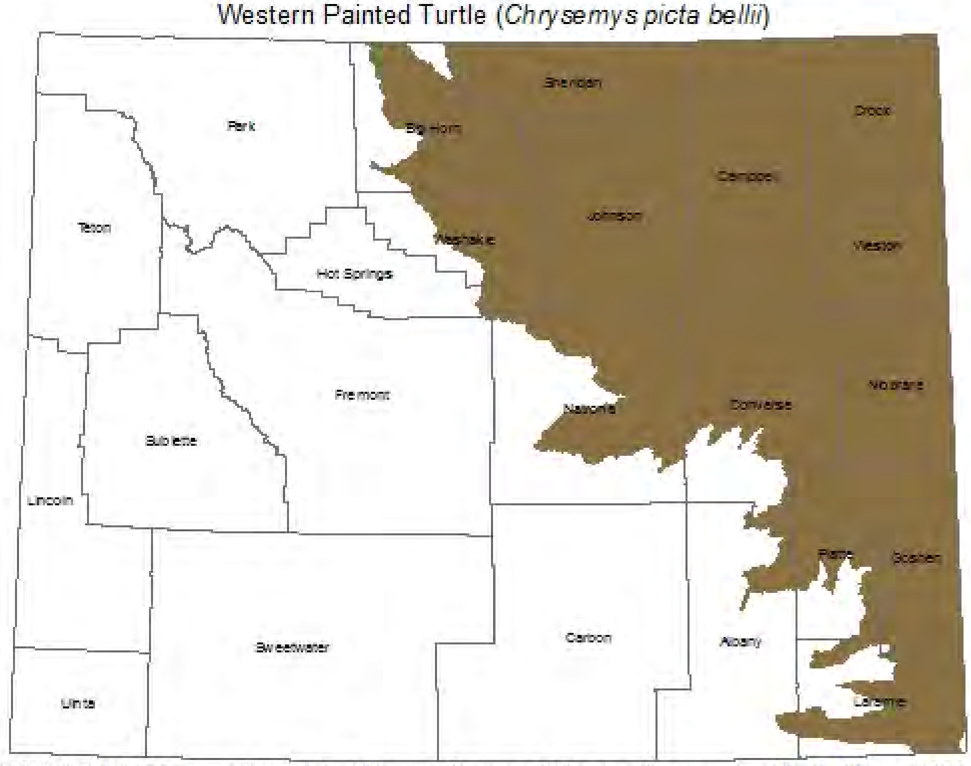
Snoberger, C.E. and Z.J. Walker. 2014. Reptile and amphibian habitat associations in southeast Wyoming. Wyoming Game and Fish Department Administrative Report. Cheyenne, Wyoming.

Western Painted Turtle (*Chrysemys picta bellii*)



SOURCE: Digital maps of ranges for Wyoming Species of Greatest Conservation Need: February 2016. Wyoming Game and Fish Department. Note that brown indicates the current known range of the species.

2017

Reviewing and Updating the SWAP

Congressional guidelines for State Wildlife Action Plans (SWAP) require they contain "descriptions of procedures to review the plan at intervals not to exceed 10 years." The WGFD plans to follow this timeline to continue to be proactive in conserving Wyoming's Species of Greatest Conservation Need (SGCN) and their habitats.

Updating Activities Prior to the 2015 Revision of the SWAP

The WGFD's Habitat Technical Advisory Group (HTAG) annually reviews and makes funding recommendations for the State Wildlife Grant (SWG) program and other sensitive species projects. HTAG will continue its role in facilitating interagency coordination on SWAP-related issues, including providing recommendations to the WGFD's administration on potential updates to Wyoming's SWAP in response to research, changing threats, partnership opportunities, and state or federal initiatives or directives.

The Wyoming SGCN Species Account Database will be continually updated cooperatively by the WGFD and Wyoming Natural Diversity Database as new information becomes available. Copies of SGCN Species Accounts are electronically available to the public. Each species account identifies information that was included in the last USFWS approved version of the SWAP and what has been subsequently added, but not formally incorporated into the approved plan.

Changes to SGCN designations will be considered on an ongoing basis as compelling information becomes available. Decisions regarding SGCN re-classifications will be made by the WGFD Director's Office and reviewed by the Wyoming Game and Fish Commission (WGFC) before being submitted to the USFWS for approval. Progress in surveying SGCN is reported annually in the WGFD Governor's report of agency performance measures.

Preparing for the 2027 Revision

Wyoming's SWAP is currently planned to be revised in 2027. The formal revision of the SWAP will begin 18 months prior to the date the SWAP is to be submitted to the USFWS for approval. The revision process will include:

1. The WGFD will publically announce its intentions to revise the SWAP on its website and through news releases. Announcements will include information on how to submit suggestions on potential SWAP changes and improvements.
2. Any changes to federal SWAP revision guidelines, including the eight required congressional elements for SWAPs, will be reviewed and incorporated.
3. Key individuals within the WGFD, partnering agencies, and stakeholders will be surveyed regarding 2017 SWAP successes and areas of improvement.
4. Successes in achieving conservation and monitoring recommendations identified in the 2017 SWAP will be quantified.
5. Wyoming's SGCN will be reviewed for potential changes in status and conservation priority.
6. Priority area maps will be re-evaluated based upon updated SGCN designations and distribution information and land use GIS data layers.
7. The 2017 SWAP terrestrial habitat types, aquatic basins, and leading wildlife conservation challenges sections will be distributed within the WGFD and externally to key wildlife and natural resource conservation stakeholders for suggested improvements.
8. Drafts of the revised SWAP will go through an internal and external comment period before it is submitted to the WGFC and USFWS for approval.

Public Participation

Public involvement and support are critical to the success of Wyoming's State Wildlife Action Plan (SWAP) and to the state's ability to meet the requirements of Element 7 of the Congressional SWAP guidelines, which requires each state's SWAP to have "an effective public participation process."

Public involvement in the SWAP has been divided into three components:

- Public outreach since the 2010 SWAP revision.
- Public involvement in the 2017 revision of the SWAP.
- Future public involvement in SWAP.

Public Outreach since the 2010 SWAP Revision

Public Access to Wyoming's SWAP
Wyoming's SWAP, has been posted on the WGFD's website since its completion in 2010. The SWAP, along with information on how to access it on the Internet, is commonly referenced in WGFD articles on SGCN and SWAP implementation projects.

WGFD Outreach Tools
The WGFD distributes information to the public through its website; its monthly *Wyoming Wildlife* magazine; monthly regional newsletters; radio and television news releases; emails; and social media including Facebook, YouTube, and Twitter. These sources have been used to feature articles about the SWAP, SWAP projects, leading conservation issues, and Wyoming SGCN.

Annual Sensitive Species Funding Reports
Information about work on individual wildlife species including SGCN is provided in the WGFD's Annual Report. SWAP projects and other sensitive-species work for birds and mammals are available in the WGFD's annual Nongame Annual Completion Report. These reports are available on the WGFD's website https://wgfd.wyo.gov/Hunting/Job-Completion-Reports.

Public Involvement in the 2017 SWAP Revision

In November 2015, a presentation to the Wyoming Game and Fish Commission was given about Wyoming's SWAP, SGCN, and the WGFD's intentions to revise its SWAP. Commission meetings are open to the public, and time is allocated for questions and comments from the audience on each subject discussed. Meeting agendas are posted on the WGFD's website three weeks prior to meetings.

At a Commission meeting in January 2016, the Commission approved a revised list of SGCN. In March 2016, a press release was distributed and posted on the WGFD's website which explained SWAP revision plans and changes to Wyoming's SGCN list. The website posting provided a place for public comment on Wyoming's 2010 SWAP. The comment link was maintained throughout the revision process.

Website Posting and Public Announcements of Revised SWAP
A draft of Wyoming's revised 2017 SWAP was posted on the WGFD's website on March 21, 2017. This posting was accompanied by a press release and website announcement regarding completion of revisions, changes that were made, where to view document, and how to provide comments on the Department's website. The comment period lasted until May 22. 2017.

On April 4th Wyoming Public Radio featured a story on Wyoming's revised SWAP and the public comment process. A video segment on the same subject ran on Wyoming local news television stations the on April 23rd. The Department also conducted a Facebook Live meeting on the revised SWAP on May 3rd. The event reached 6,357 individuals.

Public comments were incorporated and a final document was presented to the Wyoming Game and Fish Commission in July. This meeting provided an additional opportunity for the public to make comments on the 2017 SWAP prior to it being formally approved by the Commission and submitted to the U.S. Fish and Wildlife Service.

Coordination with Partners

Numerous agencies, organizations, and individuals participated in the 2010 and 2017 revision of Wyoming's SWAP by providing input and reviewing draft documents. These individuals are listed at the end of sections within each chapter. Additionally, member organizations of the SWAP Interagency Advisory Team which was active throughout the 2010 revision process where contact again by letter in April 2016 for input on improvements for the 2017 revised plan. Participants in the revision process brought varying perspectives from their organizations and constituencies.

Public Involvement in the Implementation of the SWAP and Future Revisions

Wyoming's 2017 SWAP was organized and written specifically to be accessible to the public. The selection of terrestrial and aquatic habitat classification units, the design of maps, the inclusion of background information on threats and current conservation initiatives, and the avoidance of jargon were all intentional strategies, chosen to enhance public understanding of wildlife threats and recommended conservation actions.

The WGFD's website will continue to have a page dedicated to the SWAP where the revised plan will be permanently housed along with articles and links to information on SWAP projects and SGCN. The USFWS is also creating a Wildlife TRACS (Tracking and Reporting on Actions for Conservation of Species) website which will visually display the location and results of State Wildlife Grant projects.

Through the SWAP interagency Advisory Team and in regards to specific species and issues, the WGFD will regularly engage stakeholders and partners to coordinate SWAP associated activities. The public will be notified about proposed updates to the SWAP prior to its next revision through WGFD publications, and opportunity will be provided for public input.