THREATENED, ENDANGERED, AND NONGAME BIRD AND MAMMAL INVESTIGATIONS

Wyoming Game and Fish Department Nongame Program
Statewide Wildlife and Habitat Management Section
Wildlife Division

Annual Completion Report

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Wyoming Governor's Big Game License Coalition (WG BGLC)
Wyoming Governor's Endangered Species Account Fund (WG ESAF)
Wyoming State Legislature General Fund Appropriations (WSL GFA)

OVERVIEW OF NONGAME PROGRAM PROJECTS AND FUNDING SOURCES

Species or project	BLM CA	BOR CA	GNLCC	IFGD	MFWP	NFWF	NPS CA	USACE	USFWS CA	USFWS S6	USFWS SWG	USFS BNF	USFS CA	WDFW	WAFWA	WGFD	WG BGLC	WG ESAF	WSL GFA
Black-footed Ferret										X	X								X
Trumpeter Swan	X								X										X
Secretive Marsh Birds																			X
Grassland Avian SGCN monitoring																X			X
Bald Eagle monitoring								X											X
Peregrine Falcon monitoring																			X
Juniper Obligate Avian SGCN											X								
WYPIF and IMBCR	X						X				X		X						X
Bat hibernacula and surveillance											X								X
Bats surveys in the Zone of											X								
Juniper Obligate Mammalian SGCN											X								X
Wyoming Pocket Mouse																		X	
Water Vole											X	X							X
Wolverine distribution			X	X	X	X					X		X	X		X			X

Species or project	BLM CA	BOR CA	GNLCC	IFGD	MFWP	NFWF	NPS CA	USACE	USFWS CA	USFWS S6	USFWS SWG	USFS BNF	USFS CA	WDFW	WAFWA	WGFD	WG BGLC	WG ESAF	WSL GFA
Spotted Skunk																	X	X	
Falconry	X															X			
Breeding Bird Survey	X	X					X		X				X						X
White-tailed Prairie Dog SPV									X		X								X
Central Flyway NMBTC																X			X
WY Bird Records Committee	X																		X
Greater Sage-Grouse umbrella											X								
Black-backed Woodpecker																		X	
Black Rosy-Finch											X								X

PREFACE

Most Wyoming residents and visitors know and cherish the thought of the state being rich in wildlife diversity. There is strong public interest in wildlife conservation and, along with that interest, high expectations. A 2011 national survey by the U.S. Fish and Wildlife Service (http://digitalmedia.fws.gov/cdm/singleitem/collection/document/id/858/rec/10) found that, in addition to $797 million spent on hunting and fishing in Wyoming, over $350 million was added to the state's economy by wildlife watchers. Wyoming is also rich in other natural resources that contribute to our economy, such as oil, gas, coal, livestock forage, timber, and a variety of minerals. However, sometimes the best management of one or more resources can conflict with the needs of another.

Over the past few decades, public expectations of wildlife managers have diversified. Unfortunately, traditional funding sources were not sufficient to meet these new demands. In 2005, Wyoming's Legislature approved general fund appropriations for the Wyoming Game and Fish Department's (Department) Veterinary Services section, Greater Sage-Grouse conservation, and fisheries work. In 2008, Wyoming's Legislature and former Governor Freudenthal agreed to increase appropriations to fund the Department's Terrestrial Nongame Program in order to boost data collection and strengthen management for Wyoming's nongame species, particularly those considered sensitive. In the following biennium budget sessions, funding for these Department programs, as well as the Wyoming Wildlife and Natural Resources Trust, has continued. Funding of nongame efforts is a significant and progressive expansion of the Legislature's support for natural resources in Wyoming. The expectation that accompanies such funding is to develop the information base and expertise to allow for effective decision making associated with resource management and to avoid unnecessary conflicts and restrictions.

These expectations are similar to the expectations associated with the Department's past portfolio of funding sources for nongame, but they are more targeted. In the past, the Department's nongame efforts were funded primarily by user fees collected from hunting and fishing. Many of the hunting and fishing public recognizes that sound management of nongame fish and wildlife helps provide additional support for maintaining functioning ecosystems for game species. Yet, for most of us, there is a limit to how user fees should be spent on management of non-target wildlife.

Over the past two decades, at both the national and state level, a number of efforts have focused on find alternate funding for nongame species conservation. Many of the same individuals contributing to Wyoming's economy through expenditures associated with hunting, fishing, and wildlife watching were, no doubt, involved in intense national lobbying efforts to develop nongame funding.

In response, Congress established the federally funded State Wildlife Grants (SWG) program in 2000. Since then, the Department has received over $6 million of SWG funds to address data needs for nongame birds, mammals, fish, amphibians, and reptiles, and to collect information that may provide an early warning of species heading for a potential listing under the

Endangered Species Act. Most states tended to focus SWG projects on species that would grab the attention of supporters and Congress who debate federal budgets on an annual basis. But the expectations associated with SWG also extend to species like the American pika or Harlequin Duck that are high on the interest scale for wildlife watchers but have little potential for conflict with other resource users because of the habitats they occupy in the state.

During the early years of SWG funding, we tended to focus on planning efforts that produced documents such as the Trumpeter Swan Habitat Enhancement Project, Wyoming Bird Conservation Plan, A Plan for Bird and Mammal Species of Greatest Conservation Need in Eastern Wyoming Grasslands, and A Comprehensive Wildlife Conservation Strategy in Wyoming. The latter planning document, approved in 2005, provides guidance for development of more recent SWG proposals and was the foundation for the Wyoming State Wildlife Action Plan 2010, and the Wyoming State Wildlife Action Plan 2017, In Press. We have used SWG funding to develop and implement inventory methods for sensitive species, such as raptors, Harlequin Duck, American Bittern, Mountain Plover, Brewer's Sparrow, Sagebrush Sparrow, Sage Thrasher, swift fox, and northern flying squirrels. We have also used SWG funds to collect additional information on American pika; several species of bats; Canada lynx; fisher; northern river otter; pygmy rabbit; black-tailed and white-tailed prairie dogs; wolverine; and small mammals, including shrews and water voles.

Funding provided by the Wyoming State Legislature, Wyoming Governor's Endangered Species Account, and Western Association of Fish and Wildlife Agencies, as well as cooperative agreement funds from the Bureau of Land Management, US Fish and Wildlife Service, and US Forest Service, have greatly enhanced our ability to collect information on numerous species in Wyoming, including Species of Greatest Conservation Need. These funds have given us the opportunity to greatly increase our knowledge of distribution and abundance of these species, as well as allowing us to increase our understanding of what is needed for effective and proactive management of those species. These funds have also allowed us to work cooperatively with other entities, such as the University of Wyoming, Wyoming Natural Diversity Database, Bird Conservancy of the Rockies (formerly Rocky Mountain Bird Observatory), Audubon Rockies, and private contractors, as well as interested volunteers, to implement projects that will provide population status and trend information on additional Species of Greatest Conservation Need, such as the Ferruginous Hawk, Golden Eagle, Burrowing Owl, Upland Sandpiper, Grasshopper Sparrow, pocket mice, Preble's meadow jumping mouse, wolverine, and Wyoming pocket gopher. Finally, we have also had the opportunity to implement funds provided by the US Fish and Wildlife Service, including Section 6 funds, for several additional projects, such as a collaborative survey effort for Northern Goshawks in the Wyoming Range, a study to determine the potential effects of energy development on raptor populations in Wyoming, and systematic monitoring of white-tailed prairie dogs and the reintroduced population of black-footed ferrets in Shirley Basin.

The future remains uncertain as we navigate through economic and political challenges. Anthropogenic and environmental stressors, such as climate change, will undoubtedly continue to put a strain on the Department's ability to effectively meet our statutory mandate to manage all wildlife in Wyoming. In conjunction with our partners, we will continue this collaborative endeavor to conserve this unique and diverse resource on behalf of the citizens of Wyoming.

INTRODUCTION

The Nongame Program of the Wyoming Game and Fish Department (Department) was initiated in July 1977. This report summarizes the most recent nongame bird and mammal work conducted in Wyoming from 15 April 2015 through 14 April 2016, although the complete coverage of some work may be slightly outside of this reporting period. Nongame surveys and projects in this report have been conducted by Department personnel, other government agencies, non-governmental organizations, and individuals in cooperation with the Department. Cooperating agencies and individuals are listed in the individual completion reports, but we recognize that the listing does not completely credit the valuable contributions of the many cooperators, including Department Regional personnel and members of the public.

In October of 1987, a Nongame Strategic Plan was distributed; this plan was updated and renamed in May of 1996. The 1996 Nongame Bird and Mammal Plan (Plan) presents objectives and strategies for the management and study of nongame birds and mammals in Wyoming. As part of the State Wildlife Grants funding program to provide long-term conservation planning for those species most in need, information was gleaned from the Plan and other pertinent sources and compiled into A Comprehensive Wildlife Conservation Strategy for Wyoming, which was approved by the Wyoming Game and Fish Commission (Commission) on 12 July 2005. This has since undergone a 5-year revision, was renamed the Wyoming State Wildlife Action Plan, and was approved by the Commission in 2010, with a second revision currently occurring and expected to be completed in 2017. This Nongame Annual Completion Report presents information in 6 major sections that compliment these planning efforts: Threatened and Endangered species, Species of Greatest Conservation Need, raptors taken for falconry, other nongame surveys, technical committees and working groups, and an appendix that contains reports from other entities on projects that were conducted with Department assistance.

Legislative funding has enabled the Department to significantly expand nongame and sensitive species conservation efforts, enhancing our ability to inventory, initiate monitoring, and assess the status of many species of wildlife classified as sensitive in 2010. The FY09/10 biennium budget provided general fund appropriations to the Department for the first time for all aspects of its nongame/sensitive species program: $1.2 million Maintenance and Operations (M&O) budget for existing personnel and administrative support and $609,000 in direct general fund appropriations for sensitive species program projects. In addition, $1.3 million from the Governor's Endangered Species Account fund was provided to the Department to supplement sensitive species project work. We also used several sources of federal funding for specific projects. General fund appropriations for M&O were essential for normal duties and for personnel to manage all of the special projects in this report. Specific funding sources in addition to M&O budgets are identified for each specific report.

This proactive approach is Wyoming's most effective strategy in reducing the chance that a species will be listed as Threatened or Endangered under the federal Endangered Species Act. The Department's Nongame Program is geared toward collecting information that has practical application for understanding the status of each species, as well as identifying potential risks and

management actions that may be needed to secure the healthy status of those species needing some help.

This report serves several purposes. First, it provides summaries of nongame surveys for the benefit of the Department, other agencies, and individuals that need this information for management purposes. Second, it provides a permanent record of summarized data for future use. Although some of this information is in lengthy tables, it was felt that these data should be published rather than kept in the files of the Nongame Program staff. Some information, such as Bald Eagle and Ferruginous Hawk nest sites and bat roost locations, is sensitive and is not provided in this document. Those needing this information for purposes that will lead to better management of these species can request the data from the Nongame Program staff.

Common bird names used in this report follow the most recent American Ornithologists' Union guidelines and supplements. Mammal names follow the most recent Revised Checklist of North American Mammals North of Mexico.

THREATENED AND ENDANGERED SPECIES

ESTABLISHMENT OF THE MEETEETSE REINTRODUCTION AREA FOR BLACK-FOOTED FERRETS (*MUSTELA NIGRIPES*)

STATE OF WYOMING

NONGAME MAMMALS: Species of Greatest Conservation Need / Endangered Species – Black-footed Ferret

FUNDING SOURCE: United States Fish and Wildlife Service Section 6 Funds
United States Fish and Wildlife Service State Wildlife Grant
Wyoming State Legislature General Fund Appropriations

PROJECTION DURATION: 15 April 2016 – 14 April 2017

PERIOD COVERED: 15 April 2016 – 14 April 2017

PREPARED BY: Jesse Boulerice, Nongame Biologist

ABSTRACT

Thirty-five years after the rediscovery of black-footed ferrets (*Mustela nigripes*) in Meeteetse, efforts were conducted to re-establish a reintroduction area for ferrets at the same location. On 26 July 2016, 35 ferrets were released on the landscape to initiate a second reintroduction site for ferrets in Wyoming at the Meeteetse Reintroduction Area. This report summarizes the efforts conducted in 2016. Prior to ferret releases, 2,394 ha (5,916 acres) of white-tailed prairie dog colonies were mapped, and 2,032 ha (5,021 acres) of colonies were dusted with deltamethrin within the reintroduction area. Following releases, we conducted 30-day post-release surveys in September during which 19 of the 35 ferrets were observed. This number represents a minimum known alive estimate with high likelihood that additional ferrets survived their first month in the wild but were undetected during surveys. By all accounts, both the day of release at the site and the 30-day post release surveys suggested that the reintroduction was highly successful, and ferrets were given the best possible opportunity to establish at the Meeteetse Reintroduction Area.

INTRODUCTION

The year 2016 marked the 35-year anniversary of the rediscovery of black-footed ferrets (ferret, *Mustela nigripes*) in Meeteetse, a fortuitous moment that irrefutably saved the species from extinction and initiated one of the most successful wildlife conservation stories in history. On 26 September 1981, a rancher's cattle dog brought the carcass of a species thought to be extinct in the wild to the doorstep, where the discovery was soon made that a population of

ferrets was extant in the surrounding area. However, as conservationists and biologists began efforts to study this population, researchers soon determined that a disease outbreak was drastically reducing the number of ferrets in Meeteetse (WGFD 1987). A controversial decision was made to collect all remaining ferrets and place them into a captive breeding program such that the species would not be lost. This series of events led to a successful captive breeding program responsible for re-establishing ferrets at more than 30 locations throughout the West. However, since the last wild ferret was captured from Meeteetse in 1987, ferrets have not been returned to the landscape on which the species was rediscovered.

In 1991, after some earlier struggles with the captive breeding of ferrets were resolved, the program leaders determined that the time was right to return ferrets to the wild and establish reintroduction sites for ferrets. Two sites were selected for reintroduction, Meeteetse and Shirley Basin, a region of Wyoming containing one of the largest prairie dog colonies in North America (WGFD 1990a, b). Unfortunately, leading up to the planned reintroduction, prairie dogs in Meeteetse were still struggling from disease outbreak, and the release was postponed until conditions stabilized. Thus, Shirley Basin became the first and only reintroduction site in the world at that time (Luce et al. 1992). The population in Shirley Basin has survived for over 25 years, as indicated by regular monitoring (Boulerice 2016a, 2017a). However, the delay of reintroduction in Meeteetse proved to be long-term as focus shifted to maintaining ferrets in Shirley Basin, and as of 2015 Meeteetse remained without ferrets.

In 2015, the Wyoming Game and Fish Department (Department) and the US Fish and Wildlife Service (USFWS) finalized efforts to create a statewide 10(j) designation for ferrets in Wyoming, paving the way for the establishment of additional reintroduction sites (USFWS 2015). Given the historical significance of Meeteetse, efforts were reinvigorated to consider the site for reintroduction. Fortunately, the Department had initiated a project in 2013 to evaluate the efficacy of a new vaccine for combating the plague in prairie dogs at the Meeteetse site, and had been evaluating the prairie dog population from 2013 to 2015 (Boulerice 2016b). Since all indications suggested that Meeteetse could support a ferret population, plans were officially established to reintroduce ferrets in Meeteetse in 2016.

Establishment of a reintroduction site for ferrets requires that several conditions be met, as directed by the USFWS (BFFRIT 2016). For the Meeteetse Reintroduction Area, those requirements were met as follows: During preliminary mapping efforts initiated in 2015, >1,214 ha (3,000 acres) of white-tailed prairie dog (*Cynomys leucurus*) colonies were mapped, meeting the minimum acreage require. Additional acreage was recorded in 2016 (see below), with the knowledge that more colonies existed that have yet to be mapped. The Department also solicited and received a high level of support from the landowners with property included within the reintroduction area, namely Lenox Baker, owner of Pitchfork Ranch, and Alan Hogg, owner of Lazy BV Ranch, as well as the local community in Meeteetse. In addition, a Meeteetse Reintroduction Area Management Plan was drafted and approved in 2016, fulfilling the requirement to have a site-specific management plan in place prior to reintroduction (WGFD 2016).

In the spring of 2016, an allocation request for ferrets for the purpose of establishing a population at the Meeteetse Reintroduction Area was granted to the Department by the USFWS.

In July, 35 ferrets were released. As recommended by the USFWS, the Department also conducted 30-day post-release surveys to determine initial survival rates for ferrets during their first month in the wild. This report summarizes the efforts conducted by the Department leading up to and during the release, as well as the results of the post-release surveys at the Meeteetse Reintroduction Area in 2016.

METHODS

Mapping

Over the summers of 2015 and 2016, we mapped the distribution of white-tailed prairie dogs over a 16,200-acre (6,555ha) region within the Meeteetse Reintroduction area (Figure 1). The area included portions of land owned by Pitchfork Ranch, Lazy BV Ranch, and Dan Oschner, as well as Bureau of Land Management (BLM) and State of Wyoming (State Lands) lands. We used a combination of on-the-ground observations and aerial imagery to identify areas containing prairie dog burrows. We then circumscribed active colonies either on foot or by ATV while recording boundaries to GPS units. We determined the status of colonies (active vs. inactive) by confirming visual presence of prairie dogs above ground during mapping efforts. We uploaded GPS tracks denoting colony boundaries into ArcGIS 10 and used these tracks to generate shapefiles. We calculated the total acreage of colonies from the resulting shapefiles.

Dusting

Based on the distribution of colonies we recorded during mapping efforts, we selected a portion of the colonies to be dusted with deltamethrin (Delta Dust, Bayer Science Corporation, Research Triangle Park, NC). We selected specific areas to be dusted such that the dusted area would encompass the release locations of reintroduced ferrets, contained high densities of prairie dogs based on visual counts, and incorporated landownership types that would enable the dusting to occur primarily by ATV use (off-road ATV use on BLM lands was not permitted in 2016). Dusting efforts were contracted to USDA Wildlife Services and occurred on both private and BLM lands. Dusting was completed by a team of 4-5 people who navigated along north-south transects throughout the areas designated to be dusted by ATV or on foot and applied dust to every hole for which the end could not be seen (BFFRIT 2016).

Release Locations

We designated 35 specific locations where ferrets would be released (Figure 2). Each location included ≥1 burrow in which a prairie dog was observed 3 days prior to release and was within an area of high burrow density. In addition, we selected locations for 29 of the ferrets in accordance to spacing guidelines established by the USFWS, specifically such that ferrets are released 284 m apart and at a density ≤8 ha (20 acres) per ferret in high quality habitat and ≥30 ha (75 acres)per ferret on low quality habitat (BBFRIT 2016). We selected the remaining 6 ferret locations as “VIP” ferrets to be released by public figures where media was granted access. For these ferrets, USFWS guidelines were relaxed in order to accommodate the needs of a large crowd of people.

Release Day

On 26 July 2016 at approximately 1800, we released 35 ferrets within the Meeteetse Reintroduction Area. We conducted releases by dividing ferrets and releasers into several groups such that releases occurred simultaneously and within a short time period in order to minimize stress on the ferrets. All ferrets were released by opening the doors on the pet carriers in which the ferrets were delivered by the USFWS at the designated locations assigned above. Once released, we provided ferrets with a portion of prairie dog meat for nourishment. We removed all equipment from the site at the conclusion of releases.

30-day Post-release Surveys

We conducted post-release surveys during September 2016 to estimate the survival and dispersal distances of the 35 ferrets released in July. Similar to the survey design used in Shirley Basin, we divided the Meeteetse Reintroduction Area into a series of survey routes by designating sections in which established roads, fence lines, or other obstructions created logical divisions (i.e., circular routes and/or physical boundaries). Survey routes varied in size from 200-425 ha.

We surveyed for ferrets using the standard spotlighting method employed at many ferret reintroduction sites, including Shirley Basin (Boulerice 2016a). Specifically, we conducted surveys either by foot, truck, ATV, or a combination thereof, and used high-powered lights to locate the distinctive green eyeshine of ferrets. Where existing roads allowed truck travel within each survey route, we drove vehicles equipped with roof-mounted spotlights (Model RM 240 Blitz, Lightforce Professional Lighting Systems, Orofino, ID). To survey portions of each route not accessible by truck, we navigated by foot or ATV and used a backpack spotlight unit (Walkabout Kit, Lightforce Professional Lighting Systems, Orofino, ID) to detect ferrets and other wildlife. Off-road ATV use was only allowed on private lands within the reintroduction area, with permission from the landowners. Following the established protocol of Shirley Basin, we surveyed from 2000-2300 hours and 0130-0600 hours in blocks of 3 consecutive nights (Grenier 2008, Grenier et al. 2009). Unlike Shirley Basin, we conducted surveys in Meeteetse in pairs (2 people per survey route) in order to reduce the likelihood of grizzly bear (*Ursus arctos*) encounters throughout the reintroduction area.

After we detected ferrets, we used an unbaited live trap to attempt to capture observed individuals (Sheets 1972). We checked traps hourly throughout the night and removed all traps at sunrise. Once captured and still in the trap, we carefully marked ferrets along the neck with hair dye to indicate that a captured ferret did not need to be recaptured if observed later in the survey period. We then transferred ferrets into tubes made of corrugated plastic. In the transfer tubes, we read the passive integrated transponders (PIT tags; AVID Microchip I.D. Systems, Folsom, LA), with which all reintroduced ferrets were marked prior to release, with a pit tag reader through the tube (PIT tags could not be read while ferrets were in the metal traps). After recording the PIT tag number, ferrets were releases at the location of capture.

We determined the dispersal distance of ferrets observed during post-release surveys by calculating the distance between the location of observation in September from the release site in July.

RESULTS

At the completion of our mapping efforts for 2016, we located and recorded 2,394 ha (5,916 acres) of prairie dog colonies within the Meeteetse Reintroduction Area. Both on-the-ground observations and aerial image suggests that more acreage of colonies exists beyond what we were able to map as of 2016, especially to the west and north of the current mapping extent. In total, the USDA Wildlife Services team contracted to conduct the dusting effort dusted 2,031 ha and used 1,503 kg of dust within the Meeteetse Reintroduction Area (Figure 1).

We spent 224 hours during 6 nights spotlighting for ferrets from 13-15 and 19-21 September 2016 (Table 1). We surveyed a total of 3,505 ha. We surveyed 2 of the survey routes (routes 1 and 4; Figure 3) for 2 consecutive blocks of 3 nights, and in both cases ferrets were observed during the second set of surveys that were not observed in the first. In total, we detected 19 (54%) of the 35 ferrets we released. We recorded pit tag numbers for 18 of the 19 ferrets, as one ferret was observed just before dawn on 2 occasions and could not be read prior to completion of surveys. However, given the location of this observation relative to other observations, we are confident this is a unique individual.

From the 18 ferrets for which we could indentify to individual, we determined the average dispersal distance between late July and mid September to be 1,545 m (SE = 368.9 m). The greatest dispersal distance observed was 5,546 m (Table 2, Figure 4).

DISSCUSSION

By all accounts, both the day of release at the site and the 30-day post release surveys suggested that the reintroduction of black-footed ferrets at the Meeteetse Reintroduction Area was a great success. Landowners, members of the media, and all parties present on 26 July expressed a high-level of appreciation for the events that transpired on that day. Additionally, all 35 ferrets were released in a timely fashion without issue. Likewise, our results from the 30-day post-release surveys suggest that survival rates of the ferrets in Meeteetse were one of the highest among new reintroduction sites (typically <50%, J. Hughes, National Black-Footed Ferret Conservation Center, personal communication). Although a large amount of effort will still need to be expended to ensure that the ferret population becomes successfully established within the Meeteetse Reintroduction Area, the events of 2016 indicate that the population is off to a strong start.

Importantly, the 19 ferrets observed during our 30-day post release surveys represents only a minimum known alive estimate, and the likelihood is high that several additional ferrets survived the first month on the landscape but were undetected during surveys. The spotlighting technique used to survey for ferrets is known to result in a detection rate significantly <100%

even after 3 nights of surveys. This point was illustrated in 2016 in 2 cases when survey routes that were surveyed for 2 sequential blocks of 3 nights resulted in detections of ferrets during the second survey block that were not detected during the first. Likewise, the dispersal distances we observed suggested that several of the ferrets released are likely to have survived but could have easily dispersed into habitat outside of the area encompassed in our survey efforts. Therefore, we expect that the actual number of ferrets alive within the reintroduction area is greater than the 19 we observed, although all 35 are unlikely to have survived due to the inherent challenges associated with being released into the wild for the first time.

As is typical for all newly established reintroduction sites for ferrets, additional releases are scheduled to occur at the Meeteetse Reintroduction Area for 2-3 years (2017-2019) following the initial reintroduction. Assuming that the status of prairie dogs throughout the reintroduction area remains the same or improves, we recommend that the areas along the western portion of the colonies mapped at of 2016 (Figure 1) be considered as future release locations. In 2016, those regions contained high densities of prairie dogs which would have been ideal release locations. However, we were not permitted to release ferrets on state-owned lands in time for the releases in 2016. Future releases in this area could be a benefit to expanding the distribution of ferrets beyond what we observed here, especially since additional acreage of colonies likely occurs west of the current mapping extent.

We note that during the summer of 2016, a localized outbreak of sylvatic plague was discovered to be occurring within the Meeteetse Reintroduction Area (Boulerice 2017b). The status and spread of the outbreak will certainly require monitoring and management in the coming years in order to ensure the success of the prairie dog and ferret populations. Although the timing of the outbreak is not ideal, the occurrence of plague was not unexpected in Meeteetse given the documented history with the disease at the site. Nearly all other ferret reintroduction sites in North America also are currently dealing with plague-related issues (J. Hughes, personal communication). In addition, the dusting efforts completed in 2016 completely blanketed the area where prairie dog die-off was observed and may have been sufficient in reducing the spread of infected fleas. While we believe that the plague outbreak we reported in 2016 can be appropriately managed, we recommend that robust monitoring be implemented and management strategies be prepared to enable the Department to respond in a timely fashion, if required.

Boundary delineation for colonies of white-tailed prairie dogs is known to be a challenging undertaking, and we acknowledge some difficulties we experienced in mapping acreages at the Meeteetse Reintroduction Area. Since white-tailed prairie dogs do not actively "trim" vegetation like black-tailed prairie dogs (*C. ludovicianus*) and can exist at relatively low densities throughout the landscape, defining the edges of a colony can be subjective. In Meeteetse, we attempted to circumscribe areas that contained obvious colonies (i.e., moderate to high density of burrows). However, in many cases, portions of the area outside of our mapped colonies also contained active burrows at low densities. As such, we included some of these areas in our dusting and surveying efforts, as both fleas infected with plague and ferrets could still be exploiting the prairie dogs in these regions. The differences between areas in which we included in our colony mapping and where we dusted or surveyed can be viewed in Figures 1 and 3.

In sum, the initial efforts to establish a new reintroduction site for ferrets at the Meeteetse Reintroduction Area in 2016 appear to have transpired with a high level of success. The events associated with the release day, as well as the survival rates observed for ferrets after their first month in the wild, suggest that the population has been given a solid chance to establish thus far. Given the well-documented struggles that the population at the Shirley Basin Reintroduction Site experienced during the first decade following reintroduction, we anticipate similar challenges will occur in Meeteetse (Grenier 2008). Such challenges may well already be ongoing in Meeteetse with the outbreak of plague we observed in 2016. However, as a whole, the ferret conservation efforts taken in 2016 are something of which the Department, and everyone involved, should be proud. Undoubtedly, the Department is committed to ensuring that the ferrets within the Meeteetse Reintroduction Area become firmly established such that, once again, black-footed ferrets can roam as a wild, free-ranging population on the Meeteetse prairie.

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First and foremost, we extend a sincere thank you to L. Baker and M. Heggie of Pitchfork Ranch and A. Hogg and K. Hogg of Lazy BV Ranch for their support of all activities associated with the establishment of this reintroduction site on their properties. Without their support, this reintroduction would not be possible. Funding for this project was provided by the US Fish and Wildlife Service through Section 6 of the Endangered Species Act and State Wildlife Grants, for which we are extremely grateful. We thank the following contributors for their assistance with purchasing deltamethrin for dusting: BLM, USFWS, Associations of Zoos and Aquariums, Western Association of Fish and Wildlife Agencies, World Wildlife Fund (K. Bly), Wildlife Services – Texas, and Bayer Corporations. We are extremely appreciative to the USDA Wildlife Services, especially personnel who completed all dusting efforts, namely M. Foster, E. Hepler, and the field crew. We thank all employees of the USFWS that approved of and assisted with all aspects of establishing this site, including P. Gober, J. Hughes, K. Fraser, T. Trenton, and other staff working at the National Black-footed Ferret Conservation Center. We thank R. McKay, S. DiReinzo, D. Cunningham, and all those instrumental to the planning and implementation of the release day events. Thank you to everyone who assisted with ferret releases in July. We are thankful to all those who assisted with 30-day post-release surveys. Thank you to the Pitchfork Ranch and the US Forest Service for providing lodging accommodations for our team. We also wish to recognize the contributions of J. Hogg and L. Hogg for everything that we know of ferret conservation today. Finally, thank you to Shep, the dog.

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Table 1. Survey effort expended while spotlighting for black-footed ferrets (*Mustela nigripes*) during 30-day post-release surveys at the Meeteetse Reintroduction Area, Wyoming during September 2016. A total of 224.0 hours of spotlighting was conducted by vehicle and on foot throughout white-tailed prairie dog (*Cynomys leucurus*) colonies. Surveys conducted by ATV were counted in the driving total.

Dates	Walking	Driving	Total
13-15 Sep.	77.3	26.4	103.7
19-21 Sep.	85.0	35.3	120.3
Total	**162.3**	**61.8**	**224.0**

Table 2. Details for the 35 black-footed ferrets (*Mustela nigripes*) reintroduced at the Meeteetse Reintroduction Area in July 2016 and the dispersal distance of the 18 ferrets observed during 30-day post release surveys conducted September 2016. In total, 19 ferrets were observed during post-release surveys, but the PIT tag number from one animal was not recorded. Average dispersal distance was 1,545 km (SE = 368.9 m).

Release location	Sex	DOB	PIT tag number	Observed post-release	Dispersal distance (m)
1	F	28-Mar.	836-513-844	Y	486.79
2	M	2-Apr.	836-541-587	Y	2978.34
3	F	4-Apr.	836-381-524	Y	1054.56
4	M	8-Apr.	836-353-027	Y	4815.04
5	F	15-Apr.	836-538-629	N	
6	M	17-Apr.	836-530-543	Y	1216.17
7	F	2-Apr.	836-575-349	Y	434.89
8	M	17-Apr.	836-517-866	N	
9	M	28-Mar.	836-520-773	N	
10	F	8-Apr.	836-534-302	N	
11	F	22-Jun.	018-772-835	N	
12	F	8-Apr.	836-542-515	Y	1343.3
13	M	4-Apr.	836-538-124	N	
14	F	2-Apr.	836-516-812	Y	1936.18
15	F	16-Apr.	836-541-606	Y	508.59
16	F	17-Apr.	836-380-306	N	
17	M	4-Apr.	836-358-632	Y	217.15
18	F	28-Mar.	836-517-875	Y	171.29
19	M	17-Apr.	836-538-258	N	
20	F	4-Apr.	836-528-056	Y	1441.88
21	F	4-Apr.	836-529-610	N	
22	M	8-Apr.	836-542-038	N	
23	F	28-Mar.	836-518-019	N	
24	M	4-Apr.	836-521-821	Y	2970.63
25	M	2-Apr.	836-382-330	Y	873.89
26	F	4-Apr.	836-523-824	Y	782.11
27	F	15-Apr.	836-538-593	N	
28	F	2-Apr.	836-380-591	Y	744.68
29	M	16-Apr.	836-382-770	N	
30	M	17-Apr.	836-382-262	Y	5546.63
31	M	18-Apr.	836-545-775	Y	302.51
32	F	16-Apr.	836-543-790	N	
33	F	4-Apr.	836-523-045	N	
34	M	8-Apr.	836-525-844	N	
35	F	2-Apr.	836-522-321	N	

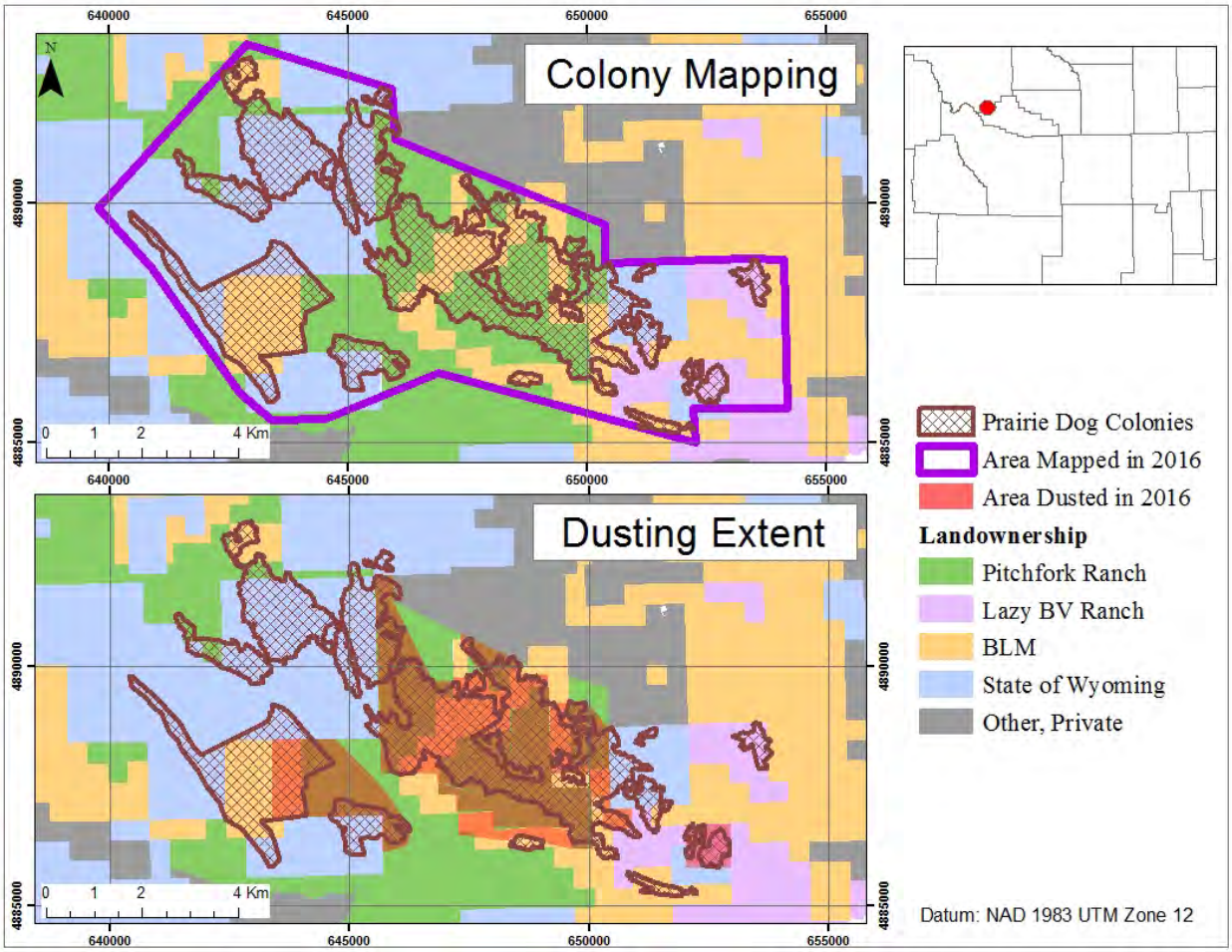

Figure 1. Distribution of white-tailed prairie dogs (*Cynomys leucurus*) mapped within the Meeteetse Reintroduction Area and the extent of dusting efforts in conducted in 2016. In total 2,394 ha (5,916 acres) of prairie dog colonies were mapped, and 2,032 ha (5,021 acres) were dusted in 2016.

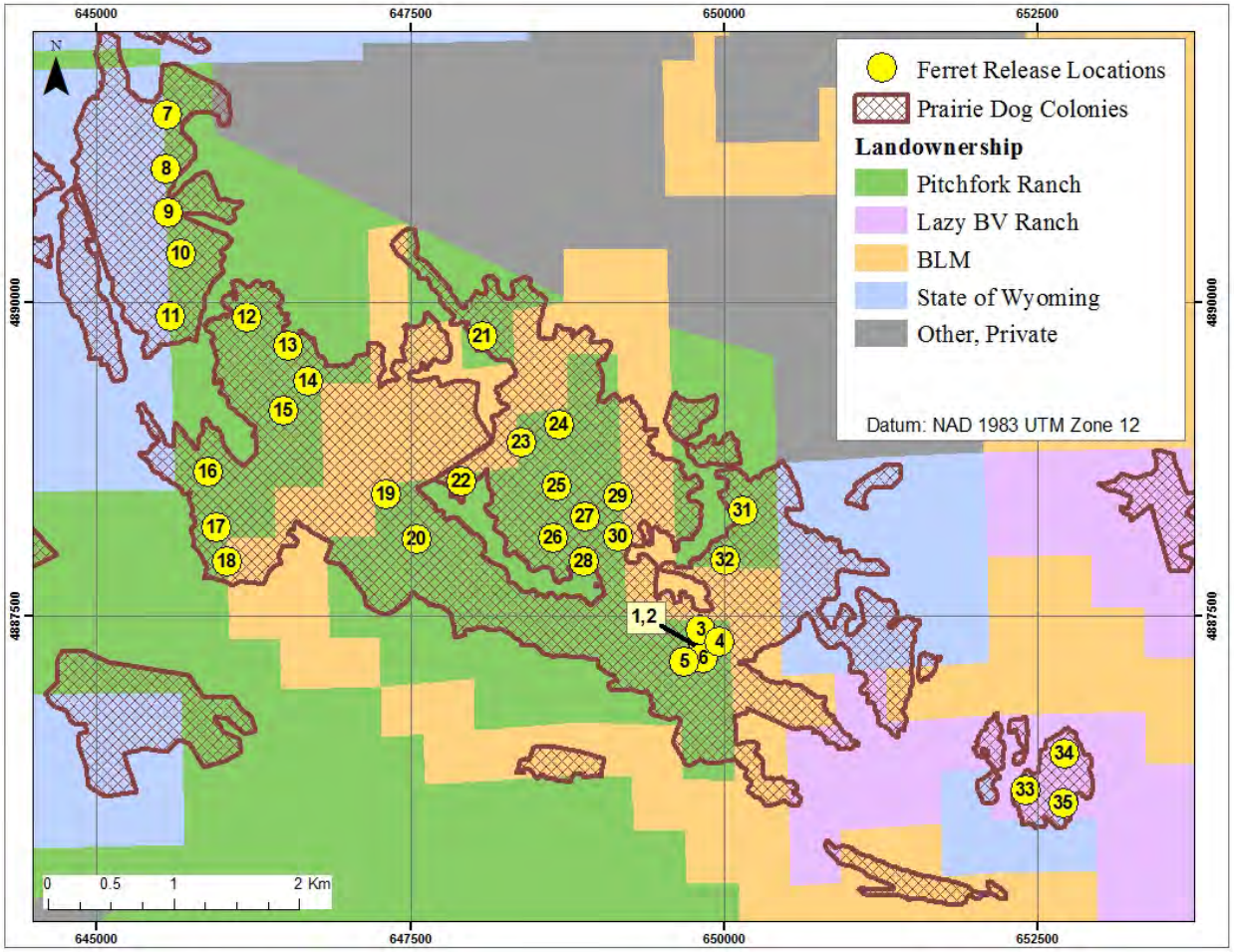

Figure 2. Locations of the 35 black-footed ferrets (*Mustela nigripes*) released in the Meeteetse Reintroduction Area on 26 July 2016. Locations 1 and 2, labeled within the tan rectangle, cannot be seen on the map due to overlap with locations 3-6. Spatial distributions of ferret releases occurred in accordance with USFWS guidelines, specifically such that ferrets were released 284 m apart and at a density ≤8 ha (20 acres) per ferret in high quality habitat and ≥30 ha (75 acres) per ferret on low quality habitat (BBFRIT 2016).

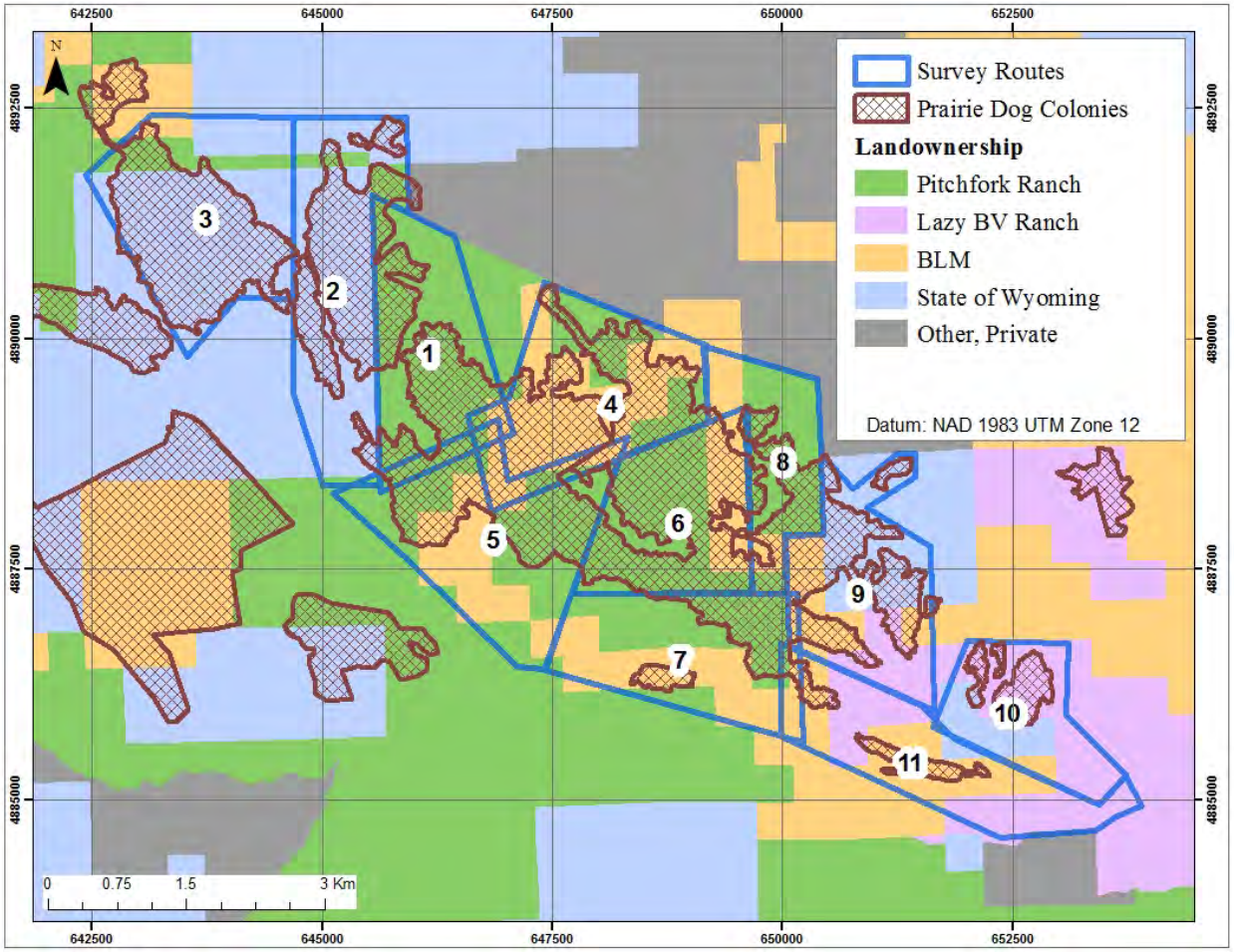

Figure 3. Spatial arrangement of survey routes created and surveyed during 30-day post release surveys at the Meeteetse Reintroduction Area in September 2016.

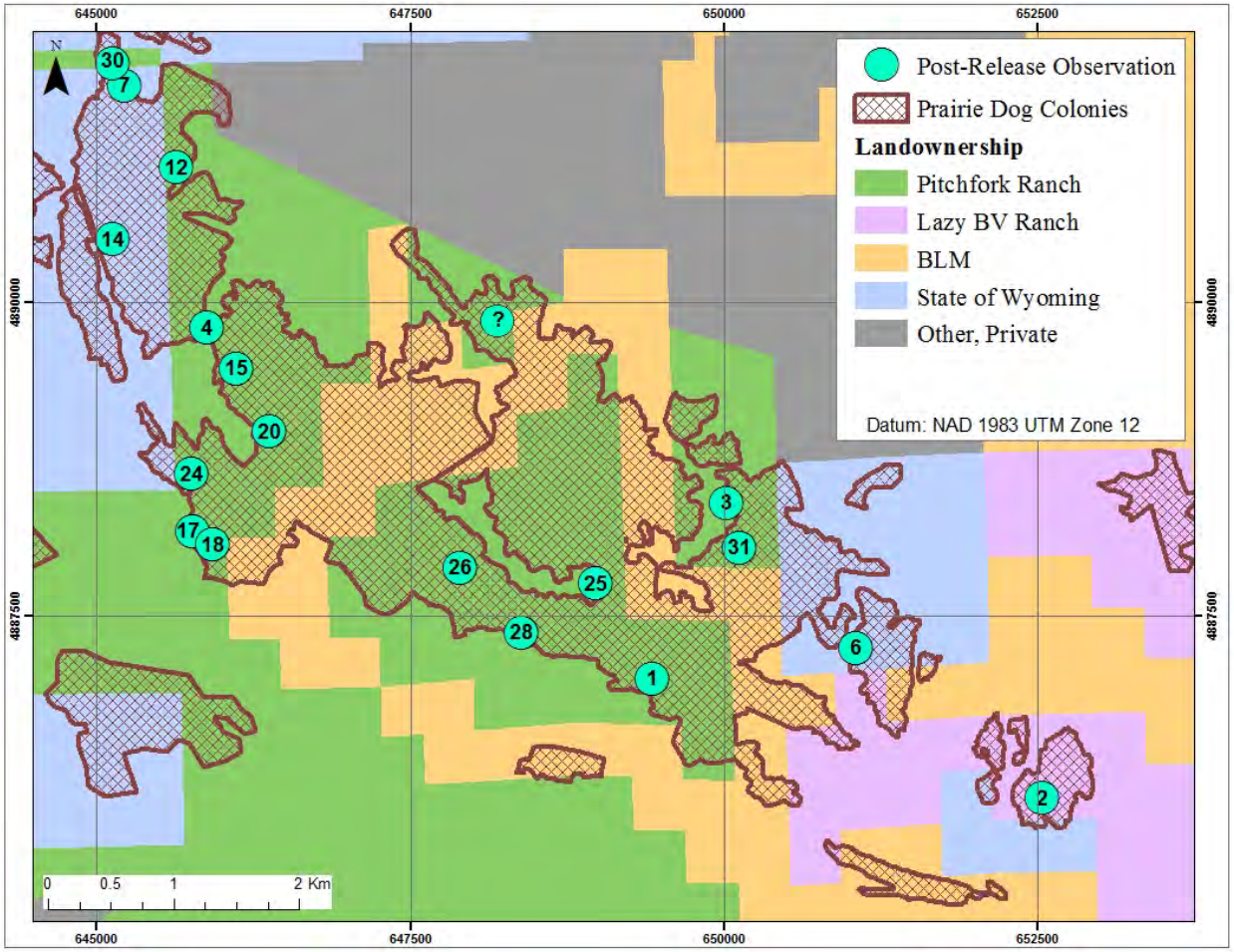

Figure 4. Locations of black-footed ferrets (*Mustela nigripes*) observed during 30-day post-release surveys conducted within the Meeteetse Reintroduction Area in September 2016. Of the 19 ferrets observed, the uniquely identifying PIT tag number was unable to be read on one animal denoted by the "?" on the map. The average dispersal distance from where a ferret was released in July to where the same individual was observed in September was 1,545 km (SE = 368.9 m).

SPOTLIGHTING FOR BLACK-FOOTED FERRETS (*MUSTELA NIGRIPES*) IN THE SHIRLEY BASIN/MEDICINE BOW MANAGEMENT AREA

STATE OF WYOMING

NONGAME MAMMALS: Species of Greatest Conservation Need / Endangered Species – Black-footed Ferret

FUNDING SOURCE: United States Fish and Wildlife Service Section 6 Funds
United States Fish and Wildlife Service State Wildlife Grant
Wyoming State Legislature General Fund Appropriations

PROJECTION DURATION: Annual

PERIOD COVERED: 15 April 2016 – 14 April 2017

PREPARED BY: Jesse Boulerice, Nongame Biologist

ABSTRACT

The black-footed ferret (*Mustela nigripes*) faces numerous challenges to recovery, including diseases, which remain the biggest threat to the persistence of the black-footed ferret in Shirley Basin, Wyoming. Releases of black-footed ferrets in the Basin were initiated in 1991 but were terminated in 1994 as a result of sylvatic plague and disease epizootics, which reduced abundance of its prey, the white-tailed prairie dog (*Cynomys leucurus*) within Primary Management Zone 1. During this period, the reintroduced population was characterized by slow population growth. However, the black-footed ferret survived this bottleneck, and the population increased exponentially from 2000-2006 before transitioning to logistical growth from 2006-2010. In 2013-2015, a dramatic decline was observed, predicted to be due to low recruitment of prairie dogs during 2011-2012 caused by drought conditions. In 2016, we spotlighted and captured black-footed ferrets in August following the same protocol as in previous years. We obtained a total of 77 observations of black-footed ferrets, and determined the minimum number alive to be 34 individuals based on a summation of discrete observations. We collected blood samples from 19 captured black-footed ferrets. All individuals were negative for plague, canine distemper, and tularemia. When standardized by survey effort, our results from 2016 indicate that the population of ferrets in Shirley Basin may be slowly recovering from the decline experienced in 2013-2015.

INTRODUCTION

In 1991, the first reintroduction site for black-footed ferrets (*Mustela nigripes*; ferret) in the world was established in Shirley Basin, Wyoming. Since the initial releases of 228 ferrets between 1991-1994, regular monitoring of the population has confirmed that ferrets have persisted on the landscape for >25 years under a minimal management strategy. In 1994, epizootics of sylvatic plague and canine distemper challenged the newly established population and significantly decreased the abundance of white-tailed prairie dogs (*Cynomys leucurus*) and ferrets throughout the reintroduction site. During this period, the reintroduced ferret population was characterized by slow population growth where few (i.e., ≤20) ferrets were located annually prior to 2000. However, spotlight surveys conducted between 2003 and 2006 estimated an annual growth rate of 35%, suggesting that the population of ferrets within the Shirley Basin/Medicine Bow prairie dog complex was increasing (Grenier et al. 2006a, Grenier et al. 2007). Since prairie dog distribution had increased in other portions of Shirley Basin where ferrets were believed to be absent, an additional 250 ferrets were released into areas north and south of Shirley Basin during the fall and winter of 2005, 2006, 2007, and 2012 (Grenier et al. 2006b, Schell and Grenier 2007).

Primary monitoring interests have remained focused on a portion of the prairie dog complex totaling about 8,000 ha (hereafter termed the "main study area"). By 2006, the population had grown rapidly within this main study area to 229 ferrets (95% CI: 169-289; Grenier et al. 2009). Estimates from 2008 (240; 95% CI: 176-303) and 2010 (203; 95% CI: 137-270) suggested that population growth had begun to taper off, as rate of growth appeared to transition from an exponential to a logistical pattern (Van Fleet and Grenier 2009, 2011). Surveys in 2013 suggested that the population had declined dramatically to ≥39 individuals (Boulerice and Grenier 2014). Although the Wyoming Game and Fish Department (Department) expected that ferrets would recover following this decline (Boulerice and Grenier 2014), surveys were not conducted in 2014 due to financial restrictions and personnel turnover. In 2015, ≥45 individuals were observed during an exhaustive effort (>1,200 hours, >10,000 ha) to evaluate the status of ferrets within the larger Shirley Basin complex (≥43 individuals observed within the main study area), which suggested that the population had not experienced significant change since the decline observed in 2013 (Boulerice 2016). In 2016, the establishment and monitoring needs of a second reintroduction site for ferrets in Wyoming at Meeteetse reduced the ability of the Department to conduct comprehensive surveys of the population at the Shirley Basin Reintroduction Site. However, given concerns associated with population decline noted in 2013-2015, a limited survey effort was undertaken within a portion of the main study area to ensure that the ferret population in Shirley Basin remained viable in 2016. This report quantifies results of fall spotlight surveys in 2016. We compared estimates of abundance and serology results to previous years, and discuss the implications of our findings for recovery of the ferret in Shirley Basin.

METHODS

We conducted spotlight surveys in 2016 within a portion of the main study area of the Shirley Basin complex that has historically contained the greatest abundance of ferrets.

Specifically, we surveyed a portion of the reintroduction site east of Highway 478 that had been previously surveyed in 2006, 2008, 2010, 2013, and 2015 (Figure 1). We specifically targeted two large colonies on the eastern-most boundary of the main study area for survey. These colonies were surveyed in their entirety, aside from a small portion on which we did not have access permission from the landowner. Additionally, we surveyed 5 smaller colonies separated from the larger colonies by a creek. Notably, we extended the area included within our survey to account for differences between the outdated maps of prairie dog colonies that were available and the distribution of colonies we observed during the summer of 2016. This included a 208 ha colony that was surveyed only in 2015 and 2016 (Figure 2). We contacted all landowners for permission to trespass prior to the initiation of surveys.

We surveyed for ferrets either on foot, by vehicle, or a combination thereof. Sampling plots accessible only by foot were approximately 121 ha in size, while those accessible by vehicle were approximately twice as large (i.e., approximately 242 ha). Actual size of the survey plots varied due to size and shape of the prairie dog colony, as well as other geographical boundaries. We surveyed from 2000-2300 hours and 0130-0600 hours in blocks of 3 consecutive nights (Grenier 2008, Grenier et al. 2009). To locate ferrets, we drove vehicles equipped with roof-mounted spotlights (Model RM 240 Blitz, Lightforce Professional Lighting Systems, Orofino, ID) along existing roads. Field personnel used a backpack spotlight unit (Walkabout Kit, Lightforce Professional Lighting Systems, Orofino, ID) to traverse portions of the colony that could not be surveyed from a vehicle.

After we located ferrets, we used an unbaited live trap to attempt to capture observed individuals (Sheets 1972). We checked traps hourly throughout the night, and removed all traps at sunrise. We transported captured ferrets to a mobile processing trailer where we used isoflurane gas to anesthetize individuals (Kreeger et al. 1998). Ferrets were assigned to juvenile or adult age classes by palpation of the sagittal crest, examination of dentition and tooth wear, and determination of reproductive status (Thorne et al. 1985). We marked ferrets with passive integrated transponders (PIT tags; AVID Microchip I.D. Systems, Folsom, LA) and hair dye (Grenier 2008). We removed any ectoparasites visible on ferrets (ticks, mites, fleas, etc.). Fleas were collected and sent to the National Wildlife Health Center (Madison, WI, Dr. Tonie Rocke) for species identification and to determine if fleas were harboring plague (*Yersina pestis*). We collected blood and hair samples from all captured ferrets. We vaccinated captured ferrets for sylvatic plague and canine distemper with vaccines provided by the National Ferret Conservation Center (Carr, CO). Following a brief recovery period, we returned each ferret to the burrow from which the animal was captured. We sent blood samples to the Colorado State University Veterinary Diagnostic Laboratory to test for the presence of sylvatic plague (*Yersinia pestis*) and to the Department's Wildlife Veterinary Laboratory to test for the presence of tularemia (*Francisella tularemia*) and canine distemper virus antibodies. Hair samples were stored for future genetic testing. Due to a low number of captures, we did not use closed population models to estimate abundance of ferrets as in 2006-2010. Instead, we estimated minimum known alive by summing all discrete observations of ferrets following guidelines outlined by Grenier (2008).

RESULTS

We spent 354 hours during 6 nights spotlighting for ferrets from 17-20 August and 22-25 August (Table 1). We surveyed a total 4,436 ha. We recorded 77 observations of ferrets, and determined the minimum known alive to be 34 individuals (Table 2). This amounted to a discrete ferret approximately every 10.1 hours of surveying. We detected ≥5 litters. We compared minimum known alive to previous years, and standardized minimum known alive by survey effort (hours and area) in Figure 3. Notably, the 34 ferrets we observed in 2016 were located within the same region of the main study area on which only 25 ferrets were observed in 2015 and 22 ferrets were observed in 2013. Over a one year period between 2015-2016, the minimum known alive for the 4,436 hectares surveyed in 2016 increased 36%.

We captured 19 ferrets, comprised of 9 males and10 females. All 19 ferrets were captured for the first time in 2016 (no recaptures from previous years). We collected blood samples from all captured ferrets. All blood samples were negative for plague, canine distemper, and tularemia. We detected no abnormalities and very few (i.e., ≤10) ectoparasites (i.e., fleas and ticks) on most ferrets handled in 2016. We collected flea samples from 9 of 19 ferrets (Table 3). Capture details for all captured ferrets are summarized in Table 4.

DISCUSSION

At the conclusion of our monitoring efforts for black-footed ferrets at the Shirley Basin complex for 2016, our observations indicated the total minimum known alive for ferrets appears to have remained similar to that in 2013 and 2015 (Figure 3). However, due to ferret monitoring needs associated with the establishment of a second reintroduction site in 2016, we surveyed only a portion of the area in Shirley Basin in 2016 that was surveyed in 2013 and 2015. Notably, the 34 ferrets we observed in 2016 where located within the same region of the main study area in which only 25 ferrets were observed in 2015 and 22 ferrets were observed in 2013. Over a 1 year period between 2015-2016, the minimum known alive for the roughly 5,000 ha surveyed in 2016 increased 36%. When accounting for the reduction in survey effort in 2016 compared to 2013-2015, the amount of time required to detect a ferret was nearly half as long in 2016. These results suggest that the ferret population may be increasing from the decline experienced in 2013-2015. However, extrapolation of results from the relatively small portion of potential habitat surveyed in 2016 to other parts of the complex, even within the main study area, should be done cautiously. Expanded surveys into the portion of the main study area not surveyed in 2016 and in adjacent areas within the complex are required in 2017 to confirm that the population is recovering.

Our extension of the area surveyed in 2016 to include the regions where we observed prairie dog colonies not included in our outdated maps has proved to be useful. Of the minimum of 35 ferrets we observed in 2016, 7 were located within 200 m of the edge of the older maps used for all previous survey efforts. Ferrets along edges of survey boundaries likely have a lower probability of being observed since edges are not approached from all directions and may not be covered as frequently throughout the night. In addition, 2 ferrets were located within the 208 ha colony included in surveys efforts only in 2015 and 2016. Without the expanded survey

effort in 2016, these 9 ferrets may have gone undetected. Notably, after surveys were completed in 2016, another large (>100 ha, >100 prairie dogs observed) colony was located for the first time well within the dispersal distance of a ferret (<3.2 km) from the main study area and may support additional individuals that have not been accounted for. These findings highlight the importance of having updated maps of the distributions of prairie dog colonies available for selecting areas to survey for ferrets and the dire need to complete a comprehensive assessment of the colonies at the Shirley Basin Reintroduction Site. Without such information, obtaining an accurate evaluation of the status of ferrets in Shirley Basin is impossible, even within the main study site.

Adjustments to the disease monitoring protocol that has been historically used in Shirley Basin could be valuable to determining the status of many of the virulent diseases of which ferrets are susceptible. Previous methods, namely testing blood samples from captured ferrets, are unlikely to be effective at monitoring the status of plague in the ferret population since infected ferrets typically succumb to the disease and are therefore unavailable to be sampled. In 2016, we implemented a slight change to the protocol by collecting all fleas detected on captured ferrets and testing fleas for plague. Testing of fleas on captured ferrets would allow the detection of infection within fleas that has not been passed to the ferret. However, additional efforts are recommended. For example, regular testing of fleas collected via swabbing of prairie dog burrows and combed from captured prairie dogs would be extremely useful for monitoring trends in plague on the landscape without relying solely on samples from captured ferrets. Establishment of a robust disease monitoring program in Shirley Basin, including the recommendations described above, will enable the Department to accurately determine the cause of fluctuations in prairie dog and ferret populations and respond appropriately.

The past 5 years of monitoring in Shirley Basin has exemplified the sensitivity of ferret populations to stochastic events, specifically the sharp population decline recorded in 2013-2015, presumably as a result of poor weather conditions, followed by indications of recovery in 2016 as weather patterns normalized (or possibly the result of disease outbreak and subsequent recovery). Factors that contribute to the success or failure of prairie dog and ferret populations on reintroduction sites, including Shirley Basin, are numerous (e.g., weather, diseases, prairie dog shooting) and stress the importance of regular monitoring to ensure that the population remains viable. However, for >25 years, ferrets have survived at Shirley Basin under a minimal management strategy in spite of the inherent variability of and sensitivity to these factors. Our results in 2016 suggest that this strategy remains effective, as ferret recovery appears to be occurring naturally without any management assistance, although additional monitoring is needed to verify this recovery. Small improvements to the manner in which surveys areas are designated and diseases are monitored as recommended above could aid in ensuring that the efforts dedicated to ferret recovery in Shirley Basin are done so in the most accurate and efficient manner.

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Table 1. Survey effort expended while spotlighting for black-footed ferrets (*Mustela nigripes*) in Shirley Basin, Wyoming during the fall of 2016. A total of 354 hours of spotlighting was conducted by vehicle and on foot throughout white-tailed prairie dog (*Cynomys leucurus*) colonies.

Dates	Walking	Driving	Total
Aug. 17-19	111	72	183
Aug. 22-24	103	68	171
Total	**214**	**140**	**354**

Table 2. Complete list of all black-footed ferrets (*Mustela nigripes*) observed in Shirley Basin, Wyoming in 2016. Discrete observations were determined based on guidelines outlined in Grenier (2008). In total, 77 observations were recorded, of which 34 were determined to be discrete observations.

Date	Time	Colony	Observer	Discrete
8/17/2016	23:05	556-1	J. Smith	Yes
8/17/2016	23:05	556-1	J. Smith	Yes
8/17/2016	23:05	556-1	J. Smith	Yes
8/17/2016	23:45	556-1	J. Smith	Yes
8/17/2016	23:45	556-1	J. Smith	Yes
8/17/2016	23:45	556-1	J. Smith	Yes
8/17/2016	22:00	556-3	J. Zeeb	Yes
8/17/2016	0:10	556-3	J. Zeeb	Yes
8/17/2016	23:45	556-5	B. Brito	Yes
8/17/2016	0:20	556-5	B. Brito	Yes
8/17/2016	1:20	556-5	B. Brito	Yes
8/17/2016	2:20	556-5	B. Brito	Yes
8/17/2016	4:54	556-6	J. Cussins	Yes
8/17/2016	23:00	556-7	J. Boulerice	Yes
8/17/2016	23:00	556-7	J. Boulerice	Yes
8/17/2016	0:00	556-7	J. Boulerice	Yes
8/17/2016	0:00	556-7	J. Boulerice	Yes
8/17/2016	4:15	556-7	J. Boulerice	No
8/17/2016	4:15	556-7	J. Boulerice	No
8/18/2016	23:15	556-1	J. Smith	No
8/18/2016	23:15	556-1	J. Smith	No
8/18/2016	23:15	556-1	J. Smith	No
8/18/2016	3:40	556-2	J. Wilson	No
8/18/2016	3:40	556-2	J. Wilson	No
8/18/2016	3:40	556-2	J. Wilson	No
8/18/2016	5:30	556-2	J. Wilson	Yes
8/18/2016	4:50	556-3	J. Zeeb	Yes
8/18/2016	6:00	556-3	J. Zeeb	No
8/18/2016	0:25	556-4	M. Worth	Yes
8/18/2016	2:15	556-4	M. Worth	Yes
8/18/2016	4:20	556-4	M. Worth	Yes
8/18/2016	4:40	556-4	M. Worth	Yes
8/18/2016	0:25	556-5	B. Brito	No
8/18/2016	0:44	556-5	B. Brito	No
8/18/2016	0:44	556-5	B. Brito	No
8/18/2016	0:44	556-5	B. Brito	No
8/18/2016	2:20	556-5	B. Brito	No
8/18/2016	23:45	556-7	J. Boulerice	No
8/18/2016	23:45	556-7	J. Boulerice	No
8/18/2016	23:45	556-7	J. Boulerice	No

Table 2. Continued.

Date	Time	Colony	Observer	Discrete
8/18/2016	23:55	556-7	J. Boulerice	No
8/18/2016	2:00	556-7	J. Boulerice	No
8/18/2016	2:00	556-7	J. Boulerice	No
8/18/2016	2:00	556-7	J. Boulerice	No
8/18/2016	22:50	556-8	N. Brown	No
8/18/2016	2:40	556-10	N. Bjornlie	Yes
8/19/2016	2:40	556-2	J. Wilson	No
8/19/2016	2:50	556-2	J. Wilson	No
8/19/2016	23:00	556-3	J. Zeeb	No
8/19/2016	20:55	556-4	M. Worth	No
8/19/2016	0:40	556-5	B. Brito	No
8/19/2016	4:15	556-5	B. Brito	No
8/19/2016	21:30	556-7	J. Boulerice	No
8/19/2016	21:30	556-7	J. Boulerice	No
8/19/2016	23:20	556-7	J. Boulerice	No
8/19/2016	23:20	556-7	J. Boulerice	No
8/19/2016	23:20	556-7	J. Boulerice	No
8/19/2016	23:20	556-7	J. Boulerice	No
8/19/2016	23:40	556-7	J. Boulerice	No
8/19/2016	21:00	556-8	N. Brown	Yes
8/19/2016	3:16	556-10	N. Bjornlie	No
8/24/2016	4:45	558-1	J. Boulerice	Yes
8/25/2016	5:00	558-1	J. Boulerice	Yes
8/22/2016	3:30	559-5	M. Renteria	Yes
8/22/2016	3:37	2016-1	N. Bjornlie	Yes
8/23/2016	4:15	554-2	B. Brito	Yes
8/23/2016	0:00	558-1	J. Boulerice	No
8/23/2016	2:15	558-1	J. Boulerice	No
8/23/2016	2:45	558-1	J. Boulerice	Yes
8/23/2016	2:25	2016-1	N. Bjornlie	Yes
8/23/2016	2:25	2016-1	N. Bjornlie	No
8/24/2016	5:05	554-1	Z. Walker	Yes
8/24/2016	21:25	554-2	B. Brito	No
8/24/2016	4:45	555-1	J. Williams	Yes
8/24/2016	21:15	558-1	J. Boulerice	No
8/24/2016	3:56	559-5	M. Renteria	No
8/24/2016	2:14	2016-1	N. Bjornlie	No

Table 3. Summary of flea species collected from 9 black-footed ferrets (*Mustela nigripes*) captured in Shirley Basin, Wyoming in 2016. Fleas were identified and counted by the National Wildlife Health Center (Madison, WI, Dr. Tonie Rocke).

Ferret	Flea species[1]	Flea count
1	*Foxella ignota*	2
	Oropsylla labis	1
	Pulex sp.	1
2	*Foxella ignota*	1
	Neopsylla inopina	2
	Pulex sp.	1
3	*Neopsylla inopina*	1
	Oropsylla labis	1
	Rhadinopsylla sectilis goodi	1
4	*Neopsylla inopina*	2
	Oropsylla labis	2
	Pulex irritans	1
	Rhadinopsylla sectilis goodi	1
5	*Foxella ignota*	1
	Pulex irritans	1
6	*Foxella ignota*	3
	Neopsylla inopina	1
	Oropsylla labis	3
	Pulex sp.	1
	Rhadinopsylla sectilis goodi	2
7	*Foxella ignota*	5
	Pulex irritans	7
	Rhadinopsylla sectilis goodi	1
8	*Foxella ignota*	2
	Pulex irritans	3
9	*Foxella ignota*	1
	Oropsylla labis	14
	Rhadinopsylla sectilis goodi	1

[1]Common hosts of each flea species: *Floxella* – pocket gopher ([*Thomomys* spp.] and weasels [*Mustela* spp.] that hunt gophers), *Neopsylla* – ground squirrels (*Spermophilus* spp.), *Oropsylla* – prairie dogs (*Cynomys* spp.), *Pulex* – humans, domestic dogs, coyotes (*Canis latrans*), *Rhadinopsylla* – deermice (*Peromyscus* spp.).

Table 4. Capture details for 19 black-footed ferrets (*Mustela nigripes*) captured in Shirley Basin, Wyoming in 2016. Blood samples taken from all 19 of the captured black-footed ferrets were negative for plague, canine distemper, and tularemia. Vaccines for plague and canine distemper were administered to all captured ferrets.

#	Pit tag	Date	Colony	Observer	Sex	Age	Weight
1	040847376	08/17/16	556-7	J. Boulerice	F	A	726
2	040824322	08/17/16	556-3	J. Zeeb	M	A	869
3	040828102	08/17/16	556-7	J. Boulerice	M	J	877
4	040813383	08/17/16	556-7	J. Boulerice	M	J	874
5	040840619	08/17/16	556-7	J. Boulerice	M	J	828
6	040883049	08/18/16	556-5	J. Cussins	F	J	656
7	040814610	08/18/16	556-1	J. Smith	F	A	720
8	040825619	08/18/16	556-4	S. Spilinek	M	A	882
9	040830638	08/18/16	556-5	B.Brito	F	A	640
10	040818554	08/18/16	556-4	M. Worth	F	A	778
11	040838105	08/18/16	556-2	J. Wilson	M	A	923
12	040815307	08/18/16	556-2	J. Wilson	F	J	690
13	040825114	08/18/16	556-2	J. Wilson	F	A	740
14	040831793	08/19/16	556-5	B. Brito	M	A	906
15	837858815	08/22/16	559-5	M. Renteria	M	J	760
16	837834323	08/23/16	558-1	J. Boulerice	F	A	726
17	837844095	08/23/16	558-1	J. Boulerice	F	A	660
18	837859340	08/23/16	2016-1	N. Bjornlie	M	J	760
19	837841795	08/24/16	558-1	J. Boulerice	F	J	571

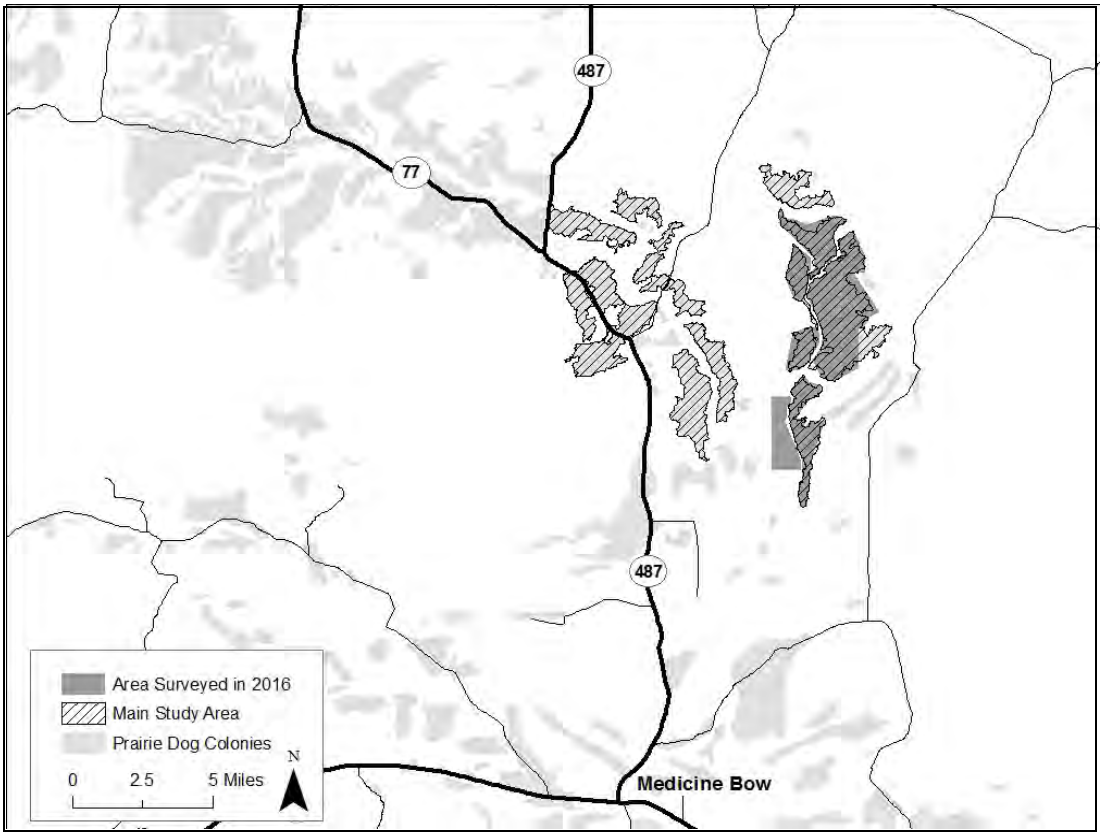


Figure 1. Overview of the Shirley Basin Reintroduction Site and the area surveyed for black-footed ferrets (*Mustela nigripes*) in 2016.

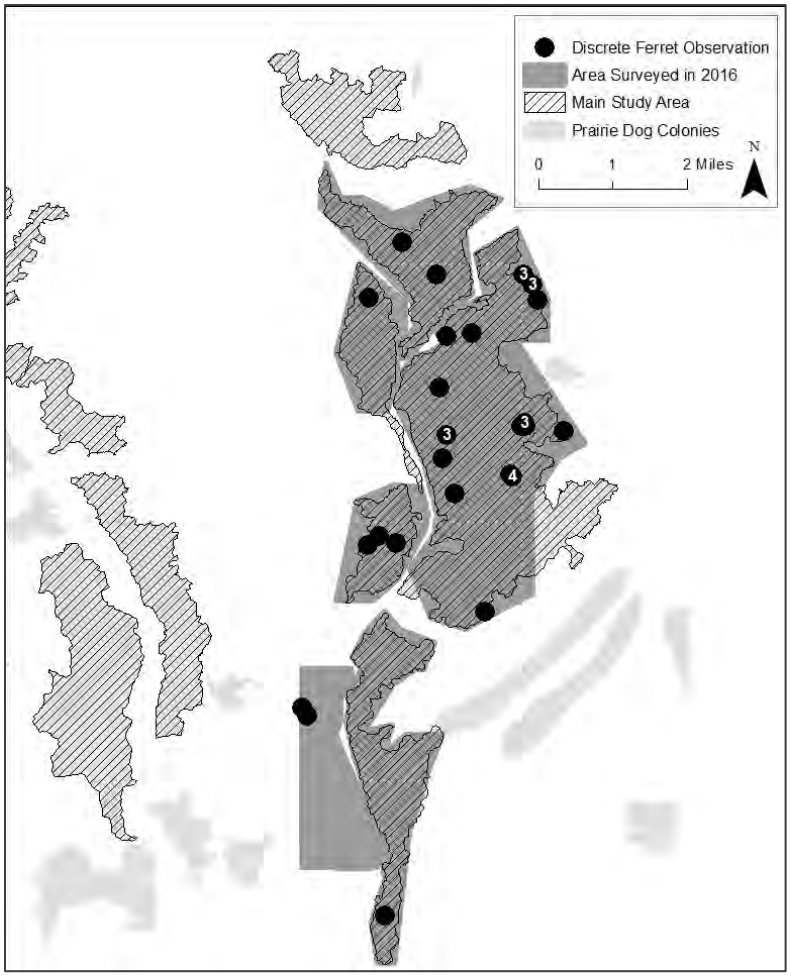
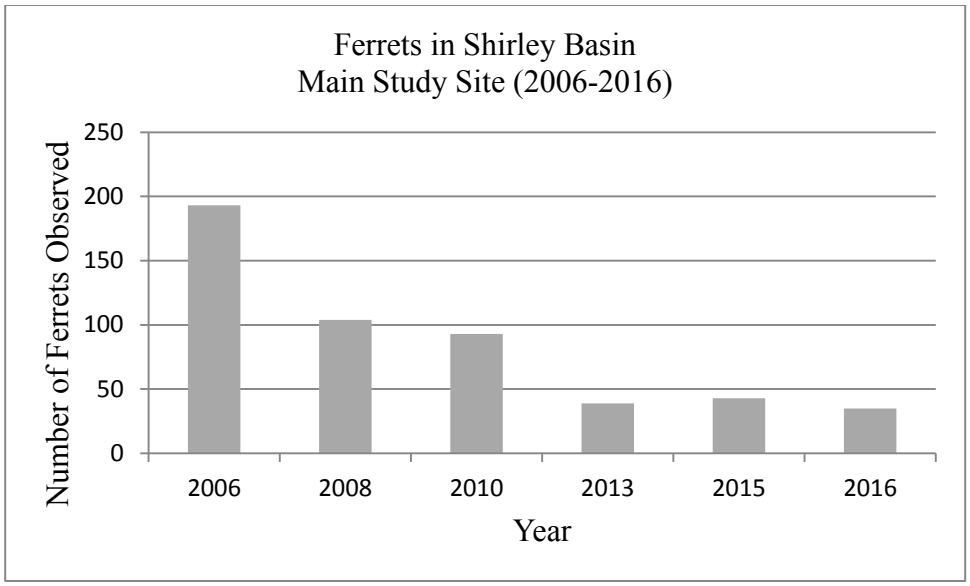


Figure 2. Spatial arrangement of discrete observations of black-footed ferrets (*Mustela nigripes*) and of white-tailed prairie dog (*Cynomys leucurus*) colonies that were surveyed in Shirley Basin, Wyoming, 2016. Numbers represent multiple discrete ferrets observed at same location.



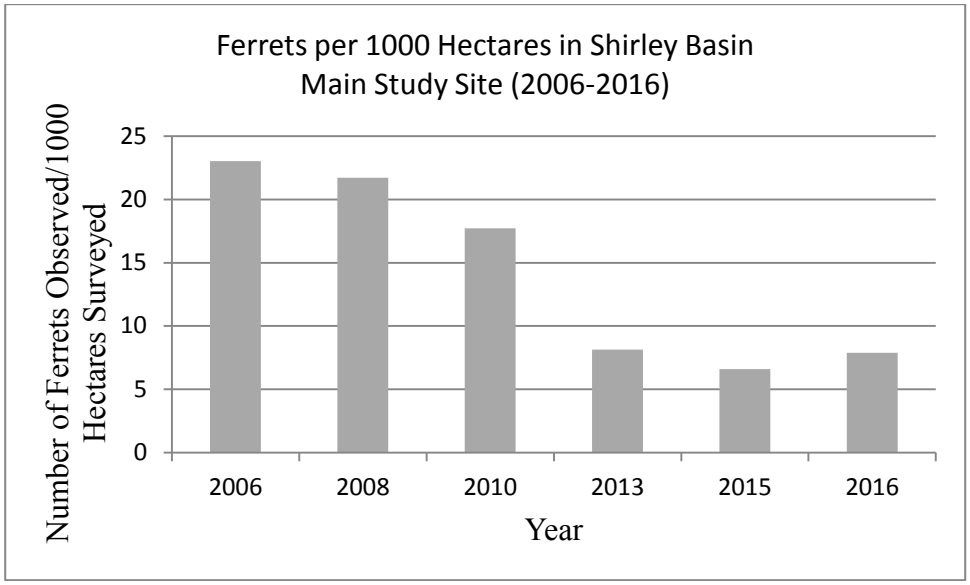


Figure 3. Abundance of black-footed ferrets (*Mustela nigripes*) within the main study area of the Shirley Basin Reintroduction Site, Wyoming, 2006-2016. A) Minimum known alive for ferrets was calculated by summing the total number of distinct observations (unique ferrets) in a given year of surveys within the main study area. B) Minimum known alive for ferrets was standardized by survey effort (MKA/1,000 hectares surveyed) in a given area. Surveys were not conducted in the main study area for years not represented in the figure.

SPECIES OF GREATEST CONSERVATION NEED – BIRDS

MONITORING AND MANAGEMENT OF THE ROCKY MOUNTAIN POPULATION OF TRUMPETER SWANS (*CYGNUS BUCCINATOR*) IN WYOMING

STATE OF WYOMING

NONGAME BIRDS: Species of Greatest Conservation Need – Trumpeter Swan

FUNDING SOURCE: Wyoming State Legislature General Fund Appropriations
Bureau of Land Management Cooperative Agreement
United States Fish and Wildlife Service Cooperative Agreement

PROJECT DURATION: Annual

PERIOD COVERED: 15 April 2016 – 14 April 2017

PREPARED BY: Susan Patla, Nongame Biologist

ABSTRACT

Since the late 1980s, the Wyoming Game and Fish Department has been actively involved in monitoring and managing Trumpeter Swans (*Cygnus buccinator*). The Trumpeter Swan is one of the rarest avian species that nests in Wyoming, and is classified as a Species of Greatest Conservation Need with Native Species Status of 2, Tier II by the Wyoming Game and Fish Department. Year-round resident Trumpeter Swans in Wyoming comprise part of the historic Tri-State population that nests in the Greater Yellowstone Area. Monitoring efforts for this species are coordinated with the US Fish and Wildlife Service, Pacific Flyway Council, and the state agencies in Idaho and Montana. We completed 3 survey flights to collect census data on total number of adults and young in summer, and to document occupancy and productivity of all known nest sites. In the 2016 fall population count, we documented only 1 additional resident adult and 4 fewer cygnet Trumpeter Swans in Wyoming outside of Yellowstone National Park compared to the previous year (n = 213 adults, 61 cygnets in 2016). Numbers in 2015 and 2016 represented record high numbers for the state, but exponential growth observed in previous years in the Green River Basin leveled off in 2016. Distribution continues to slowly increase: a pair found with 2 cygnets in the town of Green River represents the most southern nesting pair ever documented in Wyoming. We remain concerned over low productivity of swan nest sites and lack of population growth in the core Snake River area. To accommodate the growing number of nesting swans in the Green River Basin, we initiated a wetland habitat program in 2004 that focuses on cooperating with landowners to develop shallow-water wetland ponds that provide additional summer habitat for swans and other wildlife species. Funding for this work has been obtained by the Bureau of Land Management Wyoming Landscape Conservation Initiative, Wyoming Wildlife and Natural Resource Trust, Natural Resources Conservation Service, and the US Fish and Wildlife Service Partners Program. The success of this swan-focused wetland

program has helped to stimulate other wetland-related projects in the Green River area. The Wyoming Game and Fish Department is currently administrating a standard North American Wetlands Conservation Act grant proposal developed with The Conservation Fund and other partners to obtain $1 million for conservation easements and wetland habitat projects in the Green River Basin. Another project started in 2012 and completed in 2015, in partnership with The Nature Conservancy and Wyoming Natural Diversity Database, was the first basin-wide wetland assessment funded by the Environmental Protection Agency states program in Wyoming for the Green River Basin. A new partnership with the newly established Northern Rockies Trumpeter Swan Stewards (Northern Rockies Conservation Cooperative) resulted in additional monitoring of 4 nesting territories in 2016.

INTRODUCTION

The Trumpeter Swan (*Cygnus buccinator*; swan) is designated as a Species of Greatest Conservation Need in Wyoming with Native Species Status ranking 2, Tier II (WGFD 2017). Although swans were never listed under the Endangered Species Act of 1973, they have been a focal management species for federal and state agencies in the Greater Yellowstone Area (GYA) or the Tri-State Area since the establishment of Red Rock Lakes National Wildlife Refuge in Montana in 1932. This refuge was created to conserve approximately 70 swans in the GYA, which were believed to be the last remaining Trumpeter Swans in the world. Due to conservation efforts, the number of swans in the GYA increased to >600 by the 1950s (USFWS 1998). However, the population has fluctuated greatly since that time, hitting a low of 239 white birds (adults and subadults) in 1994. The total number of adult birds in the GYA exceeded 500 white birds in 2015 for the first time since 1967 (Olson 2016). This non-migratory segment of the population remains of concern even though Trumpeter Swan populations in Alaska, interior Canada, and the mid-western states have been increasing (Groves 2012).

The Pacific Flyway Council coordinates management of this population and has designated swans that nest and reside year-round in the GYA, including western Wyoming, as the Tri-State Area Flocks (TSAF). The TSAF are managed as part of the US segment of the Rocky Mountain Population (RMP) of swans, which includes those that nest in interior Canada and migrate south to over-winter in the GYA (USFWS 1998). The Wyoming Game and Fish Department (Department) coordinates with the US Fish and Wildlife Service (USFWS) Mountain-Prairie Region Migratory Bird Office and the states of Idaho and Montana to census the number of mature swans and young-of-the-year (i.e., cygnets) in the TSAF. Since the late 1980s, the Department has worked to expand summer and winter distribution of swans in Wyoming (Patla and Oakleaf 2004). These efforts have established a new nesting population in the Green River Basin. Since 2004, the Department has cooperated with willing landowners to restore and create summer habitat in the Upper Green River Basin to accommodate this expanding resident flock (Patla and Lockman 2004, Lockman 2005).

The Department is a member of the Greater Yellowstone Trumpeter Swan Working Group, which consists of state and federal agencies, non-governmental organizations, and interested citizens. The working group meets annually to review and discuss productivity trends and to coordinate management actions. Wyoming also coordinates with the Pacific Flyway RMP Trumpeter Swan Study Sub-committee. This report summarizes management activities and

monitoring data for swans in Wyoming for the 2016 nesting season. The annual coordinated winter survey, which would have occurred in February 2017, has not been flown since 2015 due to lack of funding. The winter survey provided a count of the total number of swans wintering in the Greater Yellowstone area. Subtracting the fall count from the winter count provided an estimate of the nesting population in interior Canada.

METHODS

We conducted 3 fixed-wing airplane surveys to collect data on swans in western Wyoming. We used the same pilot and Scout airplane from Sky Aviation, Worland, to fly all surveys. Flying elevation averaged 30-70 m above ground level depending on terrain and surface winds; flight speed varied between 135-160 kph. During the survey, the observer counted white birds (i.e., adults and subadults) and gray cygnets. We surveyed swan nesting areas on 2 and 3 June to determine occupancy, and again on 5and 7 July to count number of young hatched (i.e., cygnets). The fall and winter surveys were coordinated by the USFWS in the Tri-State area of Wyoming, Montana, and Idaho. We flew the Wyoming portion of the fall survey on 16 and 17 September 2016. The last winter survey was conducted on 11 and 12 February 2015. Additional data were collected through site-specific ground surveys, reports provided by federal agencies, and observations from the public. We presented talks on swan management and status at the Dubois Museum on 29 September and at the 13th Biennial Scientific conference of the Greater Yellowstone Ecosystem at Jackson Lake Lodge on 6 October. We also participated in the Greater Yellowstone Trumpeter Swan Working Group meeting on 1 and 2 February 2017 in West Yellowstone, Montana. The USFWS Mountain-Prairie Region Migratory Bird Office produced reports summarizing results for the coordinated RMP surveys that included data collected in Wyoming (Olson 2015, 2017).

RESULTS

During the last winter aerial survey in February 2015, we counted a total of 1,075 swans wintering in the Pacific Flyway portion of Wyoming outside of Yellowstone National Park (YNP), which represents a 13% increase over the previous year (Table 1, Figure 1). The largest percentage of wintering swans in the Pacific Flyway area of Wyoming occurred in the Snake River (52%) and the Green River (23%) drainages (Table 1). An additional 47 swans were documented wintering in the Central Flyway portion of Wyoming, including Bull and Dinwoody Lakes (Figure 1). The number of swans wintering in the Pacific Flyway area in Wyoming increased 6.5% per year between 1972 and 2014 (Olson 2015). An increase in wintering birds is largely the result of continued growth of the migrant interior Canada population. Current trends cannot be determined, as the coordinated winter survey is no longer conducted.

In fall 2016, we counted a similar number of white swans (adults and subadults) in Wyoming outside of YNP compared to the previous year (n = 213; Table 2). The rate of growth in Wyoming (1993-2015) has increased by 3.2% per year ($P < 0.01$) for white birds and 7.5% ($P < 0.01$) for cygnets (Olson 2017). However, the long-term trend for total number of swans in the traditional Snake River core area (1999-2015) showed no trend during this period ($p = 0.70$;

Olson 2017). Conversely, in the Green River expansion area, the number of swans has increased by 10% ($P < 0.01$) over this same time period (Olson 2017). Overall, the total TSAF fall count of white birds increased by 21% compared to the previous year (548 vs. 452), and number of cygnets increased by 28% (175 vs. 137). The TSAF have shown an annual increase of 2.4% for white birds ($P < 0.01$) and +4.1% for cygnets ($P <0.01$) between 1993 and 2015 (Olson 2017).

The number of nest sites occupied in 2016 in Wyoming outside of YNP ($n = 49$) was lower compared to the previous year, but still exceeded the 10-year average (Table 3, Figure 2). The number of young hatched in Wyoming outside YNP in 2016 remained substantial ($n = 78$), even though slightly lower than in 2015 (Table 3). Of the 49 sites occupied in 2016, 71% of pairs initiated nesting, 57% hatched young, and 49% fledged at least 1 young. Overall, swans in the Green River Basin accounted for 63% of occupied sites and 74% of fledged young (Table 4). In the Snake River core area, 39% of cygnets that hatched did not fledge, compared to 22% of hatched young that did not fledge in the Green River expansion area. This trend of greater cygnet survivorship in the Green River expansion area has held for 8 out of the last 10 years.

Site-specific occupancy and productivity results for all known swan nest sites surveyed in Wyoming outside of YNP are presented in Appendix I. An analysis of site-specific productivity data from 25 nest sites in the Snake River core area where swans attempted to nest at least once during the 12-year period (2004-2015) showed that only 3 territories produced young more than 1/2 of the years during this period (WGFD, unpublished data). Twenty percent of the sites ($n = 5$) produced no young. Swan pairs on the National Elk Refuge accounted for 35% of all productivity over this time period.

Summary of mortality data from 1991-2015 are presented in Table 5. This table will be updated with 2016 data in the future. Overall since 1998, the Department has documented a total of 339 swan mortalities. The cause of mortality could be identified in 30% of the specimens, with collisions accounting for 44%, predation 26%, disease/parasites 17%, and shooting 13% (Table 5). Many swan carcasses found during winter and early spring are in emaciated condition or have been scavenged or decayed to the degree that necropsies are not possible. In 2016, 1 brood of 5 flightless cygnets was lost in the Gros Ventre drainage in September when the adults lead the brood out of a small, isolated nesting pond to another wetland 2.5 miles to the west. One cygnet survived the walk but was predated by a Bald Eagle the next morning. Only 1 carcass of a cygnet was recovered along the route, which showed poor feather development indicating a lack of adequate nutrition for this family group at this newly pioneered wetland site (WGFD, unpublished data; Reed and Shea 2016).

DISCUSSION

The 2016 nesting season was successful, with swan numbers and productivity in Wyoming outside of YNP exceeding the 10-year means. The number and productivity of Trumpeter Swans nesting in Wyoming outside of YNP has increased in recent years, largely as a result of population growth in the Green River expansion area. We continue to document a loss of nest sites and low productivity at many sites in the Snake River core area. We have documented a dramatic increase in the number of migrant swans from interior Canada wintering

in the core area over recent decades. Migratory swans may be reducing available forage needed by resident swans in winter and early spring. Generally, most migrant swans depart by the end of March or early April, leaving resident swans to forage on the remaining aquatic vegetation until additional wetlands thaw and open. Especially in years with cold, late springs, when the thaw in some locations was delayed until late May or early June, available aquatic vegetation is in short supply during the pre-nesting period. We hypothesize that the increase in the number of wintering swans in the core area negatively impacts resident pairs as a result of depleted foraging habitat that is in very limited supply during late winter and early spring. This idea is supported by results in 2007, which was 1 of the warmest springs on record in Wyoming. Wyoming swans in that summer produced a record number of young (n = 31) in the Snake River core area. Access to supplemental food on private wetland ponds may be exacerbating the problem of increasing the number of swans in the Jackson area in winter by attracting and holding more swans.

In contrast, although the number of swans wintering along the Green River south of Fontenelle Dam has been increasing annually since 2003, we were seeing exponential growth in resident swan numbers and increasing productivity in the Green River expansion area. In 2016, the number of resident birds and productivity leveled off. Results in future years will provide evidence if this is only a temporary hiatus or if perhaps swans have now occupied most high quality nesting wetland habitat and limits to growth are being reached in this area.

Swans in Wyoming now comprise over 35% of the total TSAF and, therefore, constitute an important component of the current GYA resident population. Although, the success of the Green River range expansion program has resulted in increased numbers of swans in that area of the state, we remain concerned about productivity in the traditional core area, including YNP. We will continue to work with members of the Greater Yellowstone Trumpeter Swan Working Group and the Pacific Flyway to monitor this situation and work toward the development of management projects and joint research proposals to investigate the reasons for this decline, and to manage for a viable nesting population in the core Snake River drainage. In future years, we will continue to focus management efforts on cooperative habitat projects with willing landowners to improve and restore wetland habitats in the Green River, Salt River, and Snake River drainages as opportunities arise (Patla and Lockman 2004, Lockman 2005, WGFD 2017). Given the increasing number and productivity of swans in the Green River Basin and possible long-term drought conditions, it is important that the Department continues to be a leader in habitat improvement projects for swans and other wildlife associated with shallow-water wetland habitat. In 2016, swans used wetland sites developed by the Department as cooperative projects with landowners at 4 locations in the Pinedale area. Funding for these projects was obtained through the Wyoming Landscape Conservation Initiative, Wyoming Wildlife and Natural Resource Trust, Natural Resources Conservation Service, and USFWS Partners Program. Construction was completed in fall 2015 on a wetland restoration project near Daniel, which was funded by a standard North American Wetlands Conservation Act grant that was awarded to the Department, the USFWS, and 14 other partners in 2012 for a total of $1 million for conservation easements and wetland habitat projects in the Upper Green River Basin (see Figure 2). In 2012, we also obtained a state grant from the Environmental Protection Agency, in partnership with The Nature Conservancy (TNC) of Wyoming, to conduct the 1st basin-wide assessment of wetland habitat in the state for the Green River Basin. The final report, which was completed in

2015, will provide a more complete understanding of the types and condition of wetlands in the basin and help to focus future conservation and restoration work (Tibbets et al. 2015).

In summary, the future outlook for the resident Trumpeter Swan population in Wyoming is greatly improved compared to the status in the 1990s. We have increased the number and distribution of swans in the state, and have also increased the amount of wetland habitat important for swans and many other species of waterfowl and other wildlife. Certain risks, however, may be increasing for this species, some of which are likely related to climate change, including drought- and development-related habitat loss, new and increasing waterfowl diseases and parasites, expanding number of wintering swans, and growth in recreational water sports.

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Table 1. Number of Trumpeter Swan (*Cygnus buccinators*) adults and cygnets counted in Wyoming for the coordinated Tri-State winter survey in February 2004 through 2015. No winter surveys were conducted in the years following due to budget constraints. Results are shown for specific survey areas in Wyoming where wintering swans have been found. Occasional swans observed in the Platte River drainage are not included. Data for the entire Tri-State Area, which includes portions of southwestern Montana and southeastern Idaho, can be obtained from Olson (2015).

Year	Age group	Yellowstone National Park	Snake River	Green River	Salt River	Wind River	Wyoming total
2004	Adult	149	307	61	94	0	611
	Cygnet	33	18	17	23	0	91
	Total	182	325	78	117	0	702
2005	Adult	124	367	61	102	31	685
	Cygnet	30	109	20	35	2	196
	Total	154	476	81	137	33	881
2006	Adult	121	413	100	124	18	776
	Cygnet	14	58	13	37	3	125
	Total	135	471	113	161	21	901
2007	Adult	144	420	116	158	6	844
	Cygnet	25	84	30	35	6	180
	Total	169	504	146	193	12	1024
2008	Adult	65	316	109	174	4	668
	Cygnet	7	63	30	43	6	149
	Total	72	379	139	217	10	817
2009	Adult	88	321	160	133	24	726
	Cygnet	2	63	27	8	12	112
	Total	90	384	187	141	36	838

Table 1. Continued.

Year	Age group	Yellowstone National Park	Snake River	Green River	Salt River	Wind River	Wyoming total
2010	Adult	18	369	160	85	16	648
	Cygnet	5	56	30	12	8	111
	Total	23	425	190	97	24	759
2011	Adult	125	467	168	150	27	937
	Cygnet	42	138	51	32	8	271
	Total	167	605	219	182	35	1208
2012	Adult	51	488	210	109	27	885
	Cygnet	4	99	20	29	24	176
	Total	55	587	230	138	51	1061
2013	Adult	2	548	212	120	15	897
	Cygnet	0	120	30	20	8	178
	Total	2	668	242	140	23	1075
2014	Adult	24	411	261	123	41	860
	Cygnet	7	50	45	21	6	129
	Total	31	461	306	144	47	989
2015	Adult	111	472	211	93	39	926
	Cygnet	33	96	33	26	8	196
	Total	144	568	244	119	47	1122

Table 2. Fall survey results for the Tri-State Area Flocks of the Rocky Mountain Population of Trumpeter Swan (*Cygnus buccinator*) that are resident year-round in the states of Idaho, Montana, and Wyoming, 2008-2016 (Olson 2017). YNP represents Yellowstone National Park. YNP released 3 captive-raised swan cygnets on the Yellowstone River (Hayden Valley) in 2016; these are included in the totals below.

Year	Age group	Montana	Idaho	Wyoming YNP	Wyoming outside YNP	Tri-State total
2008	Adult	140	112	6	121	379
	Cygnet	7	5	2	34	48
	Total	147	117	8	155	427
2009	Adult	138	122	4	97	361
	Cygnet	21	21	0	33	75
	Total	159	143	4	130	436
2010	Adult	129	101	2	143	375
	Cygnet	30	29	0	48	107
	Total	159	130	2	191	482
2011	Adult	123	98	9	124	354
	Cygnet	40	12	0	37	89
	Total	163	110	9	161	443
2012	Adult	129	97	12	143	381
	Cygnet	96	30	4	48	178
	Total	163	127	16	191	559
2013	Adult	208	80	17	153	458
	Cygnet	26	28	7	52	113
	Total	234	108	24	205	571
2014	Adult	198	74	13	167	452
	Cygnet	57	23	5	56	141
	Total	255	97	18	223	593
2015	Adult	212	104	20	212	548
	Cygnet	60	47	6	65	178
	Total	272	151	26	277	726
2016	Adult	215	127	23	213	578
	Cygnet	48	28	6	61	143
	Total	263	155	29	273	721

Table 3. Occupancy and productivity data for Trumpeter Swans (*Cygnus buccinator*) nesting in Wyoming outside of Yellowstone National Park, 1992-2016. Shown are number of sites occupied, number of nesting pairs, number of pairs that hatched cygnets, number of pairs with fledged cygnets (i.e., mature young in September), total number of cygnets hatched, and number of cygnets fledged (counted in the fall survey) per year. The values in bold are those that have been changed to reflect corrections in historic data. Mean and standard deviation are shown for the 10-year period 2006-2015.

Year	Sites occupied (*n*)	Nesting pairs (*n*)	Pairs with hatchlings (*n*)	Pairs with fledglings (*n*)	Individuals hatched (*n*)	Individuals fledged (*n*)
1992	29	10	5	3	17	9
1993	24	11	7	5	15	8
1994	20	13	8	5	29	18
1995	22	12	7	5	25	15
1996	**23**	**12**	**7**	4	**17**	**6**
1997	26	**14**	**6**	4	**19**	17
1998	**23**	18	10	7	26	15
1999	**21**	15	6	6	19	12
2000 [a]	26	16	**11**	**10**	**42**	**31**
2001 [a]	28	17	**11**	**10**	**34**	**27**
2002	24	**11**	9	8	23	17
2003	26	18	13	11	42	35
2004	22	17	14	11	54	37
2005	24	16	11	10	38	35
2006	24	18	12	8	33	26
2007	35	26	20	18	74	59
2008	35	16	12	11	39	34
2009	32	24	15	11	50	33
2010	37	24	18	12	66	48
2011	44	25	18	15	51	38
2012	44	28	18	16	62	48
2013	51	34	29	20	86	52
2014	53	29	21	19	63	54
2015	57	40	28	23	81	65
2016	49	35	28	24	78	61
10-year mean (SD)	**39.4** (11.2)	**25.1** (7.4)	**18.1** (6.1)	**14.5** (4.7)	**58.4** (17.9)	**44.6** (12.4)

[a] Production data include a site in the Green River drainage where eggs were collected and five 1-day-old young from Wyoming Wetlands Society's captive flock were successfully grafted to a pair in 2000, of which 4 fledged, and again in 2001, of which 5 fledged.

Table 4. Comparison of Trumpeter Swan (*Cygnus buccinators*; swan) nest-site occupancy and productivity data for the Snake River core and Green River expansion areas in Wyoming outside of Yellowstone National Park, 2007-2016. In the Green River, Wyoming Game and Fish Department worked to expand both summer and winter distribution by translocation of wild swans or release of captive-raised swans from 1986-2003 (Patla and Oakleaf 2004). Core area is where swans nested in the Snake River drainage and its tributaries prior to range expansion efforts. Number of young fledged refers to the number of mature young counted on the September aerial survey conducted annually. Successful pair refers to those nesting pairs that hatched young. Mean and standard deviation (SD) are shown for the 10 year period 2007-2016.

Drainage and year	Occupied sites (n)	Nesting pairs (n)	Broods hatched (n)	Individuals hatched (n)	Individuals fledged (n)	Individuals hatched per successful pair ($\bar{x}$)
Snake River Core						
2007	17	11	9	37	31	4.11
2008	15	7	4	13	13	3.25
2009	14	10	6	21	12	2.33
2010	15	8	6	24	12	4.00
2011	18	10	7	22	14	3.14
2012	18	9	6	18	9	3.00
2013	19	12	11	30	16	2.72
2014	14	9	8	27	19	3.38
2015	17	10	6	17	10	2.83
2016	17	9	9	26	16	3.71
Mean	16.4	9.5	7.2	23.5	15.2	3.25
SD	1.78	1.43	2.04	6.95	6.30	0.57
Green River Expansion						
2007	16	13	11	37	28	3.36
2008	18	9	8	26	21	2.62
2009	18	14	9	29	21	2.08
2010	21	15	12	42	36	3.50
2011	24	14	10	27	23	2.70
2012	24	16	12	44	39	3.67
2013	31	22	18	56	36	3.11
2014	38	20	13	36	35	2.77
2015	38	28	22	64	55	2.90
2016	31	26	19	52	45	3.05
Mean	25.9	17.7	13.5	41.3	33.9	2.98
SD	8.16	6.09	4.65	12.87	11.01	0.47

Table 5. Summary of Trumpeter Swan (*Cygnus buccinator*) annual mortalities in Wyoming, showing age class and probable cause of death, 1991 through 15 April 2015. Mortality of cygnets includes only those lost following fledge counts in September, so does not include brood reduction during the nesting season.

Year	Total mortality (*n*)	Adult mortalities[b] (*n*)	Yearling mortalities (*n*)	Cygnet mortalities (*n*)	Collision mortalities (*n*)	Predation mortalities (*n*)	Shot or trapping mortalities (*n*)	Infection/ parasite mortalities (*n*)	Unknown mortalities (*n*)
1991-1995[a]	38	21	0	17	12	4	10	1	11
1995-1996	11	9	0	2	5	0	2	0	4
1996-1997	8	3	0	5	4	0	0	0	4
1997-1998	5								
1998-1999	10	8	0	2	2	1	0	1	6
1999-2000	10	7	0	3	6	2	1	1	
2000-2001	34	18	4	12	6	5	0	0	23
2001-2002	14	8	3	3	3	2	0	0	9
2002-2003	12	6	2	4	1	1	2	0	8
2003-2004	38	21	7	10	3	5	0	5	25
2004-2005	9	3	2	4	0	6	0	0	3
2005-2006[c]	49	27		11	1	0	1	0	47
2006-2007	10	8	0	2	0	0	0	0	10
2007-2008	11	7	1	3	4	1	2	1	3
2008-2009	16	11	3	2	4	1	0	0	11
2009-2010	6	4	1	1	1	1	0	0	4
2010-2011	7	6	0	1	4	0	1	0	2
2011-2012	32	21	3	8	5	1	1	4	21
2012-2013	37	18	11	8	2		1		24
2013-2014	13	8	0	5	1		3	2	7
2014-2015	11	5	1	1	2			3	5
2015-2016	14	9	1	4	2				8
Total [d]	339	208	49	92	47	26	13	17	236

[a] Mortality total for years 1991-1995 is not broken out by individual years; the following years' data are recorded for 15 April through 14 April for each period, but also includes carcasses and remains found after snow melt in May.
[b] Swans with all white plumage over one year of age; likely some yearlings are included in this group.
[c] Age not determined for 15 reported mortalities this period; necropsy reports not completed on 14 specimens submitted to lab.
[d] Summary statistics are calculated only for the years 1998/1990-2015/2016.

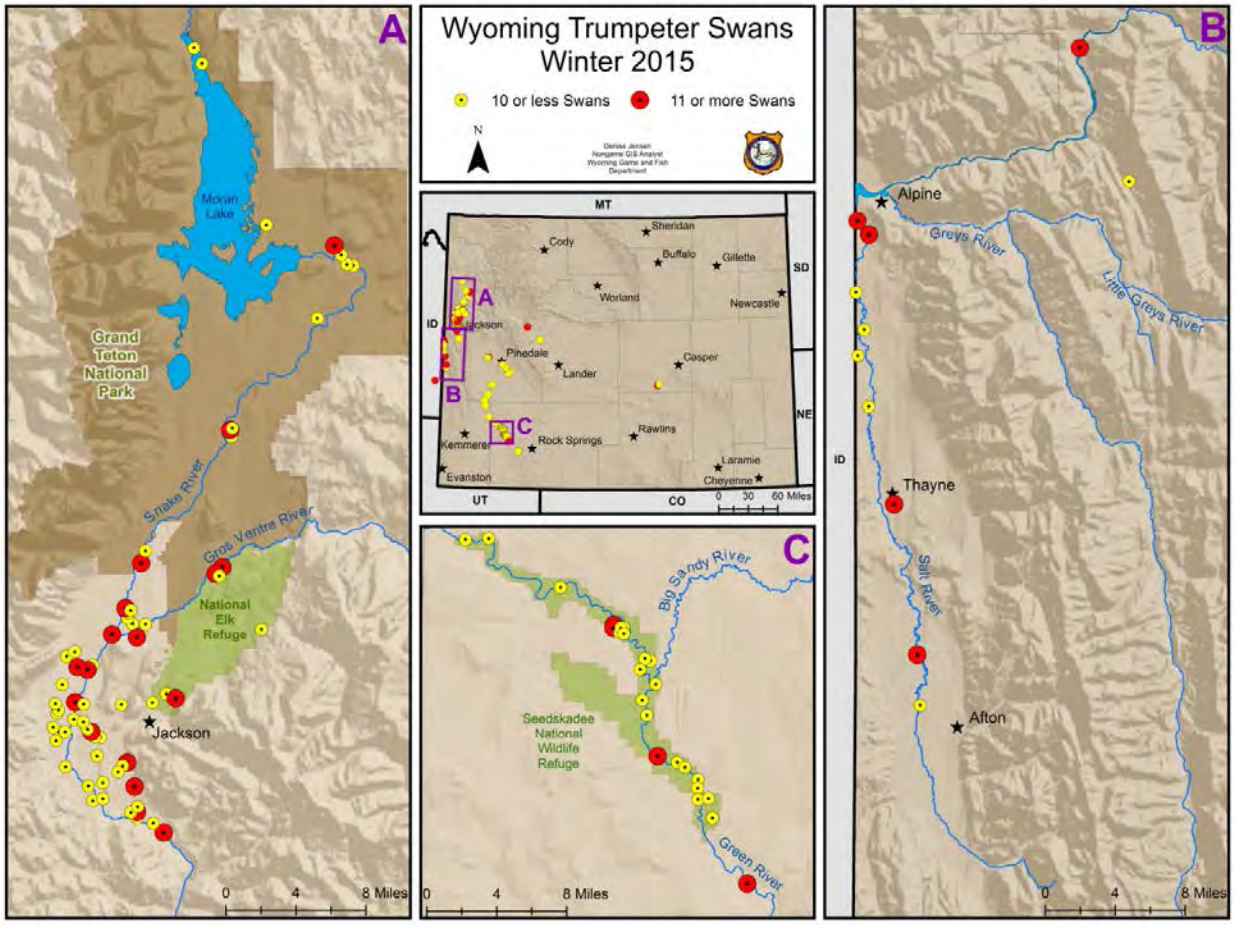

Figure 1. Locations of wintering Trumpeter Swans (*Cygnus buccinator*) in Wyoming documented during the annual winter aerial survey flown 11 February 2015 (Green River) and 12 February 2015 (Snake and Salt River drainages). Prior to management efforts beginning in the late 1980s to increase the distribution of swans in the Tri-State area, all swans wintered in the Jackson core area.

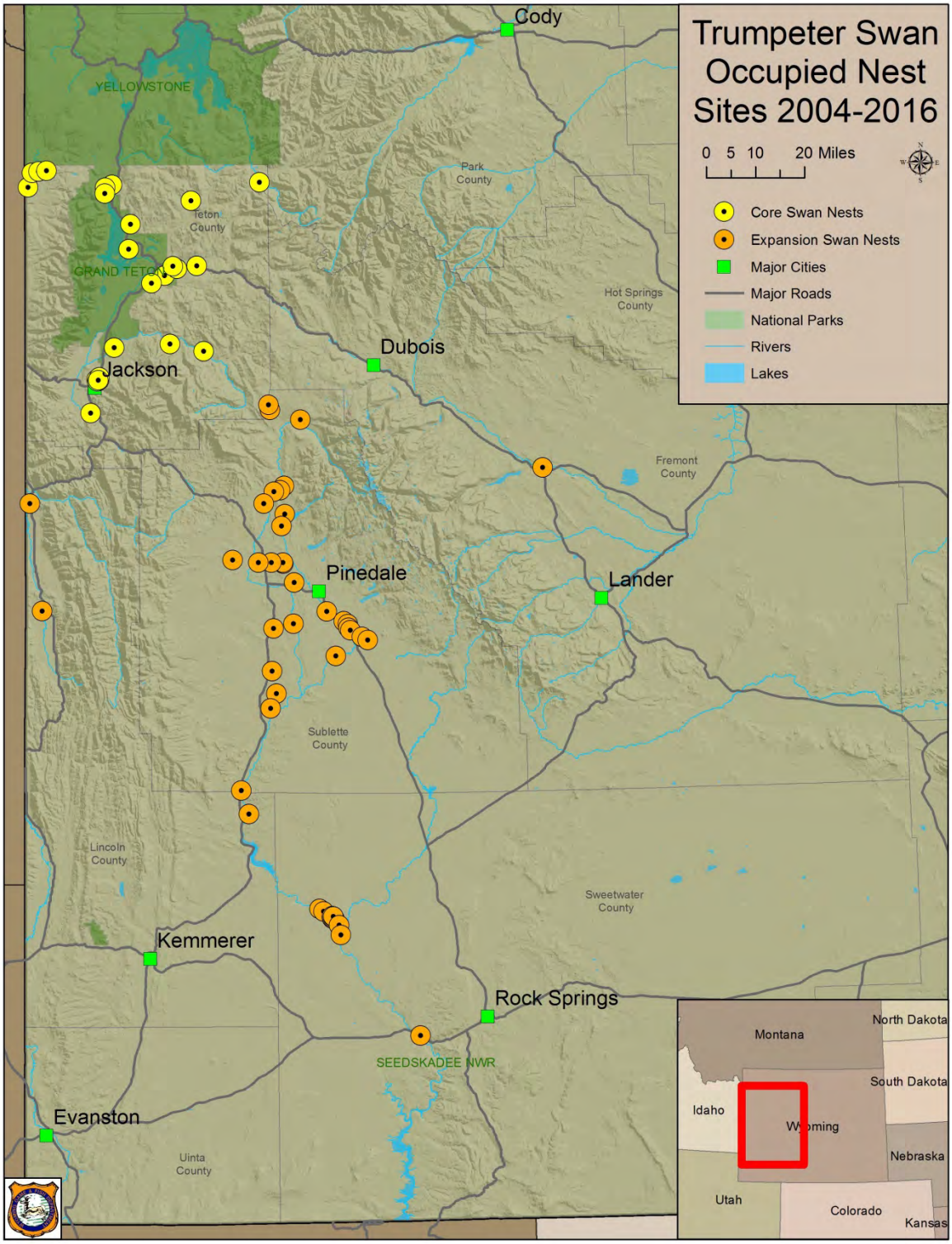

Figure 2. Locations of all wetland sites occupied at least 1 year by a pair of Trumpeter Swans (*Cygnus buccinator*) in Wyoming, 2004-2016 nesting seasons. Pairs did not build nests and lay eggs at all occupied sites. Yellows dots indicate sites located in the core Snake River area, and orange dots show sites found in the range expansion area of Wyoming.

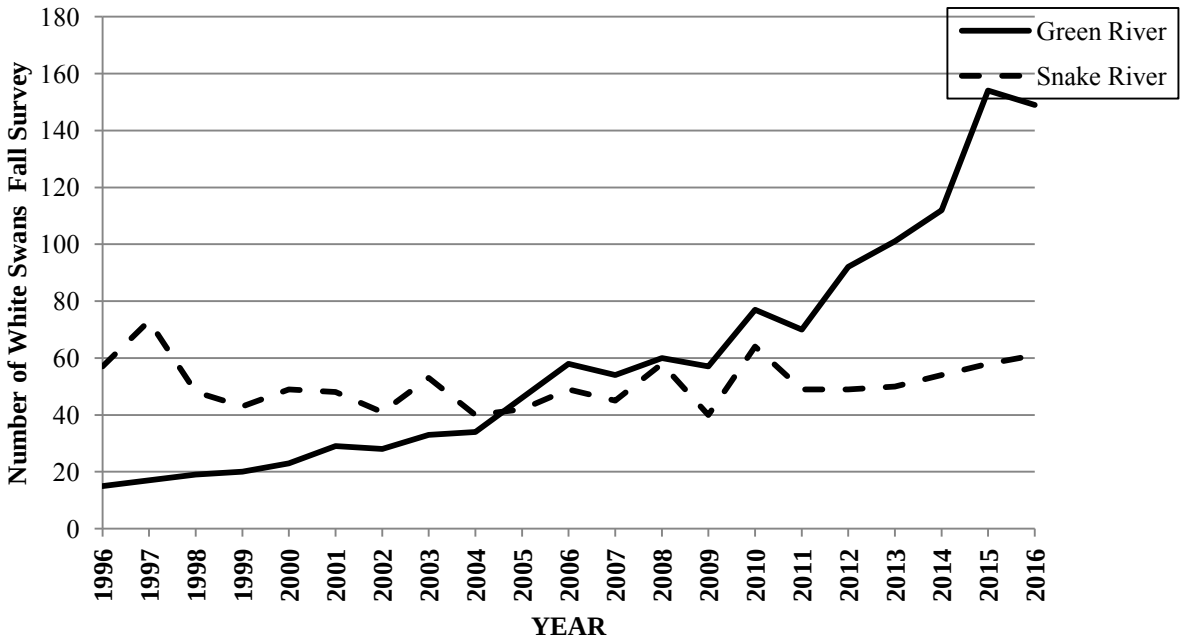

Figure 3. Comparison of the number of white swans (adults and subadults combined) counted on the annual fall aerial survey in September in the Snake River core area and the Green River expansion area in western Wyoming, 1996-2016.

Figure 4. Aerial photo of the newly completed Wild Red wetland project, September 2016 in Daniel, Wyoming. Funding for this wetland project was obtained through a standard North American Wetland Conservation Act grant that funded both conservation easement work and wetland restoration . The wetland was filled for the first time in April 2016. (Photo by S. Patla.)

Appendix I. Annual summary of occupancy and production status for all known Trumpeter Swan (*Cygnus buccinator*) nests in Wyoming outside Yellowstone National Park, 2006-2016 by area. Sites include: CTNF – Caribou Targhee National Forest; GTNP – Grand Teton National Park; NER – National Elk Refuge; and Seedskadee NWR – Seedskadee National Wildlife Refuge. Key to the table codes includes: O – pair occupied site through nest period, did not attempt to nest, did not molt on site; OM – pair occupied territory through nest period, did not attempt to nest, molted on site; OL – pair occupied site late after nest initiation period; Nxy – pair nested, x = number of young hatched, y = number of mature young in September; OUID – pair reported on site but status not determined; NB – nonbreeding swans present, likely subadults; F – swans observed on fall (September) flight only; 1A – only 1 adult present; NS – not surveyed; --- – no swans observed all season.

Site	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
CTNF											
Ernest Lake	---	---	---	---	---	---	---	---	---	---	---
Bergman Marsh	---	---	---	---	---	---	---	---	---	---	---
Indian Lake	N10	N44	O	N40	N30	N30	N41	O	OL	NB	NB
Widget Lake	---	---	---	---	---	---	---	---	---	---	---
Winegar Creek				N30	N20	N30	1A	N20	N40	N10	O
Winegar Creek east 2016											N20
Loon Lake	---	---	---	---	OL	---	---	---	---	---	F
Rock Lake	N00	---	O	---	---	---	---	---	---	---	F
Rock Lake Slough					N41	---	---	---	1A	---	---
Junco Lake	N00	---	---	O	---	---	---	---	---	F	---
Fish Lake	---	---	---	---	---	---	---	---	---	---	---
Squirrel Meadows	---	---	---	---	---	---	---	---	---	---	---
Moose Lake	---	---	---	---	---	---	---	---	---	---	---
GTNP											
Upper Glade	---	---	---	---	---	---	---	---	---	---	---
Steamboat Mountain	N43	O	O	OL	O	O	OL	N21	O	---	---
Glade Cliff Slough	N10	O	N00	O	O	O	N11	N22	N00	N33	N32
Glade South	O	O	---	---	---	---	---	O	---	F	NB
Flagg Gravel Pit Ponds						---	---	O	---	---	---
Arizona Lake	N40	N00	N00	N30	N20	N20	N00	---	O	OM	OL
Emma Matilda	NB	---	1A	OL	OL	OL	OL	O	---	O	OL

Appendix I. Continued.

Site	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
GTNP (cont.)											
Swan Lake	OL	OM	N22	O	OM	N55	O	O	O	OM	N21
Colter Slough new 2016											N00
Christian Pond	---	---	---	---	---	---	---	---	---	---	---
Hedrick Pond	1A	O	---	---	---	---	---	---	---	---	---
Elk Ranch	OM	O	O	O	OL	OL	O	O	OM	OM	O
Spread Creek Ponds	---	---	---	---	---	---	---	N20	1A	---	---
Halfmoon BV GTNP						N44	----	OL	---	1A	OL
NER											
Highway Pond NER	---	N55	---	---	N00	---	---	---	---	---	---
NE Marsh NER	N32	NB	O	---	---	O		N22	---	OM	NB
Flat Creek Island NER				N00	N10	N00	N00	N20	N53	N30	---
SE Marsh NER	N11	N42	N00	N11	---	O	N11		N11		N22
Central Marsh NER	N33	N57	N33	O	N55	N00	N11	N22	N22	N32	N21
Elk Jump Pond NER							N00	N00	N44	N00	N24
Pierre's Ponds	OM	---	---	---	NB	O	---	---	OL	F	NB
Romney Ponds	NB	N44	N44	N43	NB	O	NB	1A	OL	OM	O
Bill's Bayou								OL	---	---	---
Jackson area											
Skyline/Puzzleface	---	---	---	---	NB	NB	NB	OL	NB	O	O
WGF South Park	OL	OM	OM	N44	N66	N44	N55	N43	N55	N55	O
Pinto Pond Buffalo Valley	N33	N66	N44	N54	OM	N11	N00	N44	N44	N40	N44
Blackrock slough BTNF							N60	N60	N20	N00	---
Tracy Lake BTNF			OL	OL	OL	OL	NB	NB	NB	NB	O
Teton Wilderness											
Enos Lake BTNF	NB	NB	NB-3	---	NB	NB	NB	1A	1A	---	---
Atlantic Creek BTNF	---	---	---	nc	OUID	O	N00	N22	nc	N00	O
Gravel Lake BTNF											N?2

Appendix I. Continued.

Site	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Salt River											
Clark's Barn area pond										OL	O
Alpine Wetland North	NB	N00	---	NB	NB	NB	NB	NB	NB	NB	---
Alpine Wetland South		NB	O	N00	N00	N21	N00	O	N00	N00	O
Jacknife Creek area							O	---	---	---	---
Grover site										N00	---
Gros Ventre River											
Lower Slide Lake	---	---	---	---	NB	NB	---	NB	---	NB	---
Upper Slide Lake	N00	OM	OM	OM	OM	O	O	O	O	O	O
Blue Miner pond BTNF 2016											N50
Burnt Fork	---	---	---	NB	---	---	---	---	---	---	---
Soda Lake	---	---	---	---	---	---	---	---	---	---	---
Green/New Fork Rivers											
Wagon Creek Lake	---	---	NB	---	---	---	---	---	---	---	NB
Rock Crib	---	---	NB	---	---	---	---	---	O	---	NB
Wagon Creek Pothole		N00	---	---	N42	O	O	---	---	---	---
Mosquito Lake	NB	N32	N00	N00	O	OL	O	O	N22	N44	O
Pothole north of Mosquito										O	O
Roaring Fork Pond	---	---	---	---	---	---	---	---	---	---	---
Mud Lake	N20	N52	OE	---	OL	O	N00	O	O	N33	N40
Dollar Lake Slough										O	1A
Circle S Slough					N00	---	NB	---	N11	N22	N00
Jensen Pond, Green River							O	---	---	---	NB
Carney Oxbow	N00	N44	N00	N00	N22	N00	O	O	O	N22	N11
Carney Pond				N30	---	---	---	---	O	N11	N00
Q Y Bar Reservoir		O	O	---	---	---	---	---	---	---	---
O Bar Y Pond, new 2012							N44	N33	N44	N32	N33
Marsh Creek Pothole		N22	---	---	---	---	---	---	---	---	---
Kendall Wetland	NB	OL	N11	N33	OM	O	N44	N00	N22	N32	N00

Appendix I. Continued.

Site	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Green/New Fork Rivers (cont.)											
Blatt Res. Willow Creek							NB	O	O	NB	O
Kitchen Main	N33	N54	N53	N11	N22	N32	N43	N00	N33	N44	N22
Kitchen Middle	OM	OM	O	N22	N55	N43	---	---	N43	O	O
Fenn Duck Creek Pond									O	N10	N00
Seven Mile Ranch pond										O	---
40 Rod Creek Slough					F	NB	NB	N20	O	---	O
Vichory Reservoir							NB	N11	NB	O	N20
Webb Draw					F	N00	N10	N22	N20	N20	N22
MoCroft Lane, Pinedale							N00	---	O	N22	N33
Fayette New Fork	NB	N33	N40	N00	---	N33	N55	N52	---	---	---
Swift New Fork			N54	OL	N33	OL	NB	NB	N00	N22	N11
Barden Slough	OM	---		---	---	---	---	---	---	---	---
Swift Reservoir	OL	OL	NB	NB	OL	O	N21	N33	N11	N21	N33
EF Hunt Club/FH						N11	N21	N33	N00	N66	NB
Jensen Slough North Fork			OL	O	N22	O	N21	O	N11	N00	N33
Sommers Green River							O	N30	NB	---	---
Cottonwood Creek mouth							NB	---	---	---	NB
Rimfire Rendezvous							NB	NB	NB	NB	---
Rimfire Sophia/Alexander							OL	NB	O	NB	---
Soaphole BLM Pond							NB	N44	NB	N44	N00
Muddy Creek, N Big Piney							NB	---	O	N44	N66
Piney Cutoff Reservoir											N22
Ferry Island		N22	N33	N00	N44	OL	N22	N22	N22	N43	N33
Shafer Slough	NB	---	---	NB	NB	---	NB	---	---	O	OL
Reardon Draw						N11	NB	---	OL	---	---
Voorhees Pond	---	---	OL	---	N00	O	O	N40	O	NB	O
LaBarge Creek Pond						O	----	---	---		
Steed Canyon, new 2015										N00	N00

Appendix I. Continued.

Site	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Big Sandy River											
Big Sandy Reservoir	NS	---	nc	---	---	---	---	---	nc	NB	---
Eden Reservoir					1A	1A	NB2	---	nc	---	---
Farson area					N22	O	O	---	nc	NB	NB
Seedskadee NWR											
Hamp Unit	N53	O	N00	N00	N42	N42	N00	N22	N65	N55	N33
Block House Isle., new 2015										N00	---
Hawley 1	N54	N22	N33	N43	NB	O	N55	O	O	O	N22
Hawley 2	N66	N33	N66	N44	N55	N44	N66	N44	N20	N41	N33
Hawley 2 S					N43	N33	---	N33	O	N00	O
Hawley 3	---	NB	NB	---	NB	O	---	---	---	O	NB
Hawley 5				N33	NB	NB	---	---	---	O	
Hawley 6	N00	NB	NB	---	N44	N22	N55	N22	N66	N44	N33
Sage Pools		N31	N33	N75	N42	N22	N77	N55	N55	N22	N43
Dunkle Wetland										N11	N?0
Big Island										NB	NB
Green River Town											N?2
Other Wyoming											
Swamp Lake, Cody	---	---	NC	NC	NC	---	---	nc	nc	nc	nc
Trail Lake, Dubois	OM	---	---	---	---	---	---	---	---	nc	nc
Dinwoody Lake					F	---	---	---	---	nc	nc
Lake Julia					O	1A	---	---	---	nc	nc
Martens Pond, Wind River						O	---	N55	N33	---	1A
Alkali Lake, Wind River									NB	NB	NB
Colony, eastern WY	NS	---	---	NC	NC	OL	NB	---	nc	nc	nc

IMPLEMENTATION OF THE STANDARDIZED NORTH AMERICAN MARSH BIRD MONITORING PROTOCOLS FOR SPECIES OF GREATEST CONSERVATION NEED IN WYOMING: YEAR 2 SUMMARY

STATE OF WYOMING

NONGAME BIRDS: Species of Greatest Conservation Need – American Bittern, Virginia Rail
Secretive Marsh Birds

FUNDING SOURCE: Wyoming State Legislature General Fund Appropriations

PROJECT DURATION: Annual

PERIOD COVERED: 15 April 2016 – 14 April 2017

PREPARED BY: Andrea Orabona, Nongame Bird Biologist

SUMMARY

The American Bittern (*Botaurus lentiginosus*) is classified as an uncommon summer resident in Wyoming (Orabona et al. 2016) and a Species of Greatest Conservation Need (SGCN) with a Native Species Status (NSS) 3, Tier II by the Wyoming Game and Fish Department because of severely limited wetland habitat necessary for reproduction and survival (WGFD 2017). Because of their secretive behavior, American Bitterns require a species-specific call-playback technique to document presence. In previous years, we used the Standardized North American Marsh Bird Monitoring Protocol (Conway et al. 2009) to conduct annual monitoring along 5 survey routes on the Cokeville Meadows National Wildlife Refuge (CMNWR; Refuge) in western Wyoming to determine presence and evaluate population trend of American Bitterns over time.

In 2015, we eliminated 3 of the survey routes on the CMNWR due to issues beyond our control (e.g., flooding, blocked access) and concern for human health and safety along the railroad right-of-way through a portion of the marsh habitat along which these surveys were located. However, due to willing participation by 2 landowners with property adjacent to the Refuge, we were able to add 2 new routes in place of the routes we eliminated for a total of 4 routes on the Refuge (Figure 1).

To better ascertain distribution and status of American Bitterns and other secretive marsh birds in Wyoming, we evaluated marsh habitat throughout the state to locate additional sites suitable for implementing the standardized survey methods for secretive marsh birds. We set up 7 new survey routes (Yellowtail Wildlife Habitat Management Area [WHMA], $n = 3$; Table

Mountain WHMA, *n* = 1; Ocean Lake WHMA, *n* = 1; Dad Wetland, *n* = 1; and Hutton Lake NWR, *n* = 1) for a total of 11 routes in 6 wetland sites across Wyoming (Figures 2-13).

In 2015, we initiated an annual monitoring program for the American Bittern at these sites, and included 3 additional national marsh bird focal species: Pied-billed Grebe (*Podilymbus podiceps*), Virginia Rail (*Rallus limicola*), and Sora (*Porzana carolina*). Although the Virginia Rail and Sora are game species, there are currently no survey efforts in place to ascertain their distribution and occupancy in Wyoming. Furthermore, the Virginia Rail is classified as a SGCN NSSU, Tier III in Wyoming due to restricted population size and distribution (WGFD 2017).

Using the national secretive marsh bird call-playback technique will both standardize and add value to our survey efforts. Our results will be able to be compared with those from across the US where this method is also being employed, and our data will be added to the national marsh bird database to increase knowledge of species distribution and status on a larger scale. A summary of the species detected in 2016, the 2nd survey year, is presented in Table 1.

ACKNOWLEDGEMENTS

Funding for this project was provided by the Wyoming State Legislature, for which the Department is extremely grateful. We would also like to express our appreciation to USFWS personnel at the Cokeville Meadows National Wildlife Refuge and Seedskadee National Wildlife Refuge for supporting our monitoring program and their continued efforts to improve wetland habitat at Cokeville Meadows to benefit Species of Greatest Conservation Need. Special thanks are extended to E. Pope and T. Teichert for supporting this monitoring program by giving us permission to conduct surveys on their private lands. Thanks to C. Conway, US Geological Survey, for assistance with questions regarding the Standardized North American Marsh Bird Monitoring Protocols. Finally, we thank Department personnel J. Altermatt, S. Tessman, and T. Mong for assistance with survey site locations and directions, and Department GIS Analysts D. Jensen and N. Whitford for producing the survey maps.

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Table 1. Target species and we detected during secretive marsh bird surveys on 11 routes in Wyoming, 2016. Surveys were conducted between 12 May and 30 June 2016. We attempted to conduct 3 replicates per survey route, with a minimum of 2 weeks between each replicate. Morning surveys started by 0530 and ended by 0730. Evening surveys started by 2015 and ended by 2145.

Route name (surveyor)	1st replicate 2016	Target species (number)	2nd replicate 2016	Target species (number)	3rd replicate 2016	Target species (number)
Dad Wetland (Brad Rogers)	2 June	AMBI (1) PBGR (0) SORA (8) VIRA (0)	16 June	AMBI (3) PBGR (0) SORA (7) VIRA (0)	30 June (not run – high wind and noise)	n/a
Ocean Lake (Andrea Orabona)	New route; not set up yet	n/a	New route; not set up yet	n/a	23 June	AMBI (2) PBGR (6) SORA (1) VIRA (1)
Pixley (Andrea Orabona)	Not run due to other surveys	n/a	15 June	AMBI (7) PBGR (2) SORA (15) VIRA (0)	30 June	AMBI (0) PBGR (2) SORA (9) VIRA (0)
Pope (Andrea Orabona)	Not run due to other surveys	n/a	14 June	AMBI (4) PBGR (1) SORA (7) VIRA (0)	29 June	AMBI (9) PBGR (1) SORA (22) VIRA (0)
Teichert (Andrea Orabona)	Not run due to other surveys	n/a	14 June	AMBI (8) PBGR (3) SORA (17) VIRA (0)	29 June	AMBI (5) PBGR (4) SORA (19) VIRA (3)
Thornock (Andrea Orabona)	Not run due to other surveys	n/a	13 June	AMBI (13) PBGR (2) SORA (15) VIRA (1)	30 June	AMBI (16) PBGR (1) SORA (32) VIRA (3)
Rush Lake (Jennifer Wilson)	25 May	AMBI (0) PBGR (8) SORA (2) VIRA (1)	7 June	AMBI (0) PBGR (4) SORA (2) VIRA (3)	28 June	AMBI (0) PBGR (8) SORA (0) VIRA (0)

Table 1. Continued.

Route name (surveyor)	1st replicate 2016	Target species (number)	2nd replicate 2016	Target species (number)	3rd replicate 2016	Target species (number)
Table Mountain (Jennifer Wilson)	25 May	AMBI (0) PBGR (2) SORA (0) VIRA (2)	7 June	AMBI (0) PBGR (4) SORA (0) VIRA (3)	28 June	AMBI (0) PBGR (5) SORA (1) VIRA (1)
Yellowtail East (Jerry Altermatt)	19 May	AMBI (0) PBGR (0) SORA (4) VIRA (0)	7 June	AMBI (0) PBGR (3) SORA (1) VIRA (1)	14 June	AMBI (0) PBGR (?) SORA (0) VIRA (1)
Yellowtail South (Jerry Altermatt)	12 May	AMBI (0) PBGR (0) SORA (0) VIRA (0)	3 June	AMBI (0) PBGR (0) SORA (0) VIRA (0)	17 June	AMBI (0) PBGR (0) SORA (0) VIRA (0)
Yellowtail West (Jerry Altermatt)	20 May	AMBI (0) PBGR (0) SORA (?) VIRA (1)	6 June	AMBI (0) PBGR (0) SORA (0) VIRA (2)	17 June	AMBI (0) PBGR (?) SORA (2) VIRA (?)
Total routes = 11	*Highest total count of target species for all routes combined:* *AMBI = 29, PBGR = 31, SORA = 106, VIRA = 16*					

Key to species codes:

Species codes – target species	Common name	Scientific name
AMBI	American Bittern	*Botaurus lentiginosus*
PBGR	Pied-billed Grebe	*Podilymbus podiceps*
SORA	Sora	*Porzana carolina*
VIRA	Virginia Rail	*Rallus limicola*

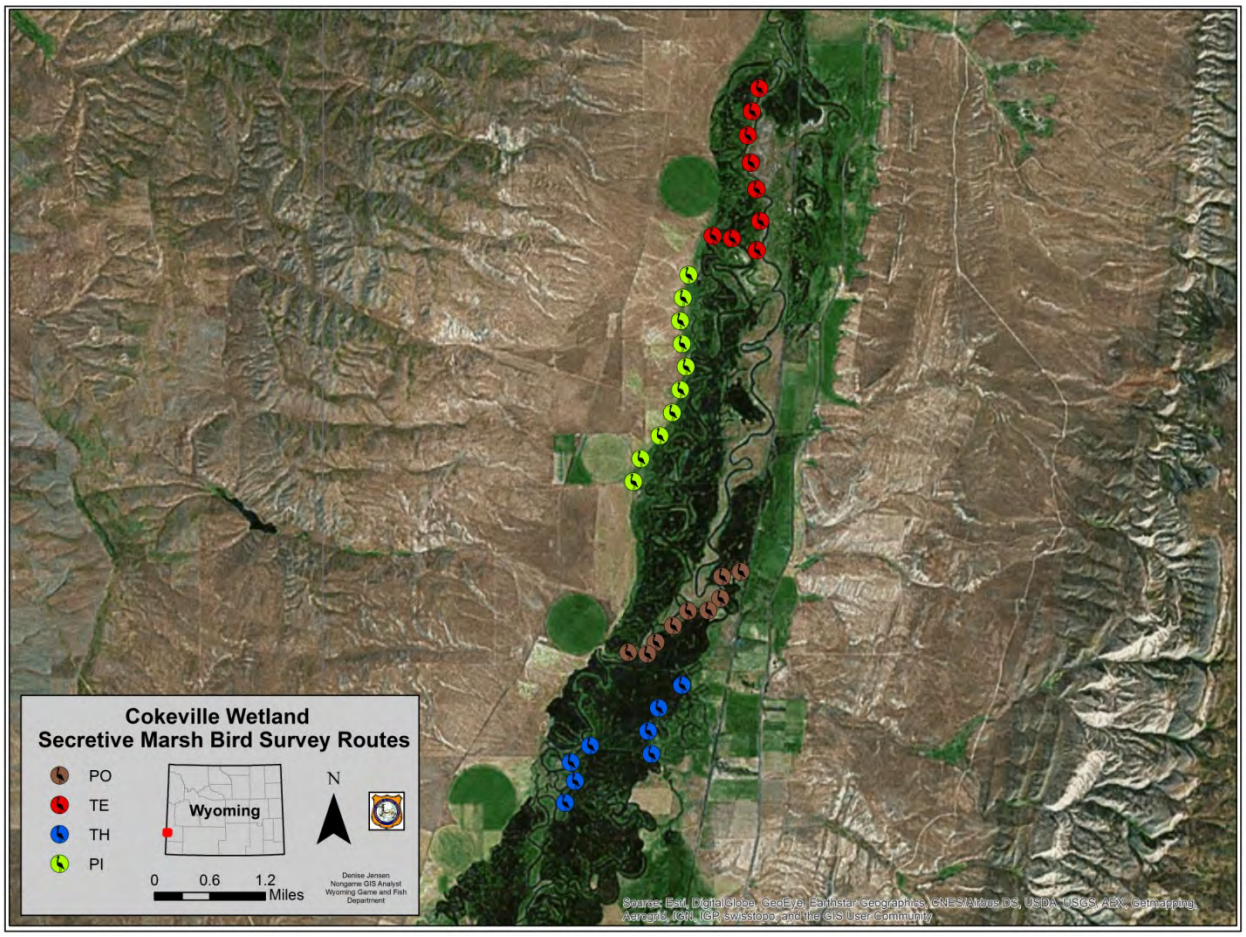

Figure 1. Locations of secretive marsh bird survey routes we established on and adjacent to the Cokeville Meadows National Wildlife Refuge (CMNWR) in Wyoming using the Standardized North American Marsh Bird Monitoring Protocol (Conway et al. 2009). PO = Pope route (private land), TE = Teichert route (private land), TH = Thornock route (CMNWR), and PI = Pixley route (CMNWR).

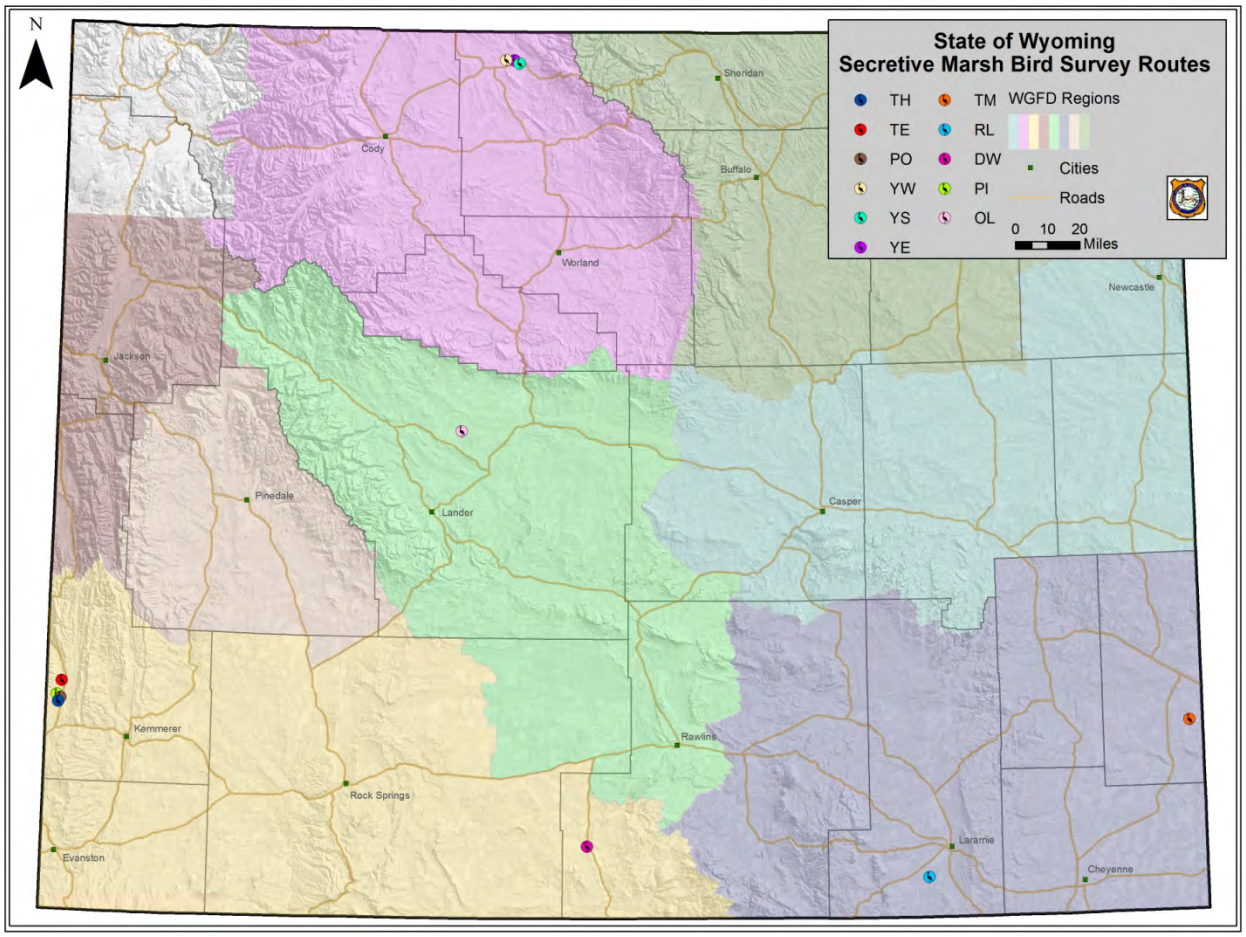

Figure 2. Statewide secretive marsh bird survey route locations we established in 2014 and 2016 in suitable wetland habitat for implementing the Standardized North American Marsh Bird Monitoring Protocol (Conway et al. 2009). DW = Dad Wetland route, PI = Pixley route, PO = Pope route, OL = Ocean Lake route, RL = Rush Lake route, TE = Teichert route, TH = Thornock route, TM = Table Mountain route, YE = Yellowtail East route, YS = Yellowtail South route, YW = Yellowtail West route.

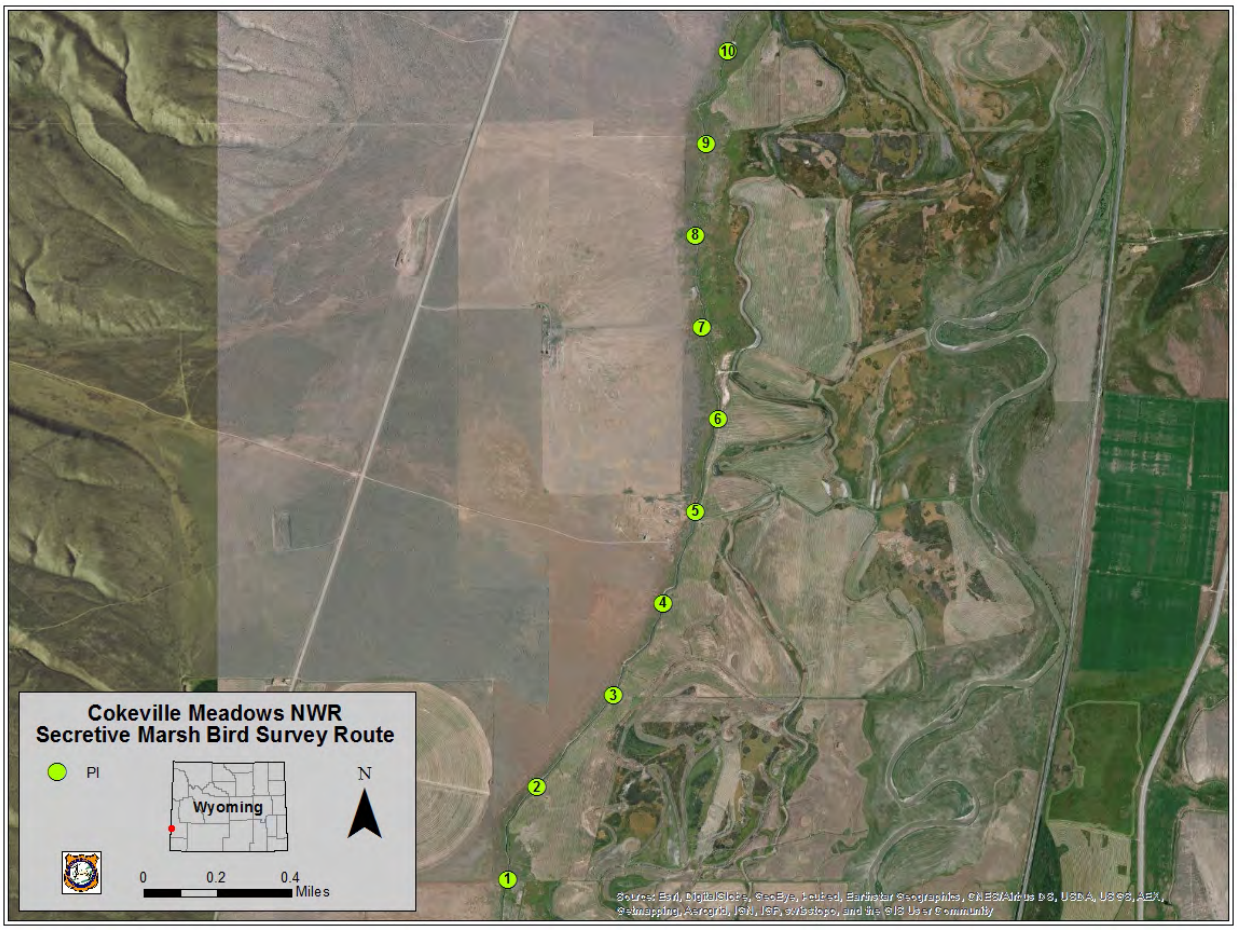

Figure 3. Location of the Pixley secretive marsh bird survey route we established on the Cokeville Meadows National Wildlife Refuge, Wyoming.

Figure 4. Location of the Pope secretive marsh bird survey route we established near the Cokeville Meadows National Wildlife Refuge, Wyoming.

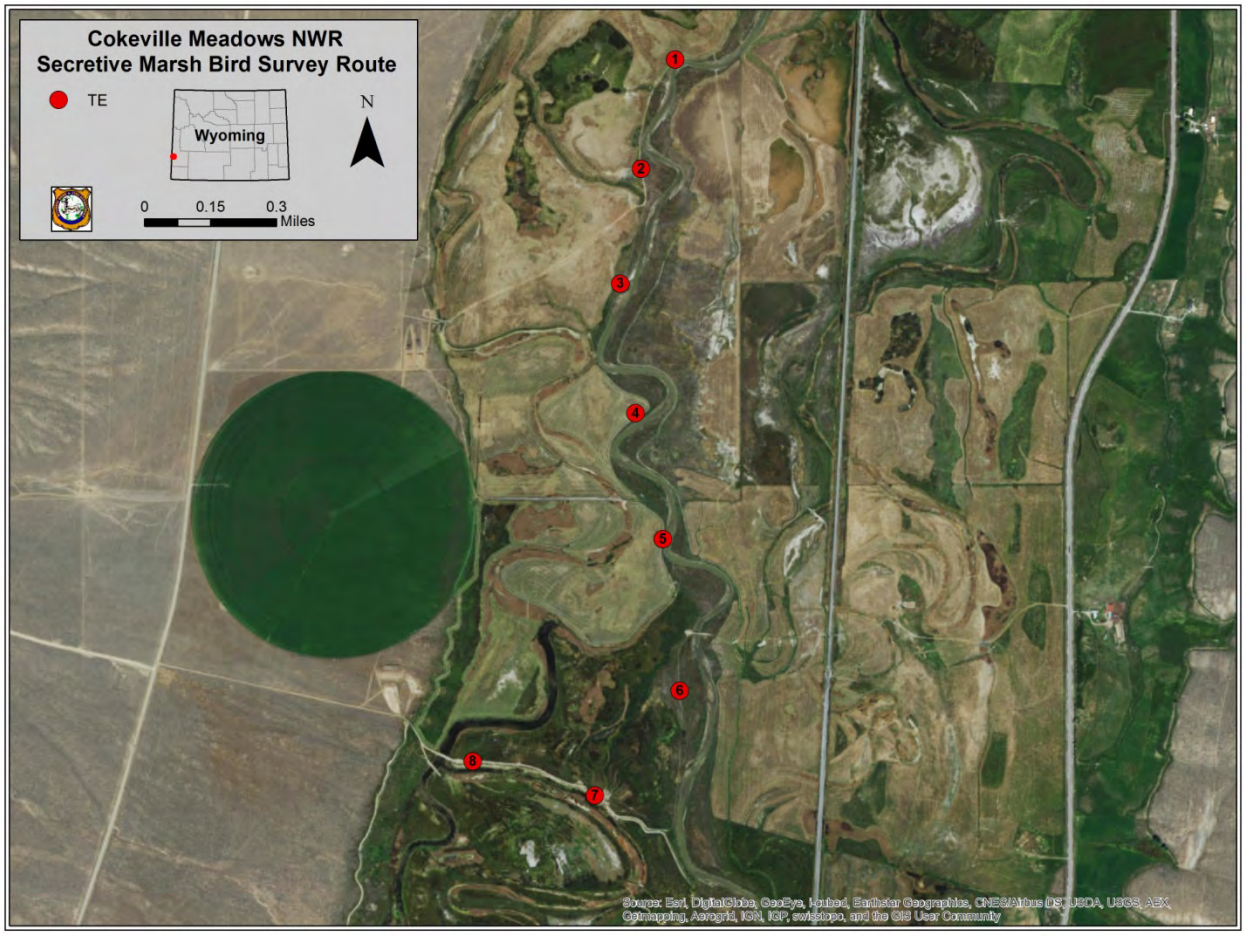

Figure 5. Location of the Teichert secretive marsh bird survey route we established near the Cokeville Meadows National Wildlife Refuge, Wyoming.

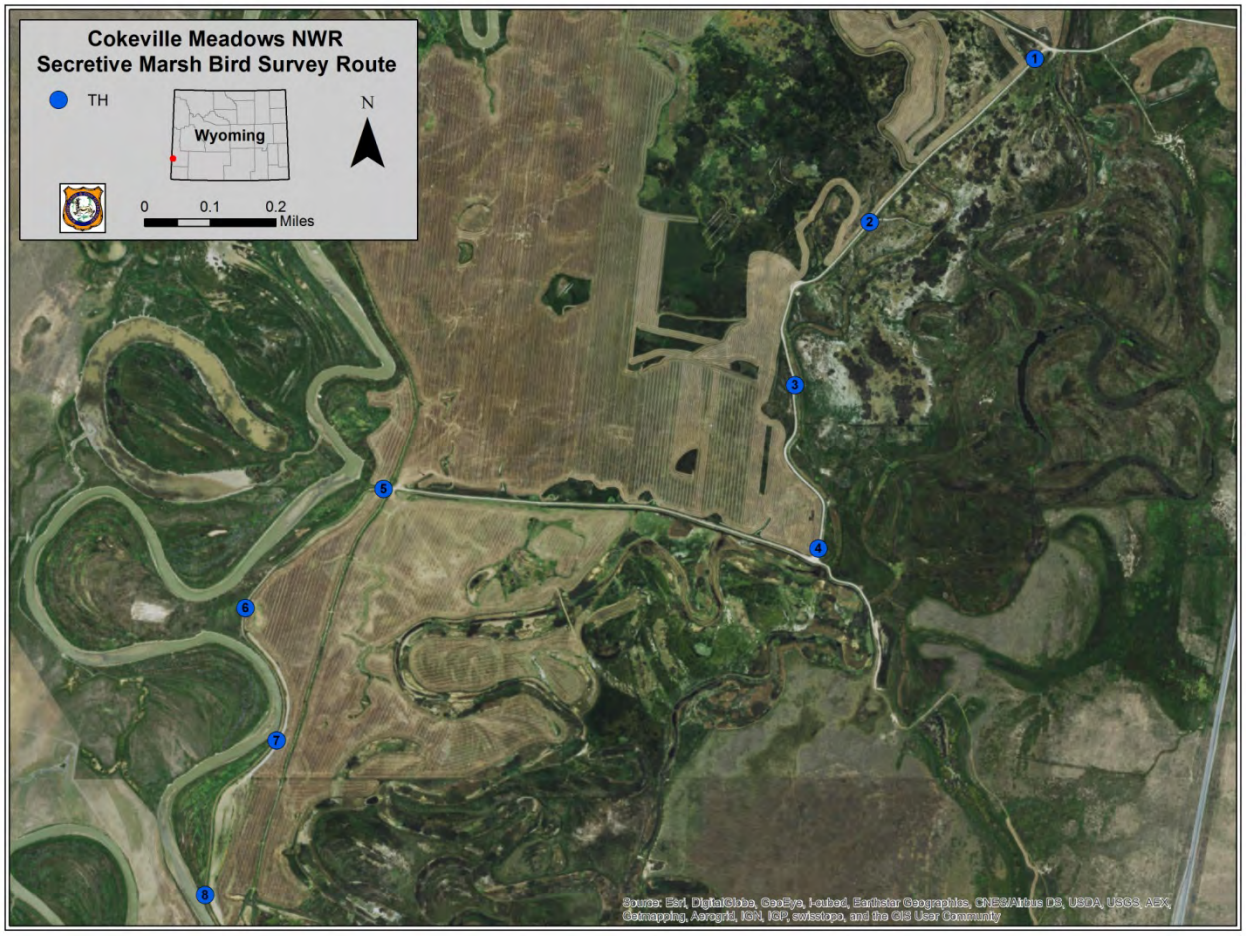

Figure 6. Location of the Thornock secretive marsh bird survey route we established on the Cokeville Meadows National Wildlife Refuge, Wyoming.

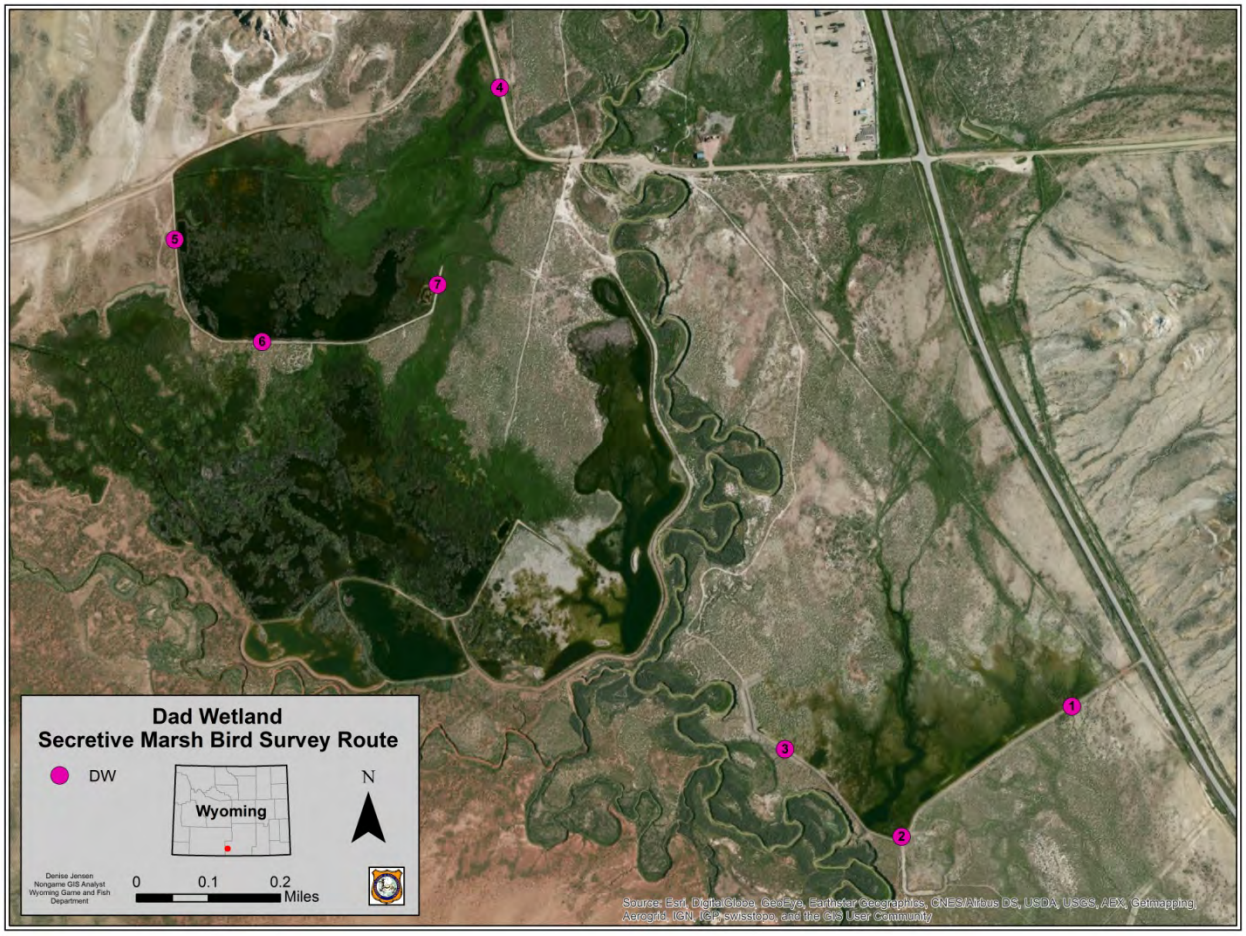

Figure 7. Location of the Dad Wetland secretive marsh bird survey route we established near Baggs, Wyoming.

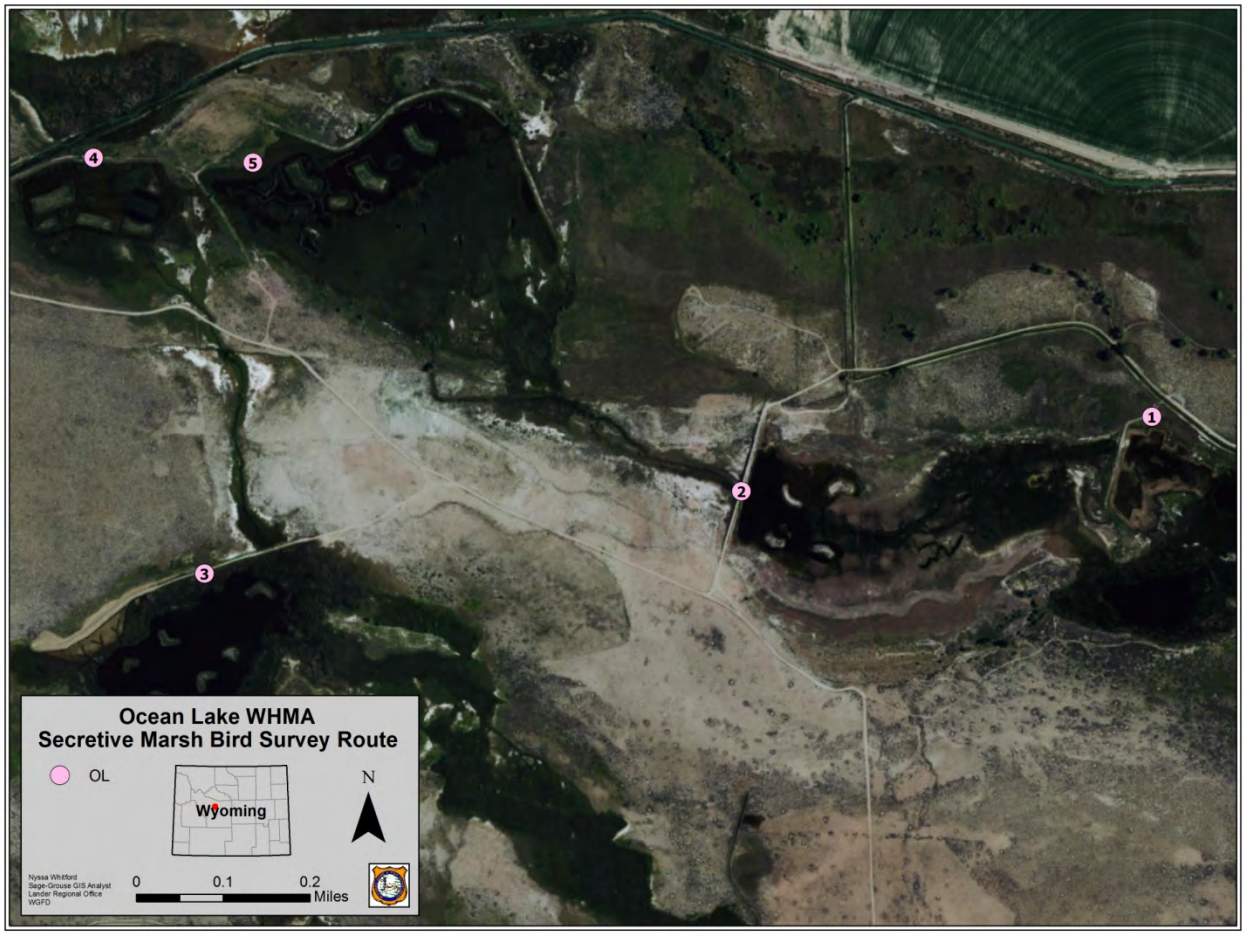

Figure 8. Location of the Ocean Lake secretive marsh bird survey route we established on the Ocean Lake Wildlife Habitat Management Area, Wyoming.

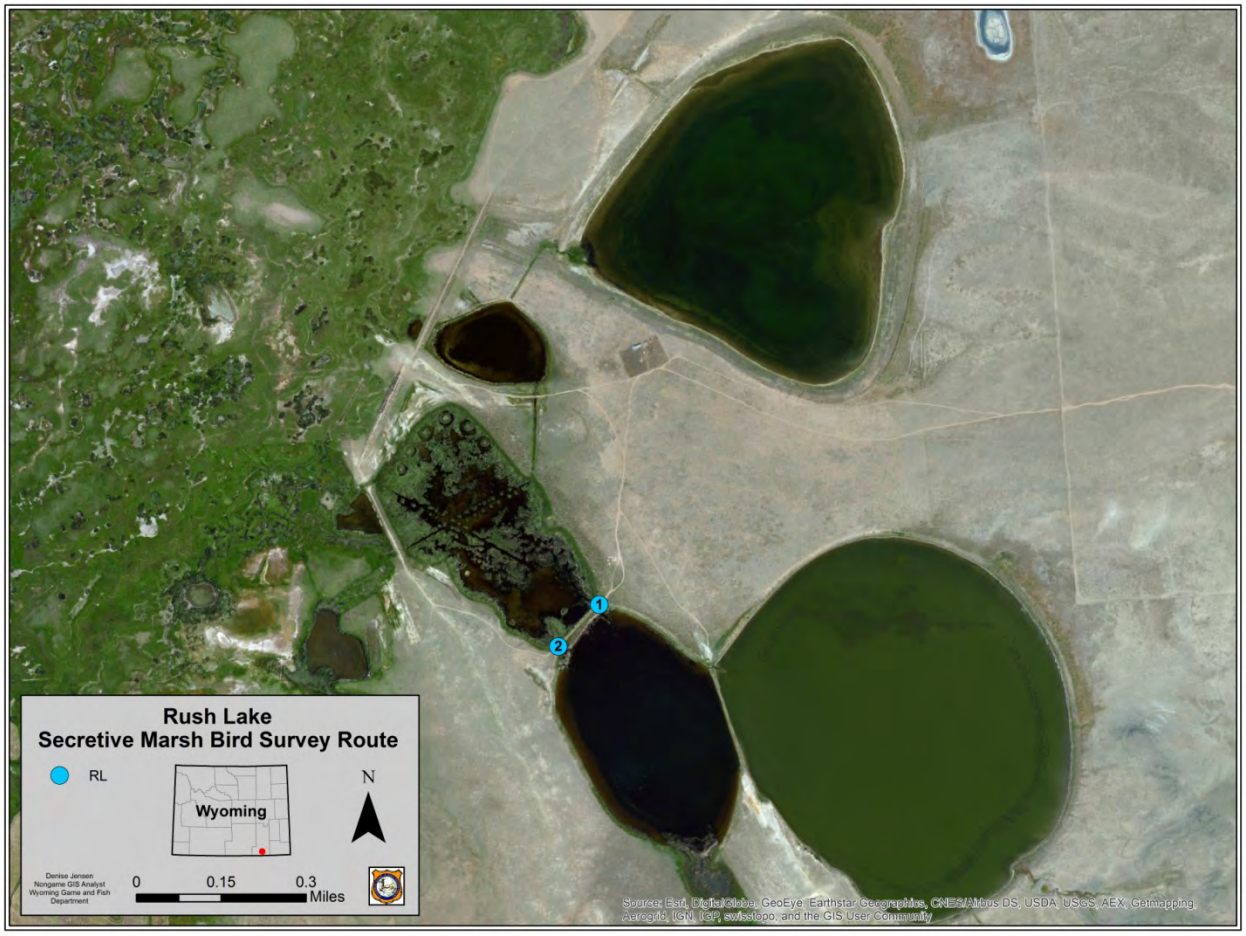

Figure 9. Location of the Rush Lake secretive marsh bird survey route we established on the Hutton Lake National Wildlife Refuge, Wyoming.

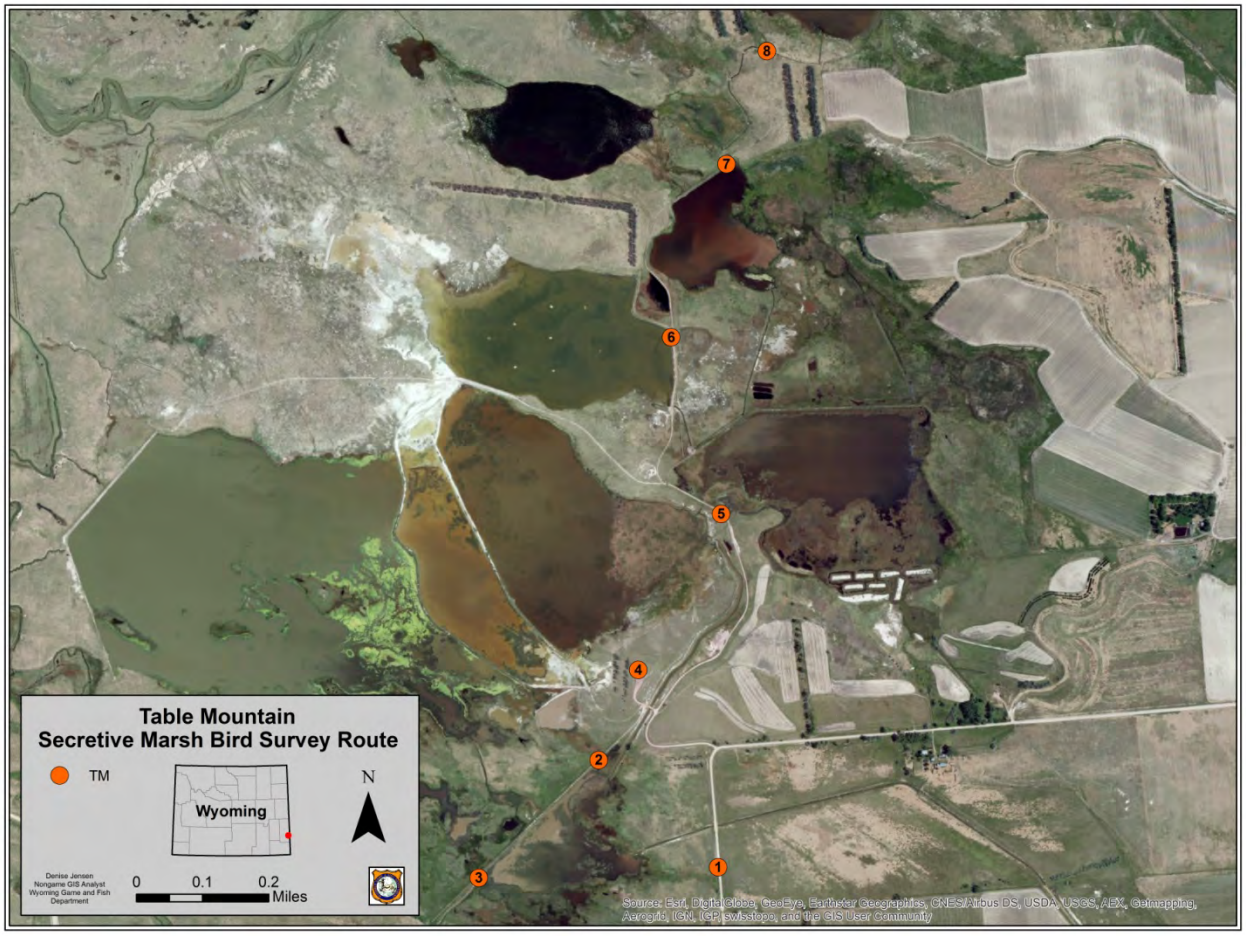

Figure 10. Location of the Table Mountain secretive marsh bird survey route we established on the Table Mountain Wildlife Habitat Management Area, Wyoming.

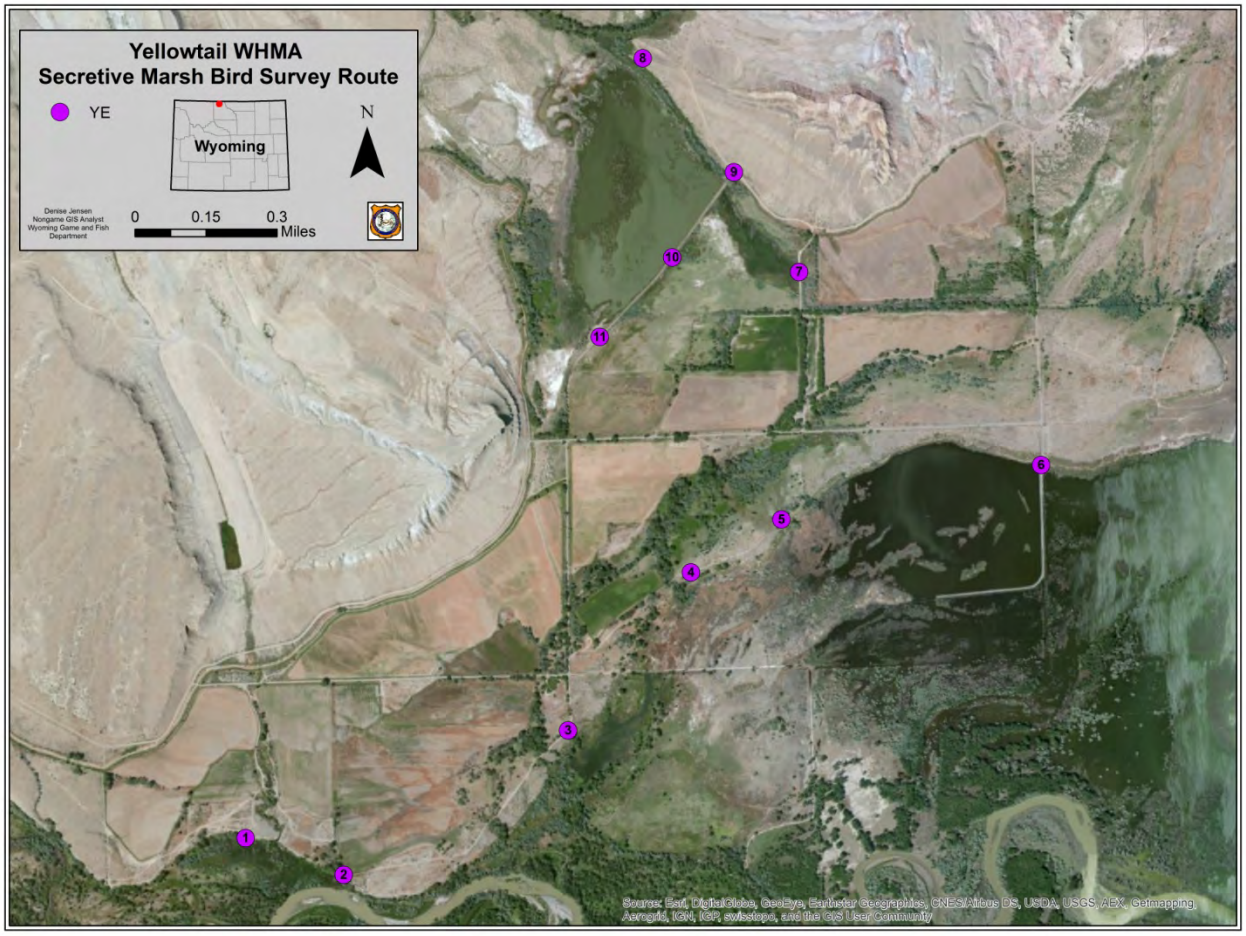

Figure 11. Location of the Yellowtail East secretive marsh bird survey route we established on the Yellowtail Wildlife Habitat Management Area, Wyoming.

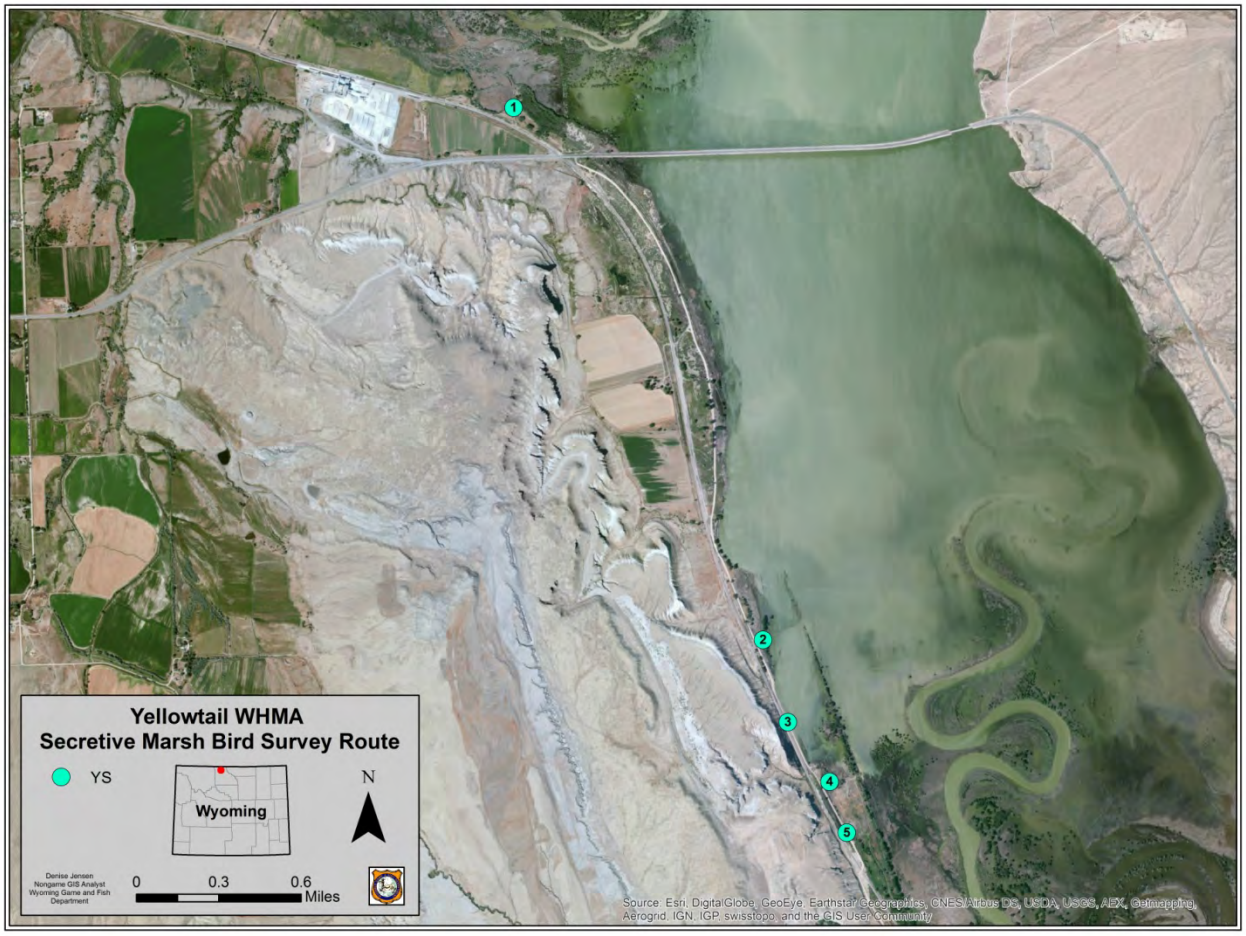

Figure 12. Location of the Yellowtail South secretive marsh bird survey route we established on the Yellowtail Wildlife Habitat Management Area, Wyoming.

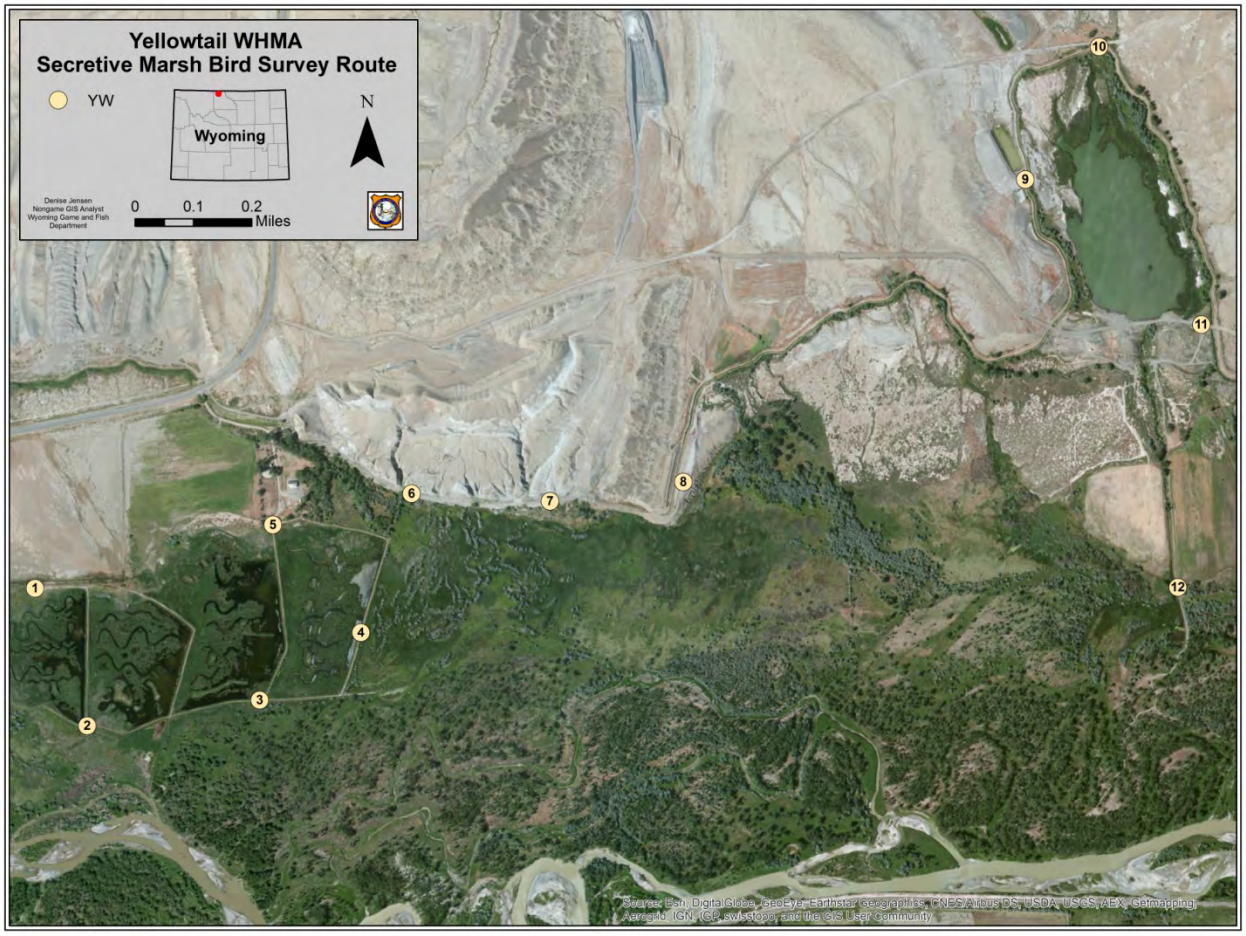

Figure 13. Location of the Yellowtail West secretive marsh bird survey route we established on the Yellowtail Wildlife Habitat Management Area, Wyoming.

LONG-TERM MONITORING OF AVIAN GRASSLAND SPECIES OF GREATEST CONSERVATION NEED IN WYOMING: SUMMARY OF YEAR 2 RESULTS

STATE OF WYOMING

NONGAME BIRDS: Species of Greatest Conservation Need – Mountain Plover, Upland Sandpiper, Long-billed Curlew, and Burrowing Owl

FUNDING SOURCE: Wyoming State Legislature General Fund Appropriations
Wyoming Game and Fish Department

PROJECT DURATION: Annual

PERIOD COVERED: 1 April 2016 – 31 August 2017

PREPARED BY: Andrea Orabona, Nongame Bird Biologist

SUMMARY

Grasslands are known to be among the most biologically productive of all plant communities (Williams and Diebel 1996). Their exceptional productivity is a result of a high retention of nutrients, efficient biological recycling, and a structure that provides for an immense assemblage of animal and plant life (Estes et al. 1982). Of the 435 avian species that breed in the US, 330 are known to breed within the 1.3 million km^2 that comprise the Great Plains (Knopf and Samson 1995). Of those 330 species, 12 are endemic to the grasslands; an additional 25 species evolved on the grasslands, even though they may also range widely into adjoining habitat types such as sagebrush, shrubsteppe, and wetlands (Mengel 1970; Table 1; Figure 1). All 9 of the avian species deemed narrow endemics to the northern Great Plains grasslands occur in Wyoming (Knopf 1996; Table 1). Furthermore, 9 of the 12 grassland endemic species and 15 of the 20 secondary grassland-specific species are regularly occurring breeders in Wyoming (Table 1). The majority of bird species endemic to the shortgrass and mixed-grass prairies are associated with large grazing animals such as bison, while other species such as the Ferruginous Hawk (*Buteo regalis*), Prairie Falcon (*Falco mexicanus*), and Burrowing Owl (*Athene cunicularia*) are either somewhat or strongly associated with the presence of prairie dog colonies on the landscape (Knopf and Samson 1997).

Land conversions from native prairie to agricultural uses, habitat loss and fragmentation, industrialization including wind energy development and natural resources extraction, the introduction and spread of invasive and noxious plants, urbanization, fire suppression, wetland draining, and the removal of native grazers have transformed the grasslands of the Great Plains into 1 of the most imperiled ecosystems in North America (Knopf 1996, Samson et al. 1998; Fellows and Jones 2009). As a group, grassland birds have shown steeper, more consistent, and

more widespread declines than any other guild of species in North America (Knopf 1992, 1994, 1996).

In 2003, Wyoming Partners in Flight presented information, issues, and recommendations for priority species in the Wyoming Bird Conservation Plan, Version 2.0 (Nicholoff 2003). Recommendations included dedicated monitoring for priority species. In 2006, Wyoming Game and Fish Department (Department) Nongame Program personnel developed A Plan for Bird and Mammal Species of Greatest Conservation Need in Eastern Wyoming Grasslands (Grassland Plan) that identified habitat and species issues and presented objectives to address these concerns (WGFD 2006). The objectives included maintaining inventory and monitoring programs for wildlife populations, working toward removing species from Species of Greatest Conservation Need (SGCN) classification, and working cooperatively with landowners to achieve common goals. The Wyoming State Wildlife Action Plan (SWAP) further identifies problems, conservation actions, and monitoring and research needs for all SGCN (WGFD 2017). Two grassland endemics—Mountain Plover (*Charadrius montanus*) and Long-billed Curlew (*Numenius americanus*)—and 2 secondary grassland associates—Upland Sandpiper (*Bartramia longicauda*) and Burrowing Owl—are classified as SGCN in the SWAP (WGFD 2017; Table 1).

Although objectives, inventories, and conservation actions were initially being addressed by the Department's Landowner Incentive Program Coordinator, this position was vacated and is no longer available, leaving a gap in the grassland SGCN monitoring program and a limited ability to adequately address management and conservation of these SGCN. With a probable increase in industrialization in Wyoming and associated habitat modifications, the need to fill these data gaps is of critical importance. This will enable us to determine population parameters of these species, identify risks and concerns, and apply timely actions to address issues and avoid potential listings under the federal Endangered Species Act (ESA).

This project addresses 4 avian SGCN, 3 of which are classified as Native Species Status Unknown (NSSU; WGFD 2017) and will benefit greatly from a dedicated monitoring program. Current long-term monitoring programs (i.e., Breeding Bird Survey and Integrated Monitoring in Bird Conservation Regions) adequately monitor numerous species of birds in Wyoming, but do not sufficiently quantify population parameters for these 4 grassland species due to the seasonal timing during which the surveys are conducted and/or the survey techniques used.

The Mountain Plover is an uncommon summer resident in Wyoming (Orabona et al. 2016) with a NSSU, Tier I classification in the SWAP (WGFD 2017). A narrow range of habitat requirements combined with a high degree of site fidelity and susceptibility to disturbance during the nesting season increases its vulnerability to impacts that occur at breeding sites. In addition, crucial breeding areas are only partially identified, so management efforts may not adequately address conservation needs. Throughout its breeding range, the Mountain Plover is classified as uncommon to relatively common, but the species exists in low densities. The Mountain Plover was previously petitioned for listing as Threatened under the federal ESA on 2 separate occasions, further emphasizing the need to adequately determine population status (USFWS 1999, 2010).

The Upland Sandpiper is an uncommon summer resident in Wyoming (Orabona et al. 2016) with a NSSU, Tier II classification in the SWAP (WGFD 2017). Populations in eastern Wyoming may be experiencing serious declines due to habitat conversions, the encroachment of woody vegetation into grassland habitats, humanization, and the invasion of noxious species, all of which severely degrade breeding habitat for this species. This species is also sensitive to human disturbance during the breeding season. Population status and trends are largely unknown in Wyoming, and current monitoring programs do not adequately track this species because populations occur at low densities.

The Long-billed Curlew is an uncommon summer resident in Wyoming (Orabona et al. 2016) with a NSS3, Tier II classification in the SWAP (WGFD 2017). Although the breeding status is well known in the northwestern portion of Wyoming and monitoring is on-going, populations in eastern Wyoming are not well documented and may be declining significantly. Habitat degradation is 1 of the most considerable threats to this species, particularly in the Great Basin grasslands.

The Burrowing Owl is an uncommon summer resident in Wyoming (Orabona et al. 2016) with a NSSU, Tier I classification in the SWAP (WGFD 2017). It has experienced range-wide contractions due to habitat loss and degradation and the elimination of burrowing rodents. While distribution of this species is understood in the state, there is concern about the impacts of on-going and proposed oil, gas, and wind energy development in Burrowing Owl habitat in Wyoming, and informed management decisions are difficult to make without adequate occupancy and population trend information.

Wyoming Governor's Endangered Species Account funds were used to hire a seasonal field biologist from April through September in 2013 and 2014 to assist the Department's Nongame Bird Biologist with implementing this long-term, targeted monitoring program. We used existing information to identify preferred breeding habitat for our focal species, and followed standardized, peer-reviewed survey techniques specifically designed for each of our focal SGCN to delineate our survey routes (Figures 2-5).

Wyoming contains substantial areas of known and potential habitat for these SGCN, including areas where habitat degradation and conflicts with industrialization are likely to occur in the near future. However, due in part to personnel and funding constraints, important breeding areas and population status are only partially identified, which makes effective statewide management decisions challenging. Once we are able to implement targeted monitoring for these species, we can use survey results to address concerns, data deficiencies, and conservation actions presented in the Wyoming Bird Conservation Plan (Nicholoff 2003), Grassland Plan (WGFD 2006), and SWAP (2017). Moreover, avian grassland species are equally dependent on quality habitat in their breeding, migration, and winter ranges (Knopf 1996). Thus, the results of this project will help inform management decisions, address conservation concerns, and direct conservation actions on these species' breeding grounds in Wyoming. Results will also enhance our ability to advance conservation and management of grassland birds and their habitats through full life-cycle conservation.

ACKNOWLEDGEMENTS

Funding for this project was provided by the Wyoming State Legislature General Fund Appropriations, for which the Department is extremely grateful. We also thank Governor Mead for providing funding assistance in 2013 and 2014 through the Wyoming Governor's Endangered Species Account, which enabled us to establish over 90 new survey routes for Species of Greatest Conservation Need. Thanks to Department GIS Analysts, Denise Jensen and Nyssa Whitford, for producing all survey maps. We extend special thanks to the numerous Department personnel for their valuable monitoring assistance; individuals are identified in each of the SGCN tables.

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Table 1. Endemic and secondary species associated with the Great Plains grasslands (Mendel 1970). Species that breed in Wyoming are denoted in bold. Native Species Status (NSS) and Tier are from the Wyoming State Wildlife Action Plan (WGFD 2017). NSSU = Native Species Status Unknown. Table excludes wetlands-associated species, and those species that have stronger ecological associations with sagebrush (*Artemisia* spp.) landscapes of the Great Basin.

Common name	Scientific name	Seasonal status	Native species status and tier
Endemic species			
Ferruginous Hawk	*Buteo regalis*	**Year-round**	**NSS4, II**
Mountain Plover	*Charadrius montanus*	**Summer**	**NSSU, I**
Long-billed Curlew	*Numenius americanus*	**Summer**	**NSS3, II**
Marbled Godwit	*Limosa fedoa*	Migrant	
Wilson's Phalarope	***Phalaropus tricolor***	**Summer**	
Franklin's Gull	***Larus pipixcan***	**Summer**	**NSSU, II**
Sprague's Pipit	*Anthus spragueii*	Migrant	
Chestnut-collared Longspur	***Calcarius ornatus***	**Summer**	**NSS4, II**
McCown's Longspur	***Rhynchophanes mccownii***	**Summer**	**NSS4, II**
Cassin's Sparrow	*Peucaea cassinii*	Accidental	
Lark Bunting	***Calamospiza melanocorys***	**Summer**	
Baird's Sparrow	***Ammodramus bairdii***	**Summer**	**NSS4, II**
Secondary species			
Sharp-tailed Grouse	***Tympanuchus phasianellus***	**Year-round**	**NSS4, II**
Greater Prairie-Chicken	*Tympanuchus cupido*	Accidental	
Lesser Prairie-Chicken	*Tympanuchus pallidicinctus*		
Mississippi Kite	*Ictinia mississippiensis*	Accidental	
Northern Harrier	***Circus cyaneus***	**Summer**	
Swainson's Hawk	***Buteo swainsoni***	**Summer**	**NSSU, II**
Upland Sandpiper	***Bartramia longicauda***	**Summer**	**NSSU, II**
Burrowing Owl	***Athene cunicularia***	**Summer**	**NSSU, I**
Short-eared Owl	***Asio flammeus***	**Year-round**	**NSS4, II**
Prairie Falcon	***Falco mexicanus***	**Year-round**	
Horned Lark	***Eremophila alpestris***	**Year-round**	
Clay-colored Sparrow	***Spizella pallida***	**Summer**	
Vesper Sparrow	***Pooecetes gramineus***	**Summer**	
Lark Sparrow	***Chondestes grammacus***	**Summer**	
Savannah Sparrow	***Passerculus sandwichensis***	**Summer**	
Grasshopper Sparrow	***Ammodramus savannarum***	**Summer**	**NSS4, II**
Henslow's Sparrow	*Ammodramus henslowii*		
Dickcissel	***Spiza americana***	**Summer**	**NSSU, II**
Eastern Meadowlark	*Sturnella magna*	Accidental	
Western Meadowlark	***Sturnella neglecta***	**Summer**	

Table 2. Results from the 2nd year of surveys for Mountain Plover (*Charadrius montanus*) in Wyoming. We planned to survey Mountains Plovers (MOUP) from the last 10 days of June through the 1st week of July in 2016, during the pre-fledging and brood-rearing phase. We attempted to conduct 1 Mountain Plover survey per route.

MOUP route	Assigned observer	Survey date	Total MOUP	Comments and other Species of Greatest Conservation Need detected
Arminto	Heather O'Brien	21 June	1	Flight call heard
Bucknam Road	Daniel Beach	6 July	0	
Bush Rim	Andrea Orabona	5 July	11	4 juvenile MOUP also detected
Fetterman Road	Bob Lanka	26 June	0	
Great Divide Basin	Greg Hiatt	28 June	1	SGCN = 1 Burrowing Owl
Laramie Basin	Lee Knox	29 June	0	
Lysite	Greg Anderson	28 June	2	
Marshall Road	Jennifer Wilson	n/a	n/a	Data sheet unavailable due to computer issues
Mexican Flats	Tony Mong	30 June	0	
North Cody	Tim Woolley	5 July	11	1 juvenile MOUP also detected; Juliann Terry ran the route
Polecat Bench	Tim Woolley	18 July	0	Juliann Terry ran the route
Red Desert	Stan Harter	7 July	2	
Shirley Basin	Will Schultz	26 and 30 June	1	Split date on survey due to inclement weather
Thunder Basin Central	Joe Sandrini	29 June	0	SGCN = 2 adult and 2 juvenile Upland Sandpipers
Thunder Basin North	Joe Sandrini	21 June	9	1 juvenile MOUP also detected; SGCN = 2 Burrowing Owls
Thunder Basin South	Willow Steen	28 June	3	3 juvenile MOUP; SGCN = 1 Upland Sandpiper
Total routes = 16		*Total Adult MOUP = 41*		*Total routes completed out of 16 = 15*

Table 3. Results from the 2nd year of surveys for Upland Sandpiper (*Bartramia longicauda*) in Wyoming. We planned to survey Upland Sandpipers (UPSA) from early June to mid-July 2016, when they are on their breeding grounds in Wyoming. We attempted to conduct 2 surveys along each route using the same observer per route, with surveys separated by a minimum of 10 and maximum of 14 days to incorporate the range of the breeding season and facilitate detection.

UPSA route	Assigned observer	1st replicate	Total UPSA	2nd replicate	Total UPSA	Comments and Species of Greatest Conservation Need (SGCN) detected
Bariod Road	Andrea Orabona	8 June	8	8 July	3	Surveys completed
Douglas	Rod Lebert	n/a	n/a	n/a	n/a	Data sheets unavailable due to computer issues
East Sheridan	Dustin Shorma	?	0	?	0	Data sheets unavailable due to computer issues; observer has never detected UPSA on the route
East Yoder	Grant Frost	28 June	0	8 July	1	Surveys completed
Glendo	Martin Hicks	8 June	3	none	n/a	Only 1 survey completed
Goldie Divide	Andrea Orabona	7 June	7	7 July	5	Surveys completed
Hulett West	Erika Peckham	10 June	1	15 July	0	Surveys completed
Jireh Road	Willow Steen	10 June	5	21 June	8	Surveys completed; SGCN = 2 Burrowing Owls 10 June, 1 Burrowing Owl 21 June

Table 3. Continued.

UPSA route	Assigned observer	1st replicate	Total UPSA	2nd replicate	Total UPSA	Comments and Species of Greatest Conservation Need (SGCN) detected
Lusk North	Brady Vandeberg	8 June	1	18 June	1	Surveys completed; SGCN = 1 Long-billed Curlew 8 June, 3 Long-billed Curlews 18 June
Lusk South	Brady Vandeberg	7 June	3	15 June	0	Surveys completed; SGCN = 7 Long-billed Curlews 7 June, 2 Long-billed Curlews and 2 Burrowing Owls 15 June
Moorcroft	John Davis	20 June	25	7 July	7	Surveys completed
Pleasantdale	Dustin Kirsch	14 June	5	none	n/a	Only 1 survey completed
Rockpile	Jennifer Wilson	1 June	4	15 June	2	Surveys completed
Rocky Point	Jennifer Wilson	2 June	3	14 June	0	Surveys completed
Seely	Chris Teter	21 June	35	6 July	3	Surveys completed
West Sheridan	Bruce Scigliano	?	0	?	0	Data sheets unavailable due to computer issues; observer has never seen an UPSA on the route
Total routes = 16		*Total UPSA = 100*		*Total UPSA = 30*		*Total replicates conducted out of 32 = 28*

Table 4. Results from the 2nd year of surveys for Long-billed Curlew (*Numenius americanus*) in Wyoming. We planned to survey Long-billed Curlews (LBCU) during the pre-incubation and courtship stages, between 21 April and 15 May 2016, when birds are easier to detect. We attempted to conduct 2 surveys along each route using the same observer per route, with surveys separated by a minimum of 7 and maximum of 14 days.

LBCU route	Assigned observer	1st replicate	Total LBCU	2nd replicate	Total LBCU	Comments
Arvada	Brian Zinke	22 April	0	3 May	0	Surveys completed
Beckton	Brian Zinke	21 April	1	4 May	3	Surveys completed
Buffalo South	Dan Thiele	5 May	0	12 May	0	Surveys completed
Carpenter West	Rachel Nuss	6 May	0	13 May	0	Surveys completed
Chapman Bench	Doug McWhirter	3 May	7	n/a	n/a	Only 1 survey completed
Cheyenne River	Brian Zinke	23 April	0	5 May	0	Surveys completed
Chugwater Flats	Ian Tator	6 May	0	20 May	0	Surveys completed; 2nd survey date was late
Dull Center	Willow Steen	2 May	0	9 May	0	Surveys completed
East Bill	Rod Lebert	?	?	?	?	Data sheets unavailable due to computer issues
Elk Refuge	Susan Patla	25 April	18	17 May	9	Surveys completed
Glenrock East	Justin Binfet, Gary Boyd	11 May	1	19 May	0	Surveys completed; Justin Binfet ran 1st replicate
Goshen Hole	Jennifer Wilson	6 May	0	13 May	0	Surveys completed
Grand Teton	Aly Courtemanch	5 May	13	15 May	9	Surveys completed

Table 4. Continued.

LBCU route	Assigned observer	1st replicate	Total LBCU	2nd replicate	Total LBCU	Comments
Harmony Heights	Jennifer Wilson	5 May	0	10 May	0	Surveys completed
Hawk Springs	Steve Tessman	5 May	0	19 May	0	Surveys completed
Heward Ranch	Jennifer Wilson	?	0	11 May	2	Surveys completed; data sheet unavailable due to computer issues
Horse Creek	Jill Randall	13 May	110	23 May	97	Surveys completed
Huntley	Andrea Orabona	25 April	0	12 May	0	Surveys completed
Jay Em	Andrea Orabona	26 April	0	13 May	0	Surveys completed
Kaan Road	Brady Vandeberg	11 May	0	19 May	0	Surveys completed
Lance Creek	Willow Steen	3 May	0	13 May	0	Surveys completed
Little Medicine	Will Schultz	3 May	0	13 May	0	Surveys completed
Meadowdale West	Martin Hicks	n/a	n/a	19 May	0	Only 1 survey completed; survey date was late
Meriden	Bob Lanka	3 May	0	11 May	0	Surveys completed
Morrissey Road	Joe Sandrini	3 May	3	10 May	1	Surveys completed; this route replaced noisy/dangerous Clareton East route
New Fork	Dean Clause	5 May	20	12 May	15	Surveys completed

Table 4. Continued.

LBCU route	Assigned observer	1st replicate	Total LBCU	2nd replicate	Total LBCU	Comments
Node	Brady Vandeberg	13 May	0	22 May	0	Surveys completed; 2nd survey date was late
Osage	Troy Achterhof	10 May	0	17 May	0	Surveys completed
Veteran	Jennifer Wilson	n/a	n/a	12 May	0	Only 1 survey completed
Weston	Erika Peckham	?	?	?	?	Data sheets unavailable due to computer issues
Wildcat South	Erika Peckham	5 May	0	?	?	Data sheet unavailable due to computer issues
Wyarno	Tim Thomas	23 April	0	3 May	0	Surveys completed
Total routes = 32		*Total LBCU = 173*		*Total LBCU = 136*		*Total replicates conducted out of 64 = 55*

Table 5. Results from the 2nd year of surveys for Burrowing Owl (*Athene cunicularia*) in Wyoming. We planned to survey for Burrowing Owls (BUOW) from 15 April to 7 August 2016 to encompass each of the 3 nesting stages (pre-incubation, incubation/hatching, and nestling). We attempted to conduct 3 surveys of each route, with each survey occurring during a 30-day survey window and separated from the previous survey by at least 10 days. Ad = adult BUOW, Juv = juvenile BUOW.

BUOW route	Assigned observer	1st replicate	Total BUOW	2nd replicate	Total BUOW	3rd replicate	Total BUOW	Comments and Species of Greatest Conservation Need (SGCN) detected
Agate Flat	Linnea Sailor	14 May	0	29 June	0	8 August	0	Surveys completed; data sheets unavailable due to computer issues
Bar X	Patrick Burke	17 May	0	28 June	0	7 August	0	Surveys completed
Fontenelle	Tom Christiansen	12 May	0	29 June	0	2 August	0	Surveys completed
Greybull North	Leslie Schreiber	14 May	0	n/a	n/a	4 August	0	2 of 3 surveys completed
Hiattville West	Leslie Schreiber	19 May	0	n/a	n/a	25 July	0	2 of 3 surveys completed
Jonah	Jordan Kraft	18 May	0	n/a	n/a	25 July	0	2 of 3 surveys completed
North Dunes	Andrea Orabona	20 May	0	18 June	0	4 August	0	Surveys completed
North Huntley	Grant Frost	3 May	12 Ad 7 nests	7 June	11 Ad 9 nests	19 July	29 Ad 13 Juv 17 nests	Surveys completed

Table 5. Continued.

BUOW route	Assigned observer	1st replicate	Total BUOW	2nd replicate	Total BUOW	3rd replicate	Total BUOW	Comments
Pinedale Mesa	Andrea Orabona	n/a	n/a	18 July	7 Ad 2 Juv 3 nests	5 August	6 Ad 8 Juv 4 nests	New route set up after 3 PTT units deployed on females in June; 2 of 3 surveys completed
South Wamsutter	Jen Wilson	n/a	n/a	21 July	3 Ad 11 Juv 2 nests	4 August	3 Ad 8 Juv 2 nests	2 of 3 surveys completed
Tipperary Road	Zack Walker Jen Wilson	5 May	15 Ad 5 nests	23 June	5 Ad 2 nests	10 August	0	Surveys completed; Jen Wilson completed 2nd and 3rd replicates
Upton South	Joe Sandrini	16 May	0	14 June	0	20 July	0	Surveys completed
Wamsutter	Jen Wilson	19 May	0	21 July	0	4 August	3 Ad 5 Juv 2 nests	Surveys completed
Wamsutter Highway	Jen Wilson	19 May	0	20 July	0	3 August	0	Surveys completed
West Gillette	Erika Peckham	n/a	n/a	27 June	0	21 July	0	2 of 3 surveys completed
Wildcat Butte	Jeff Short	18 May	1 Ad	12 June	1 Ad	7 August	0	Surveys completed
Total routes = 16		*Total BUOW =* *28 adults* *0 juveniles* *12 nests*		*Total BUOW =* *27 adults* *13 juveniles* *16 nests*		*Total BUOW =* *41 adults* *34 juveniles* *25 nests*		*Total replicates conducted out of 48 = 42*

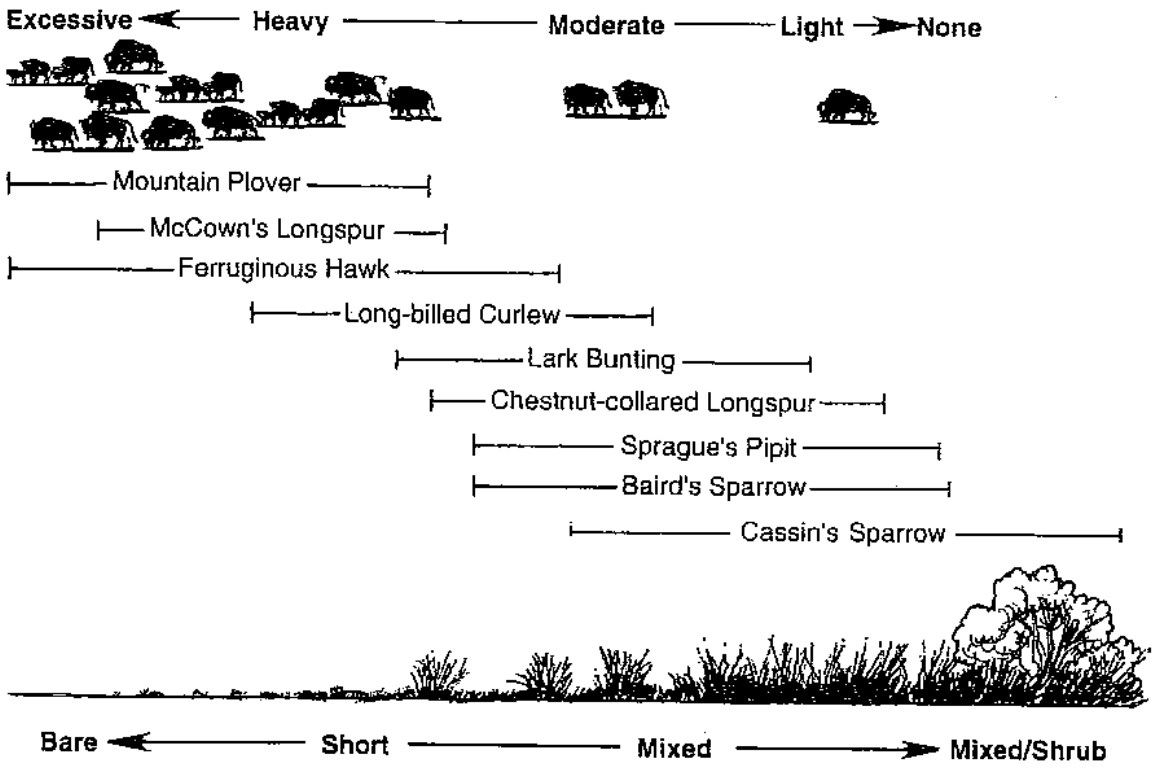

Figure 1. Distributions of avian species endemic to the Great Plains in relation to grassland type and historical grazing pressure (Knopf 1996).

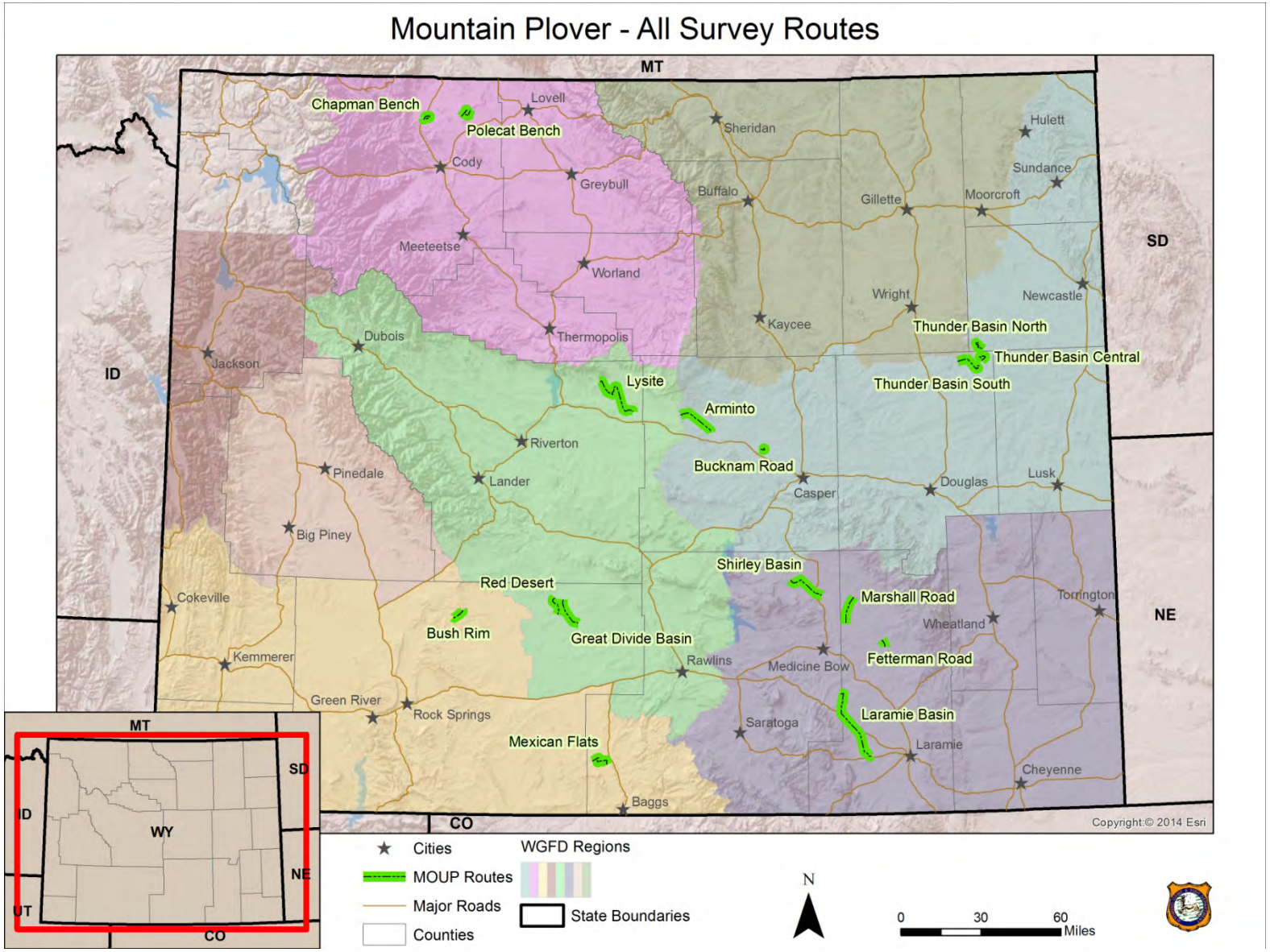

Figure 2. Survey routes we established for monitoring Mountain Plovers (*Charadrius montanus*) in Wyoming.

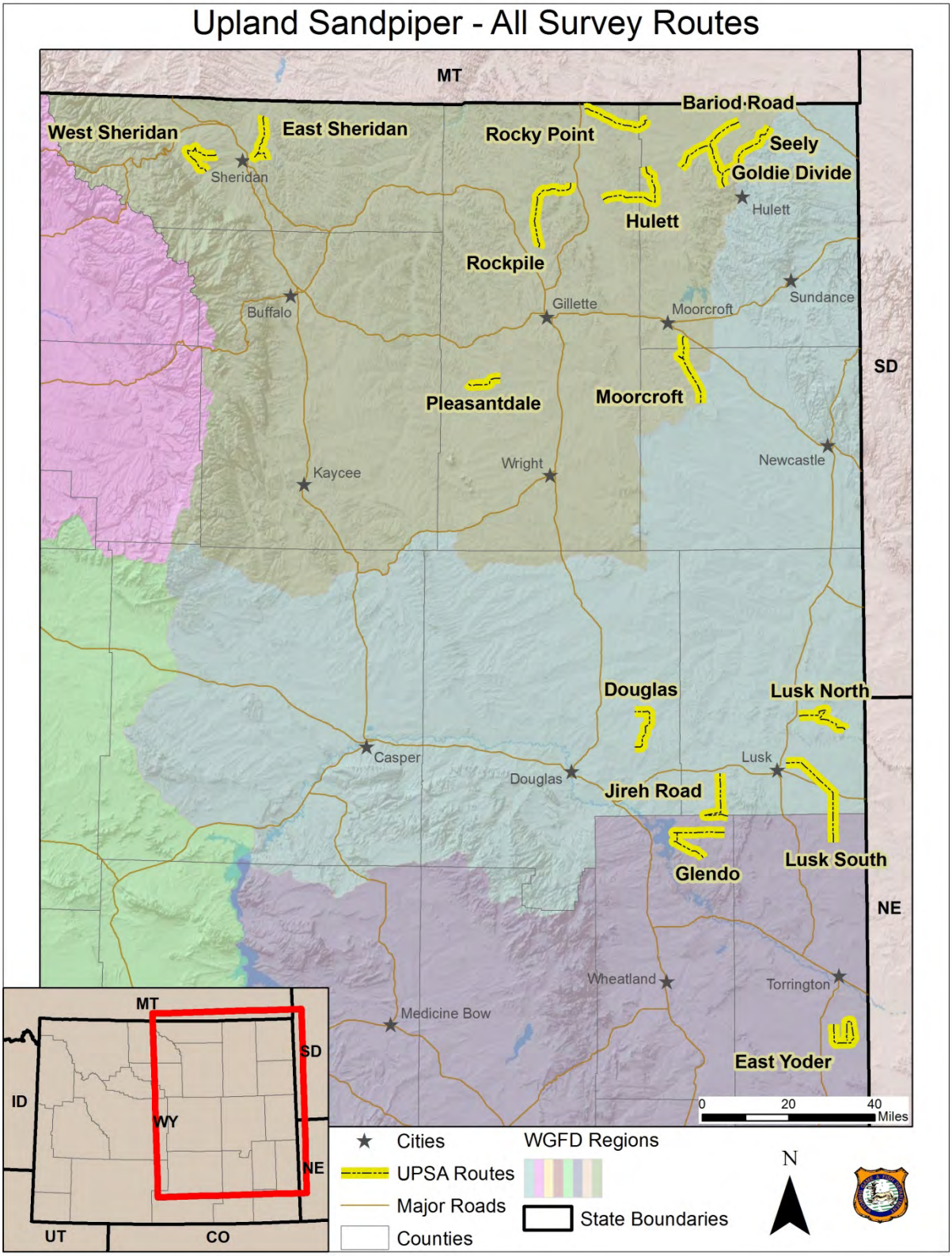

Figure 3. Survey routes we established for monitoring Upland Sandpipers (*Bartramia longicauda*) in Wyoming.

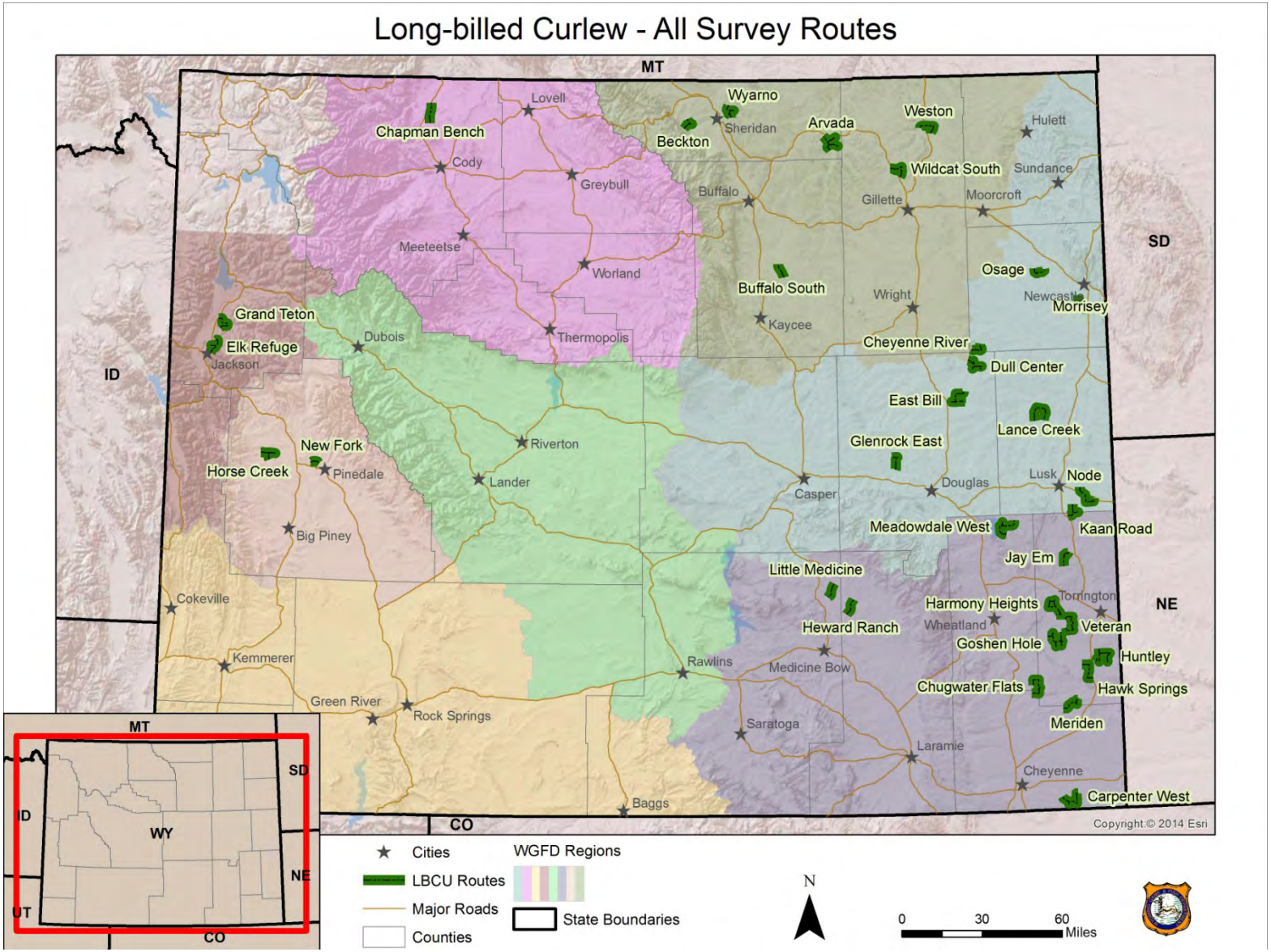

Figure 4. Survey routes we established for monitoring Long-billed Curlews (*Numenius americanus*) in Wyoming.

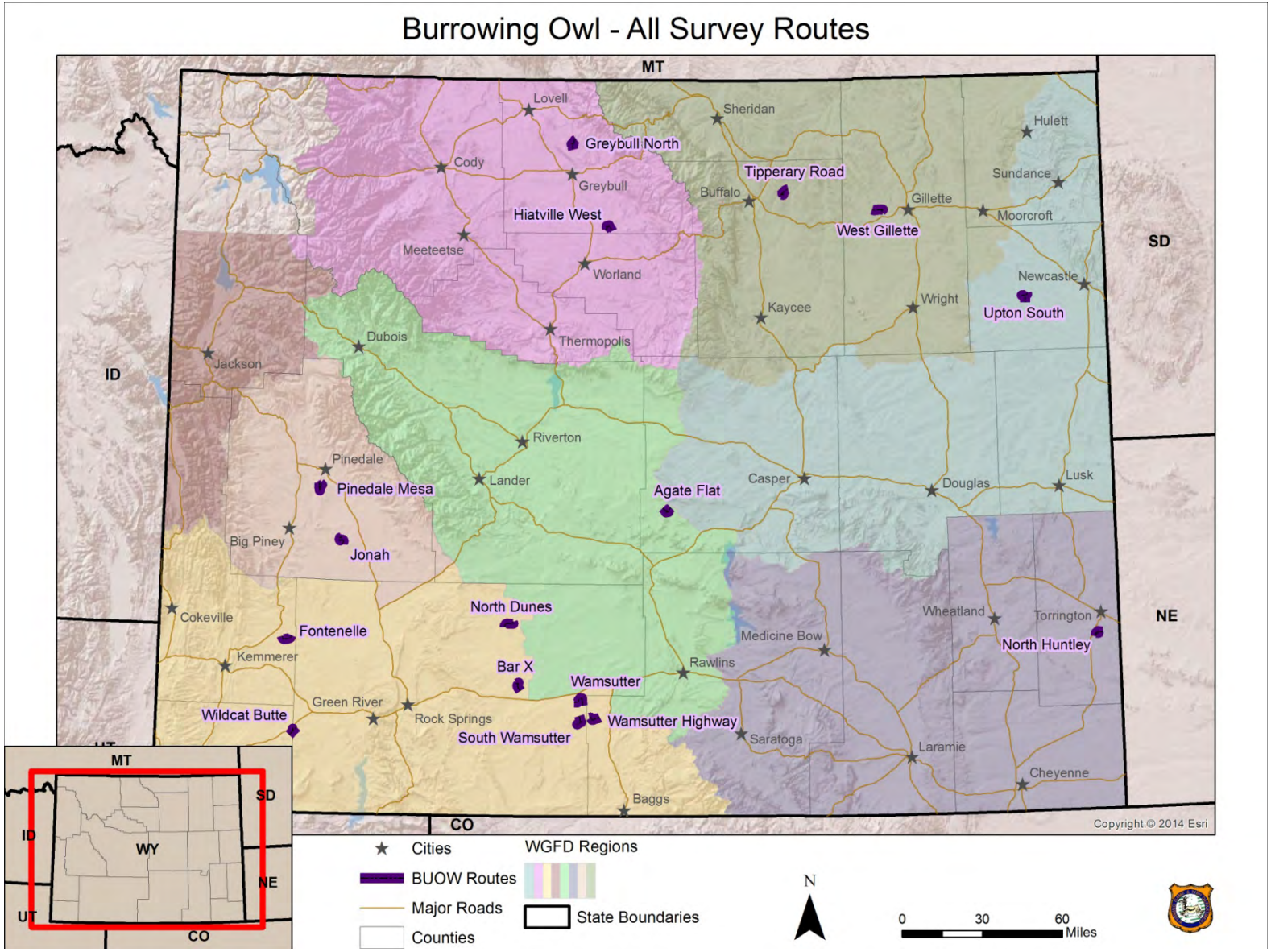

Figure 5. Survey routes we established for monitoring Burrowing Owls (*Athene cunicularia*) in Wyoming.

BALD EAGLE (*HALIAEETUS LEUCOCEPHALUS*) MONITORING IN WESTERN WYOMING

STATE OF WYOMING

NONGAME BIRDS: Species of Greatest Conservation Need – Bald Eagle

FUNDING SOURCE: United States Army Corps of Engineers
Wyoming State Legislature General Fund Appropriations

PROJECT DURATION: Annual

PERIOD COVERED: 15 April 2016 – 1 March 2017

PREPARED BY: Susan Patla, Nongame Biologist

ABSTRACT

The Bald Eagle (*Haliaeetus leucocephalus*) occurs throughout most of North America from Alaska to central Mexico and winters generally throughout the breeding range, except in the far north. It nests along major river drainages and lakes throughout Wyoming, with the most significant concentrations in Teton, Sublette, and Carbon Counties, including a significant number of nesting pairs in Grand Teton and Yellowstone National Parks. We initiated monitoring for Bald Eagle statewide in 1978. The Bald Eagle, although no longer designated as a Threatened species under the Endangered Species Act, remains protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act, and is classified as a Species of Greatest Conservation Need with a Native Species Status of 2 in Wyoming. We currently monitor the population of Bald Eagles that nest in the western portion of the state (i.e., Snake and Green River drainages) annually, and obtain data when available from other areas of the state. We have detected ≥139 nest sites to-date. However, we believe there is potential habitat for ≥200 territories to occur statewide. In 2016, we obtained occupancy data for 104 territories and productivity data for 69 nest sites, which produced a total of 95 young. As in previous years, Bald Eagles occupied a high proportion (i.e., ≥83%) of nesting territories we monitored, and successful nests produced an average of 1.67 young per nest. The Bald Eagle nesting population in western Wyoming continues to increase slowly, with a few new nest sites found each year. Occupancy rate and productivity remain high. Some site-specific risks remain due to increasing energy development, rural development, recreational activities, and environmental contaminants. The Departments continues to receive and process numerous requests for information and management recommendations for Bald Eagle nest and roost sites.

INTRODUCTION

The Bald Eagle (*Haliaeetus leucocephalus*) nests along all major river systems in Wyoming, but the largest number of nesting pairs is found in northwestern Wyoming in the Greater Yellowstone Area (GYA) along the Snake River drainage and its tributaries. Bald Eagles in the northwestern part of the state have long been recognized as part of a distinct population that nests in the Rocky Mountain West. This genetically distinct population extends into Idaho and Montana (Swenson et al. 1986). Recovery of the species in Wyoming centered on the Jackson area beginning in the 1980s. The numerous territories located along the Snake River continue to serve as a source of Bald Eagles for other areas of the GYA and other parts of Wyoming (Harmata and Oakleaf 1992). Since 2000, we have also documented a substantial increase in the number of pairs that nest in the Green River Basin.

The US Fish and Wildlife Service (USFWS) removed the Bald Eagle from protection under the Endangered Species Act in the western US in July 2007. However, the species continues to be protected under the Bald and Golden Eagle Protection Act (BGEPA) and the Migratory Bird Act Treaty. The USFWS released national management guidelines to advise landowners and land managers under what circumstances the protective provisions of BGEPA may apply to activities where eagles occur (USFWS 2007). They have also released guidelines to assist developers of land-based wind energy projects in identifying risks to wildlife species, including Bald Eagles (USFWS 2012). In addition, they have finalized permit regulations that allow for limited take of bald and golden eagles where the take is associated with otherwise lawful activities (USFWS 2016a). A population status report was also completed (USFWS 2016b).

The Wyoming Game and Fish Department (Department) initiated monitoring for Bald Eagles statewide in 1978. Currently, program objectives include monitoring occupancy and productivity at nesting territories in the Snake River and Green River Basin, south to Seedskadee National Wildlife Refuge (NWR). Additional surveillance data are collected at a number of other sites around the state by Department personnel. We continue to receive numerous requests by other state and federal agencies and the public for information on status of nests of Bald Eagles, and provide recommendations on mitigation measures to conserve nest sites in Wyoming. The Army Corp of Engineers (ACE) request data every year on the status of nest sites located adjacent to the Snake River dike system in the Jackson area to schedule maintenance projects. The ACE has provided funding the last few years for aerial survey work. Management guidelines have been developed for nest sites for the GYA based on a long-term ecological study, and provide valuable information for avoiding disturbance to nesting eagles (Greater Yellowstone Bald Eagle Working Group 1996). The Department is actively involved in reviewing new federal regulations through participation in the Central Flyway Nongame Migratory Bird Technical Committee.

METHODS

We conducted aerial surveys to monitor occupancy and productivity at a majority of known Bald Eagle nest sites in western Wyoming. Fixed-wing aircraft surveys were conducted in mid- to late March to document the number of occupied sites with incubating adults, and again in late May and early June to determine number of mature young produced per site. During aerial surveys, we recorded the number of adult and young Bald Eagles observed, UTM coordinates of nests, condition of nests, and species of nest tree, and photographed new sites. We also recorded locations of other Species of Greatest Conservation Need (WGFD 2017).

In 2016, we used a single observer and fixed-wing Scout airplane (Sky Aviation) that flew approximately 100-200 m above ground and at speeds of 120-160 kph to conduct aerial nest occupancy surveys on 26 March, and a productivity survey on 2 and 3 June. We combined the productivity flight for eagles with a monitoring survey for Trumpeter Swan (*Cygnus buccinator*) to reduce overall survey costs. We surveyed all known nest sites along the main stem and tributaries of the Snake River, Gros Ventre River, Salt River, New Fork River, and the Green River from Green River Lakes to south of Seedskadee NWR.

Biologists from Grand Teton National Park, Seedskadee NWR, the Department, and the USFWS contributed data from their respective monitoring efforts. A few volunteers in Jackson also surveyed specific territories on a regular basis. In other parts of the state, Regional Wildlife Biologists collected data for a subset of known nests that were visible from the ground. For ground-based surveys, observers used spotting scopes or binoculars from observation points that were sufficiently far away to prevent disturbance to nesting Bald Eagles. Survey duration was typically ≤2 hours depending on visibility, behavior of adult birds, and status of the nest. Some wildlife consultant companies provided nest observation data, as well.

RESULTS

In 2016, we evaluated occupancy status of 104 nest sites (Table 1). Data collected from nest sites in Yellowstone National Park and by private consultant groups in other parts of Wyoming are not summarized here. Monitoring effort was concentrated in western Wyoming where the majority of nests are known to occur and where the Department has collected nest site data since the late 1970s.

Bald Eagles occupied 85% of sites surveyed. Table 1 presents productivity data for nest sites in western Wyoming that we monitored with repeated aerial or ground surveys. The majority of occupied nests were found along the main stem of the Snake River (including Jackson Lake) and the Green River drainage (Table 1, Figure 1). Overall, 83% of the territories we checked for productivity in western Wyoming produced mature young down 2% from the previous year. The number of mature young produced per successful nest was 1.67 or 1.25 per occupied nest. Overall, 8 nest sites failed in the Snake River drainage, and 3 others in the Green River and Salt River drainages. No emergency dike work was required in 2016 by the ACE along the Snake River dike system. A project to remove vegetation along the Snake River dikes continued along the river south of Wilson.

DISCUSSION

The number of nesting pairs of Bald Eagles appears to have stabilized in the Snake River drainage in Wyoming, with some shift in pairs occurring over time but few new territories being discovered. A few new nest territories continue to be found in the Green River drainage. Comparing productivity data for the Greater Yellowstone population collected from 1982-1995 to the current year indicates that current productivity, or the number of young produced per occupied site, for 2016 is within the historic range (Greater Yellowstone Bald Eagle Working Group 1996).

The Department provides data on nesting eagles for numerous requests every year from county, state, and federal agencies and private consultants for use in evaluating proposed projects and developing mitigation measures to protect nesting territories. In the future, additional surveys may be needed in areas where energy developments (i.e., oil, gas, and wind) occur or are proposed along major drainages or known migration routes and wintering areas. We hypothesize that in areas undergoing high levels of development along major river corridors, Bald Eagles could experience higher mortality rates, lower productivity, or loss of nest sites if adequate mitigation measures are not applied. Aging stands of cottonwood trees that are failing to regenerate may also reduce nesting habitat in some areas in future years.

ACKNOWLEDGEMENTS

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Table 1. Summary of Bald Eagle (*Haliaeetus leucocephalus*) nesting data collected by the Wyoming Game and Fish Department Nongame Program in 2016 compared to 2015 results. We present data by major drainages and geographic boundaries in Wyoming. [a] Greater Yellowstone Area (GYA) does not include data from Yellowstone National Park. [b] Aerial surveys from Green River Lakes to Manns Flat south of Seedskadee National Wildlife Refuge. [c] Data from the Wildlife Observation System posted by regional biologists in districts outside of the main survey area. [d] Percentage of occupied territories checked for productivity that produced mature young. [e] Mature young is the number of fully feathered nestlings counted prior to fledging in June and July. nc = not counted.

Nesting data collected	Wyoming portion of GYA[a]	Green River[b]	Salt River	Western Wyoming total	Other Wyoming sites[c]
2016 Territories checked for occupancy (*n*)	52	35	2	89	15
2015 Territories checked for occupancy (*n*)	50	31	2	83	
2016 Territories occupied (*n*)	43	31	2	76	15
2015 Territories occupied (*n*)	42	30	2	74	
2016 Percent of territories occupied	83%	89%	100%	85%	
2015 Percent of territories occupied	84%	90%	100%	89%	
2016 Territories surveyed for productivity (*n*)	39	28	2	69	
2015 Territories surveyed for productivity (*n*)	39	26	2	67	
2016 Territories that produced young (*n*)	31	25	1	57	
2015 Territories that produced young (*n*)	29	26	2	57	
2016 Percent of successful nests[d]	79%	89%	50%	83%	
2015 Percent of successful nests[d]	74%	100%	100%	85%	
2016 Mature young produced[e] (*n*)	46	48	1	95	
2015 Mature young produced[e] (*n*)	42	37	2	81	

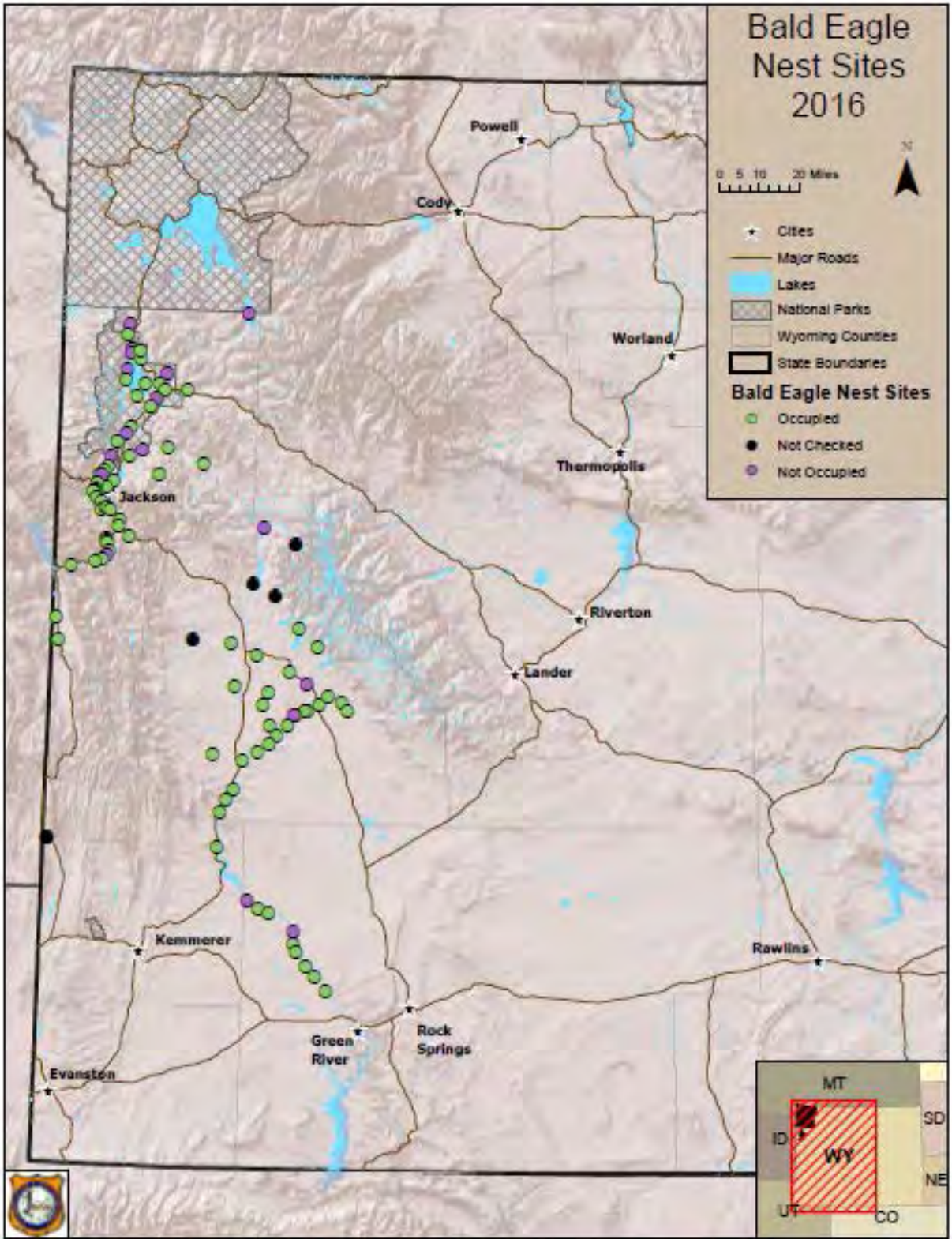

Figure 1. Map of Bald Eagle (*Haliaeetus leucocephalus*) nest sites occupied by nesting pairs that we monitored, along with partners, in western Wyoming in 2016. Occupied nest sites in Yellowstone National Park are not shown.

RECOMMENDATIONS FOR MONITORING PEREGRINE FALCONS (*FALCO PEREGRINES*) IN WYOMING

STATE OF WYOMING

NONGAME BIRDS: Species of Greatest Conservation Need – Peregrine Falcon

FUNDING SOURCE: Wyoming State Legislature General Fund Appropriations

PROJECT DURATION: Annual

PERIOD COVERED: 15 April 2016 – 14 April 2017

PREPARED BY: Bob Oakleaf, Wyoming Game and Fish Department (retired)
Susan Patla, Nongame Biologist, Wyoming Game and Fish Department
Andrea Orabona, Nongame Bird Biologist, Wyoming Game and Fish Department

SUMMARY

Nesting Peregrine Falcons (*Falco peregrines*; peregrines) were mostly extirpated from Wyoming, and national population trends warranted the US Fish and Wildlife Service (USFWS) to de-list the species in 1999 (USDI 1999). Cade et al. (2003) detailed factors contributing to the national endangered species status and recovery of the species prior to the 1970s (Oakleaf and Craig 2003). We did not locate any nesting pairs during surveys from 1978-1983. We documented the first nesting pair in1984, and at least 121 nesting territories in Wyoming by 2015. Recovery of peregrines in Wyoming resulted from nationwide restrictions on the use of the insecticide dichlorodiphenyltrichloroethane (DDT), and reintroduction of 325 captive produced young in Wyoming, 1980-1995 (Oakleaf and Craig 2003, Enderson et al. 2012, Baril et al. 2015). We have not released peregrines since 1995 because we attained project objectives in 1994-1995, and the species was subsequently delisted at the national level in 1999. We do, however, continue monitoring efforts, as populations are relatively limited.

The Wyoming Game and Fish Department and Yellowstone and Grand Teton National Parks continued monitoring nesting success of peregrines until 2015. We documented the production of over 1,057 nesting attempts of peregrines in Wyoming (Figure 1). Portions of monitoring included cooperative efforts with the USFWS post de-listing protocol (USDI 2003). We followed standard raptor monitoring protocol and terminology (Steenhoff and Newton 2007). These data are currently being evaluated in detail. Continued monitoring of nesting success beyond 2015 is warranted due to the large investment for recovery, continued high public interest, and the concept that peregrines have proven valuable as an environmental indicator. Although DDT has been banned, other potentially detrimental compounds are likely to be

developed that may become concentrated in the food chain and affect top level predators. For example, Baril et al. (2015) reviewed the literature relating to potential risks of compounds within the family of brominated flame retardants. DeWeese et al. (1986) provided additional information on organochlorine contaminants in peregrine prey. In addition, the potential risks to avifauna from some diseases such as West Nile Virus are not well known.

The monitoring database for Wyoming peregrines was extremely costly to collect. Such expenditures and effort will likely never be repeated. Yet, if we take advantage of the opportunity to use the database as a foundation for continued monitoring, expenditures could be minimal and a fraction of what it would take to recreate such a foundation, if ignored for years. Some of our preliminary findings could guide future monitoring efforts.

Three general survey areas were monitored: Yellowstone National Park (YNP); Bridger-Teton National Forest, Grand Teton National Park, and adjacent areas (BTGTA); and the Shoshone and Bighorn National Forests and nearby habitats (SBHNF). All survey areas averaged over 1.5 young fledged per occupied site, but do not have significant trends ($R^2 < 0.089$), indicating an adequate production rate. Annual fluctuations among the 3 survey areas are not correlated ($R^2 < 0.086$). Lack of correlation indicates that weather and/or other factors are not operating uniformly among the areas, suggesting that future monitoring sites should be evenly distributed among these survey areas to track reproduction trends in the future.

The amount of effort required to annually monitor a nesting site can vary from a few hours to several days depending on the location, characteristics of the site, and other factors influencing logistics. We compared sites that were easy to monitor to more difficult sites. The criteria for a site to be classified as easy included sites that are within 2 hours from the nearest town with public access, have a good view conducive to a complete young count, have a history of few alternate sites, and have recent years of occupancy. Sites with less than 3 years of monitoring were not included in the analysis. We found that easy sites averaged as many or higher young per occupied site than more difficult sites (Table 1). We believe that complete counts of mature young were more likely to occur at easy sites, and factors such as nearby roads did not negatively impact production. Monitoring of these sites could also be completed with less experienced personnel or trained volunteers.

Evaluations of Wyoming data indicate that we can focus on indices requiring less effort. Past monitoring protocol required occupancy surveys during early phases of the nesting season. Once established, we found that nearly all known nest sites were reoccupied in following years. The few sites (<3%) recorded as not occupied were mostly associated with incomplete understanding of alternate nesting sites or, in a few cases, the establishment of nesting at extremely marginal sites. All of the sites recommended for long term monitoring do not have any years when they were recorded as not occupied; all (100%) were occupied during years surveyed. Therefore, we recommend a monitoring scheme that assumes all sites are occupied and primarily focuses on documenting the number of mature young during the fledging period.

In addition to monitoring the number of young at these historic sites, data are still needed at many locations in Wyoming before they can be classified as established peregrine nesting sites. In 2016, for example we documented peregrine young at 7 sites where only adults had

been recorded previously. The database includes 21 probable nesting sites that should be surveyed until young have been documented. In addition, there are reports of nesting peregrines at 3 sites that need further documentation while the information is current.

In summary, we recommend selecting 5 of the easy nest sites for each survey area. Ideally, sites with the most years of data would be selected. In addition, Grand Teton National Park may continue to monitor nest sites (5) within the Park, and results could be additive or evaluated separately. Approximate survey dates can be identified from previous fledging data. Trained volunteers or agency personnel should plan at least 1 day in July to record success and number of young of selected sites according to protocol. We also recommend that experienced personnel continue follow-up on reports or survey sites needing better documentation.

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Table 1. Average production recorded at Peregrine Falcon (*Falco peregrines*) nesting sites that were classified as easy to survey compared to difficult sites to survey.

Survey area [a]	Easy to survey [b]		Difficult to survey	
	N	Young/occupied nest	N	Young/occupied nest
YNP	12	1.7	16	1.6
BTGTA	10	1.9	11	1.3
SBHNF	17	1.9	16	1.7
All	39	1.8	43	1.5

[a] Includes Yellowstone National Park (YNP); Bridger-Teton National Forest, Grand Teton National Park, and adjacent areas (BTGTA); and the Shoshone and Bighorn National Forests and nearby habitats (SBHNF).

[b] Sites classified as easy to monitor can be accessed within 2 hours from the nearest town, have a good view conducive to a complete count of young, have a history of few alternate sites, and have recent years of occupancy. Sites with less than 3 years of monitoring were not included in the analysis.

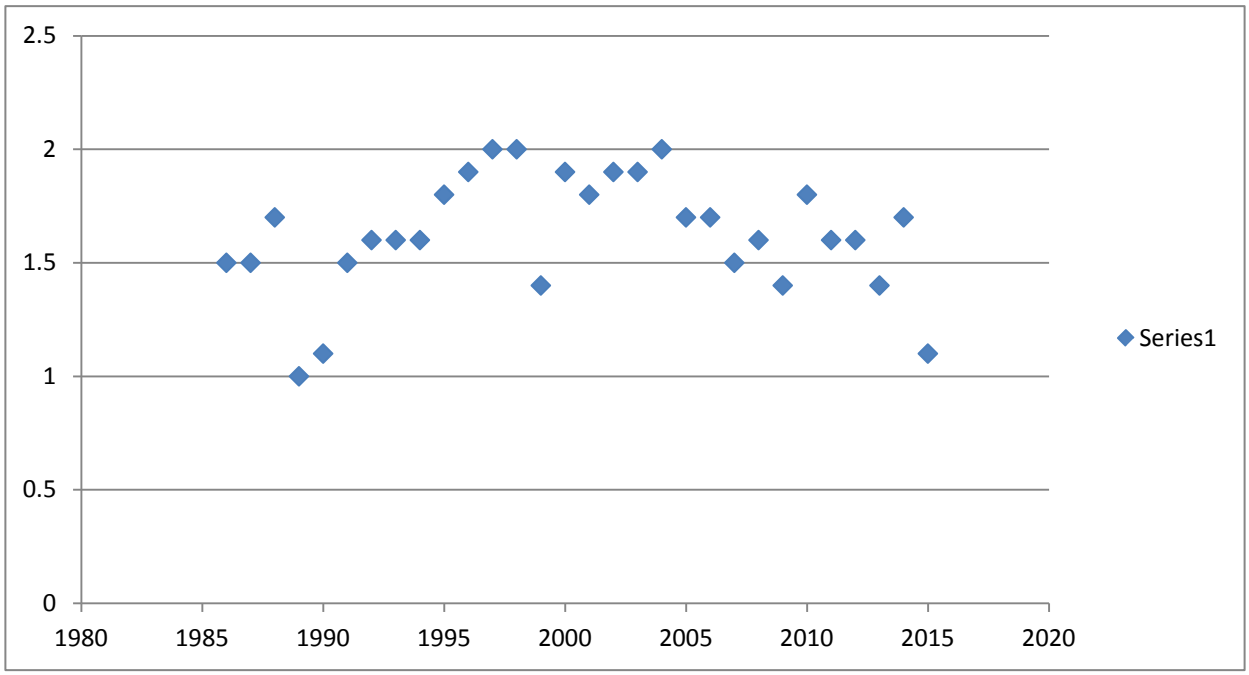

Figure 1. Average young per occupied Peregrine Falcon (*Falco peregrines*) nest site in Wyoming, 1986-2015. Data for 1984-1985 are not included, as there was only 1 site.

AN INVESTIGATION OF JUNIPER-OBLIGATE AVIAN SPECIES OF GREATEST CONSERVATION NEED IN SOUTHWESTERN WYOMING

STATE OF WYOMING

NONGAME BIRDS: Species of Greatest Conservation Need – Bushtit, Juniper Titmouse, Woodhouse's Scrub-Jay, Scott's Oriole, Gray Vireo, Ash-throated Flycatcher

FUNDING SOURCE: United States Fish and Wildlife Service State Wildlife Grant

PROJECT DURATION: 1 July 2015 – 30 June 2018

PERIOD COVERED: 3 April 2016 - 30 October 2016

PREPARED BY: Leah Yandow, Nongame Biologist

ABSTRACT

Pinyon-juniper woodlands are one of the most widespread plant communities in North America and support a diverse and distinct suite of wildlife. Changes in climate, fire regimes, and land use over the last several decades have made this system particularly vulnerable to habitat loss and fragmentation. In Wyoming, pinyon-juniper is restricted to the southwestern portion of the state and is host to several Species of Greatest Conservation Need whose most northern portion of their range occurs there. We initiated a project to address knowledge gaps about several Species of Greatest Conservation Need considered juniper-obligate species. We conducted bird surveys as an overlay project with the Integrated Monitoring in Bird Conservation Regions program to target 6 juniper-obligate birds including Bushtit (*Psaltriparus minimus*), Juniper Titmouse (*Baeolophus ridgwayi*), Woodhouse's Scrub-Jay (*Aphelocoma woodhouseii*), Scott's Oriole (*Icterus parisorum*), Gray Vireo (*Vireo vicinior*), and Ash-throated Flycatcher (*Myiarchus cinerascens*). During our 1st season of the study, we detected 5 of 6 target bird species. Data will be analyzed within an occupancy modeling framework to test for effects of habitat characteristics on occupancy rates upon completion of the 2nd field season. This systematic effort to detect species in pinyon-juniper woodland in southwestern Wyoming will add to our understanding of species using this habitat and the value of pinyon-juniper characteristics.

INTRODUCTION

The 6 juniper-obligate target species—Bushtit (*Psaltriparus minimus;* NSS3, Tier II), Juniper Titmouse (*Baeolophus ridgwayi;* NSS3, Tier II), Woodhouse's Scrub-Jay (*Aphelocoma*

woodhouseii; NSS3, Tier II), Scott's Oriole (*Icterus parisorum;* NSSU, Tier II), Gray Vireo (*Vireo vicinior;* NSSU, Tier II), and Ash-throated Flycatcher (*Myiarchus cinerascens;* NSS3, Tier II) were originally recognized as Species in Need of Special Management in Wyoming in the late 1980s when designated as such by the Wyoming Game and Fish Department (Department; Fitton 1989). The updated 2017 list of Species of Greatest Conservation Need (SGCN) retains these 6 species as SGCN. The common reasons these species remain listed are: 1) the limited distribution of suitable breeding habitat is restricted to southwestern Wyoming; 2) Utah juniper (*Juniperus osteosperma*) habitat is vulnerable to loss, degradation, and fragmentation because of large-scale landscape changes such as energy development; and 3) there is a lack of data on population status and trends in Wyoming (WGFD 2017). We intend to address the last concern with this project.

Most of what we know about juniper-obligate birds in southwestern Wyoming comes from 2 key efforts. Early work by Fitton and the Department was initiated to add to historical records, gain understanding about the distribution of the species in the region, and record natural history observations (Findholt and Fitton 1983, Fitton and Scott 1984, Fitton 1989). A subsequent effort in the early 2000s aimed to establish a baseline for monitoring, as well as address questions regarding habitat suitability. A few papers resulted from the latter effort, which describe habitat preferences and community patterns using a landscape approach. In total, this small body of work has been essential to our understanding of the species' distributions and has allowed us to make assumptions regarding implications of management actions for the residents of juniper habitat in southwestern Wyoming. As the new and renewed challenges of climate change, fire suppression, and energy development evolve, there is ample need to update and add to our understanding of these SGCN.

One of the species we know more about in the region is the Juniper Titmouse (NSS3, Tier II) because of its conspicuous nature and possibly its higher abundance than many of the other juniper-obligates. Juniper Titmouse is a year-round resident considered rare in southwestern Wyoming. It is particularly sensitive to human disturbance at the nest. Juniper Titmouse is associated with high juniper cover, and numerous snags and dead branches, indicating a preference for mature juniper stands (Pavalacky and Anderson 2001; Fitton 1989). It nests in natural cavities or cavities created by woodpeckers, and forages for seeds from trees.

Woodhouse's Scrub-Jay is also a year-round resident sensitive to human disturbance, abandoning a nest readily if disturbed. They reside in family groups or pairs, and nest in medium to low canopy cover of Utah juniper and are considered very rare in the state. They are omnivorous, foraging on the ground and in low branches for arthropods, seeds, and juniper berries in both woodlands and in the sagebrush (*Artemisia* spp.) mosaic.

The Ash-throated Flycatcher is a very rare summer resident in southwestern Wyoming. This species is insectivorous and occupies mature juniper woodlands in southwestern Wyoming from May to September while sub-zero nights are infrequent and, therefore, prey is most abundant. Ash-throated Flycatchers are associated with snags, and use dead branches from which to forage. They are gleaners and secondary cavity nesters, and rely exclusively on Utah juniper (J*uniperus osteosperma*) for nesting (Fitton 1989).

The Bushtit is also considered a rare juniper-obligate in Wyoming, and is also most often found in the southwestern portion of the state. Bushtits are insectivorous gleaners that build intricate cryptic nests that hang from tree branches. They forage along the edges of juniper woodlands in sagebrush and mountain mahogany (*Cercocarpus montanus*) habitats, and generally prefer younger but reproductively mature juniper stands.

Scott's Oriole and Gray Vireo are rare summer residents in Wyoming. Since there are very few observations in Wyoming, data are lacking on habitat preferences. However, Scott's Orioles likely spend their time in moderate to sparse juniper canopies as in the more southern parts of their range (Findholt and Scott 1983), and Gray Vireos forage throughout shrubs and within the canopy of juniper woodlands. The first account of Scott's Oriole in Wyoming was in the late 1960s. Few detections of either species in Wyoming have been reported since the 1980s.

METHODS

The study area is located on the east and west side of Flaming Gorge Reservoir in southwestern Wyoming, south of Interstate 80. The area is marked by rocky juniper terrain, wildfire scars, high grassy plateaus, large greasewood (*Sarcobatus* spp.) and shrubland drainages, and intermixed with extensive patches of sagebrush.

For all aspects of the avian surveys, we used established protocols developed by Bird Conservancy of the Rockies for their cooperative monitoring program titled Integrated Monitoring in Bird Conservation Regions (IMBCR). Prior to fieldwork, we selected survey sites based on a 1 km x 1 km grid system that covered the study area. We eliminated any grids that had private landownership, and included grids made up of Bureau of Land Management (BLM), state, US Forest Service, Rock Springs Grazing Association, Anadarko, and Union Pacific lands for which we could obtain permission to access. Using data from WOGCC 03.14.16, we also eliminated grids that had producing oil or gas wells. We visually assessed the percent juniper cover of each available grid using National Agriculture Imagery Program (NAIP) imagery from 2012. Each grid that was ≥50% juniper cover was retained for a subsequent spatially-balanced random selection using the Generalized Random Tessellation Stratified (GRTS) method (Stevens and Olson 2004). We used GRTS to select 60 grids to be surveyed in 2016 and 2017, and 20 oversample grids in case we were unable to survey some selected grids. Per IMBCR protocol, we generated a transect for each selected grid consisting of 16 points spaced 250 m apart and 125 m from the edge of the grid in a 4 x 4 fashion. Because each chronological set of grids is spatially balanced, we started with the first grid and attempted to survey each subsequent grid. We did not survey grids where access was extremely difficult or unsafe.

In the field, we conducted avian surveys during the breeding season in the month of June using point counts and following the IMBCR protocol. Each observer surveyed up to 1 grid per day by conducting 6-minute point counts at each of the 16 points starting 30 minutes before sunrise and surveying no later than 5 hours after sunrise. After arriving at a point count station, we recorded habitat data within 50 m of the point count center including overstory, understory, ground cover data, plant species abundances, grass height, presence of cliffs and snags, and overall habitat type. For each bird detected, we recorded the minute when the detection occurred

(minutes 1-6), the 4-letter alpha species code, distance from the observer, how the detection occurred (visually, audibly, or both), if the bird was male or female, if it was migrating, and how many individuals we detected. After completing the point, we hiked to the next point and surveyed again until all points within the grid were completed.

RESULTS

We conducted 17 surveys for birds across the study area from 3 June through 29 June 2016. We recorded 2,555 detections of 54 different species. We had 350 additional bird detections of unknown species and 358 minutes out of 1,632 total survey minutes (21.9%) where no birds were detected. We detected 5 of the 6 target species including, in order of highest number of occupied grids, Juniper Titmouse, Ash-throated Flycatcher, Bushtit, Woodhouse's Scrub-Jay, and Gray Vireo (Table 1). We detected 49 other species during surveys (Table 2). The 1st year of data collection did not provide enough data for robust statistical analysis. Upon completion of the 2nd year of data collection, we will have additional results including density and occupancy estimates.

We conducted a large majority of point counts in pinyon-juniper habitat (77%) and sagebrush habitat (17%). Shrubland, cliff/rock, and riparian were the primary habitat for the remainder of the surveys (Table 3). Mean shrub cover was 18.6% with a height of 1.4 m, and mean canopy cover was 9.2% with a height of 2.6 m. Pinyon-juniper habitat was dominated by Utah juniper with rare pinyon pine (*Pinus edulis)* scattered throughout the most southern sites.

DISCUSSION

The sites that we surveyed generally encompassed the diversity of landscape features and habitat types we observed within the study area, and we ultimately surveyed within juniper habitat a large majority of the time. We concluded that the methods we used for selecting sites, including our assessment of aerial imagery for juniper abundance, were adequate. Given time constraints and resources, 17 survey sites was our maximum capacity to survey.

Though efforts were not synonymous, we documented Gray Vireo and Bushtit, which were not recorded in the most recent survey effort to document juniper obligates in the region (Pavalacky and Anderson 2001). Annual differences in precipitation affecting grass cover, insect abundance, and predator numbers could be one explanation, among many, of changes in occupancy over the course of many years. While the result is not surprising, it does raise the question: How often do the very rare species such as Scott's Oriole and Gray Vireo occur in Wyoming and in what abundances? For very rare species, it may be difficult to address such questions within the scope of this 2-year project. However, more long-term efforts, such as IMBCR surveys, if targeting the relevant habitat, may be able to answer such questions.

Upon completion of analyses by Bird Conservancy of the Rockies, we will have occupancy and density estimates for those species observed during the 2016 field season that have enough detections to produce robust results. We will have context for these results using

the Avian Data Center database and comparing estimates to species at a wider scale, such as across Wyoming or across the Bird Conservation Region. Furthermore, we can also test for differences in detections based on habitat attributes. For example, Ash-throated Flycatcher is associated with mature juniper with a sparse understory and lots of dead snags. Because the study area is at the most northern part of the range for these juniper-obligates, it will be interesting to see if patterns such as these hold true in this part of their range.

Juniper woodlands in southwestern Wyoming host a diverse suite of species and are likely to undergo changes in the near future as landscape-scale changes continue to develop. In some places, including in southwestern Wyoming, certain interest groups consider juniper an expendable weed. With changes in fire regimes and fire suppression over the last decade, some areas are in need of assisted disturbance, particularly where early seral juniper communities are establishing in places where, to our knowledge, they did not previously occur. For example, recent treatments have occurred in areas where juniper are creeping down in elevation and invading deeper soils where sagebrush normally occurs (P. Lionberger and M. Zornes, personal communications). It should be noted, however, that there is a wide diversity in preference for various habitat characteristics of juniper woodlands across juniper-obligates (Findholt and Fitton 1983; Pavalacky and Anderson 2001, 2004). In addition, several species other than juniper-obligates are also influenced by changes to juniper communities. For example, Pavalcky and Anderson (2004) found patterns of use from 12 bird species across altitudinal and successional gradients, which suggest value in maintaining diverse woodlands that consists of all seral stages. Furthermore, larger landscape changes, including changes in climate and recurring pressure to develop the area for energy resources, may affect this habitat in the coming years. Efforts to maintain a complex juniper ecosystem across the landscape in southwestern Wyoming will be important for supporting a diverse suite of native species.

ACKNOWLEDGEMENTS

Funding for this project was provided by the US Fish and Wildlife Service State Wildlife Grants program and Wyoming State Legislature General Fund Appropriations, for which the Department is extremely grateful. We would like to sincerely thank N. VanLanen and Bird Conservancy of the Rockies for their continued collaboration and support. We thank our Department ArcGIS support, N. Whitford, for conducting site selection for the project. We also thank Green River Region Department personnel, including M. Zornes, P. Burke, and K. Spence, who contributed ideas to the study design, particularly in the nascent stages of the project. Finally, thank you to A. Marquardt who assisted with data collection.

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Table 1. Summary of detections of juniper-obligate target species found in the Flaming Gorge study area in southwestern Wyoming from 3-29 June 2016.

Common name	Alpha code	Scientific name	Grids detected (#)	Grids detected (%)
Ash-throated flycatcher	ATFL	*Myiarchus cinerascens*	9	53
Bushtit	BUSH	*Psaltriparus minimus*	7	41
Gray Vireo	GRVI	*Vireo vicinior*	1	6
Juniper Titmouse	JUTI	*Baeolophus ridgwayi*	13	76
Scott's Oriole	SCOR	*Icterus parisorum*	0	0
Woodhouse's Scrub-Jay	WESJ	*Aphelocoma woodhouseii*	3	18

Table 2. Number of individuals and relative abundance of each species detected during Integrated Monitoring in Bird Conservation Regions surveys for the juniper-obligate project in southwestern Wyoming, 2016. Data are presented in alphabetical order. The 6 juniper-obligate target species are in bold.

Species (common name	Number detected	Relative abundance (%)
American Kestrel	1	0.04
American Robin	8	0.31
Ash-throated Flycatcher	**28**	**1.1**
Bewick's Wren	329	12.88
Black-billed Magpie	40	1.57
Black-headed Grosbeak	1	0.04
Black-throated Gray Warbler	129	5.05
Blue-gray Gnatcatcher	63	2.47
Brewer's Sparrow	279	10.92
Broad-tailed Hummingbird	1	0.04
Brown-headed Cowbird	16	0.63
Bushtit	**8**	**0.31**
Canyon Wren	1	0.04
Cassin's Finch	20	0.78
Chipping Sparrow	59	2.31
Clark's Nutcracker	26	1.02
Common Nighthawk	30	1.17
Common Raven	51	2
Cooper's Hawk	3	0.12
Dusky Flycatcher	25	0.98
Ferruginous Hawk	3	0.12
Golden Eagle	3	0.12
Grasshopper Sparrow	2	0.08
Gray Flycatcher	218	8.53

Table 2. Continued.

Species (common name	Number detected	Relative abundance (%)
Gray Vireo	**1**	**0.04**
Great Horned Owl	2	0.08
Green-tailed Towhee	229	8.96
Horned Lark	14	0.55
House Finch	6	0.23
House Wren	16	0.63
Juniper Titmouse	**38**	**1.49**
Lark Sparrow	15	0.59
Mountain Bluebird	152	5.95
Mountain Chickadee	10	0.39
Mourning Dove	207	8.1
Northern Flicker	60	2.35
Northern Rough-winged Swallow	1	0.04
Pinyon Jay	27	1.06
Plumbeous Vireo	46	1.8
Red-tailed Hawk	8	0.31
Rock Wren	173	6.77
Sage Thrasher	11	0.43
Sagebrush Sparrow	40	1.57
Say's Phoebe	15	0.59
Swainson's Hawk	9	0.35
Tree Swallow	3	0.12
Turkey Vulture	1	0.04
Vesper Sparrow	66	2.58
Violet-green Swallow	16	0.63
Western Kingbird	1	0.04
Western Meadowlark	29	1.14
Western Scrub-Jay	**6**	**0.23**
Western Wood-Pewee	2	0.08
Yellow-rumped Warbler	7	0.27
Total individuals	2,555	
Total species	54	

Table 3. Number of sites and relative frequency of primary habitats surveyed during Integrated Monitoring in Bird Conservation Regiond surveys for the juniper-obligate project in southwestern Wyoming, 2016.

Primary habitat	Number of sites	Relative frequency (%)
Cliff/Rock	3	1
Pinyon Juniper	221	77
Riparian	1	0.3
Sagebrush	50	17
Shrubland	11	4

WYOMING PARTNERS IN FLIGHT AND INTEGRATED MONITORING IN BIRD CONSERVATION REGIONS

STATE OF WYOMING

NONGAME BIRDS: Species of Greatest Conservation Need

FUNDING SOURCE: Wyoming State Legislature General Fund Appropriations
Bureau of Land Management Cooperative Agreement
National Park Service Cooperative Agreement
United States Fish and Wildlife Service State Wildlife Grant
United States Forest Service Cooperative Agreement

PROJECT DURATION: Annual

PERIOD COVERED: 15 April 2016 – 1 June 2017

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ABSTRACT

Landbird populations have declined due to a variety of influences, both natural and human-caused. The Partners in Flight program was initiated in 1990 to address these declines through comprehensive bird conservation planning efforts. Wyoming's working group, Wyoming Partners in Flight, produced the Wyoming Bird Conservation Plan, Version 2.0, which presents avian population objectives, habitat objectives, Best Management Practices to benefit birds, and recommendations to ensure the viability of birds and their habitats, and was used to develop portions of the State Wildlife Action Plan (Nicholoff 2003, WGFD 2017). Monitoring is a key component of the Wyoming Bird Conservation Plan. Through cooperative funding via Wyoming Partners in Flight, numerous partners have jointly implemented the Integrated Monitoring in Bird Conservation Regions program (formerly Monitoring Wyoming's Birds) through the Bird Conservancy of the Rockies (formerly Rocky Mountain Bird Observatory). Data gathered from this program allow us to estimate density, population size, occupancy, and detection probabilities for numerous avian species, including Species of Greatest Conservation

Need (SGCN). In 2016, field technicians completed 2,540 point counts on 198 of the 200 planned survey grids (99%) within the 37 strata in the 5 Bird Conservation Regions in Wyoming, covering a total of 253,747 km^2. They detected 185 avian species, including 47 SGCN. Biometricians estimated occupancy for 155 species (83.8%), including 32 SGCN. Data provided robust occupancy estimates (CV <50%) for 87 species, (56.1%), including 22 SGCN. Biometricians estimated density and population size for 152 species (82.2%), including 30 SGCN. Data provided robust density estimates (CV <50%) for 80 species (51.6%), including 13 SGCN. The Integrated Monitoring in Bird Conservation Regions design allows us to monitor trends of avian SGCN that may be overlooked or under-represented by other survey techniques, including sagebrush- and grassland-obligate species; permits slight modifications to the design in order to investigate other priority species as needs arise; reduces monitoring costs through coordination and collaboration with monitoring partners; and can be stepped up to evaluate population parameters on a regional scale.

INTRODUCTION

Long-term data analyses indicate that trends for many populations of North American landbirds have declined due to land use changes; habitat loss, fragmentation, and deterioration; pesticide use; and human influences and disturbance (Robbins et al. 1989, Peterjohn et al. 1995, Sauer et al. 1996, Boren et al. 1999, Donovan and Flather 2002). The International Partners in Flight (PIF) program was initiated in 1990 to address and reverse these declines. The PIF mission is to help species at risk and to keep common birds common through voluntary partnerships that benefit birds, habitats, and people. State, regional, national, and international Bird Conservation Plans comprehensively address the issues of avian and habitat conservation on a landscape scale. The North American Bird Conservation Initiative (NABCI) was initiated in 1998 to ensure the long-term health of North America's native bird populations through effective conservation initiatives, enhanced coordination among the initiatives, and increased cooperation among the governments and citizens of Canada, the US, and Mexico (NABCI 2016).

The state PIF working group, Wyoming Partners in Flight (WYPIF), was established in 1991 and is comprised of participants from the Wyoming Game and Fish Department (Department), Bird Conservancy of the Rockies (Bird Conservancy; formerly Rocky Mountain Bird Observatory), Bureau of Land Management (BLM), US Forest Service (USFS), US Fish and Wildlife Service, Bureau of Reclamation, National Park Service (NPS), Audubon Rockies and affiliate chapters, Wyoming Natural Diversity Database (WYNDD), University of Wyoming, and The Nature Conservancy. The Department's Nongame Bird Biologist has served as the WYPIF chairperson since its inception. As a group, WYPIF produced the Wyoming Bird Conservation Plan, Version 2.0 (Plan; Nicholoff 2003). The Plan presents objectives for populations of birds and major habitat groups in the State, Best Management Practices to benefit birds, and recommendations to ensure that populations of birds and the habitats they require remain intact and viable into the future through proactive and restorative management techniques. Many components of the Plan have been used to develop portions of the Wyoming State Wildlife Action Plan (WGFD 2017).

One of the highest priority objectives throughout the Plan for populations of birds is to implement Monitoring Wyoming's Birds: The Plan for Count-based Monitoring (Leukering et al. 2001). Monitoring of populations is an essential component of effective wildlife management and conservation (Witmer 2005, Marsh and Trenham 2008). Besides improving distribution data, monitoring allows us to evaluate populations of target species and detect changes over time (Thompson et al. 1998, Sauer and Knutson 2008), identify species that are at risk (Dreitz et al. 2006), and evaluate responses of populations to management actions (Lyons et al. 2008, Alexander et al. 2009) and landscape and climate change (Baron et al. 2008, Lindenmayer and Likens 2009).

For the 16th consecutive year, biologists from the Department, Bird Conservancy, BLM, USFS, NPS, WYNDD, and Audubon Rockies have collaborated to execute a state-of-the-art avian monitoring program across Wyoming. Resources are provided by numerous federal agency cooperative agreements, State Wildlife Grants funds, and dollars from the Wyoming State Legislature General Fund Appropriations. This cooperative effort allows us to execute a statewide monitoring program for birds and revise distributions and estimate abundance of numerous avian species, including Species of Greatest Conservation Need (SGCN; WGFD 2017). Funding is also provided to develop educational materials and improve outreach opportunities that focus on birds in Wyoming. The Bird Conservancy is responsible for implementing the monitoring program, which originally focused on 6 habitats in Wyoming (i.e., aspen, grassland, juniper woodland, mid-elevation conifer, montane riparian, and shrub-steppe) under the Monitoring Wyoming's Birds design. Since 2009, this monitoring program, now called Integrated Monitoring in Bird Conservation Regions (IMBCR), incorporates a region-wide approach and uses a stratified, spatially balanced, grid-based design (Hanni et al. 2014). The BLM, USFS, NPS, and Department (through State Wildlife Grants support) contribute funding to the program, and WYNDD assists in program monitoring. Audubon Rockies assists with inventory and monitoring for those species that require techniques other than point-counts (e.g., Monitoring Avian Productivity and Survivorship bird banding stations), producing and distributing educational materials on birds and their habitats, and providing nature-based outreach opportunities for the public. The Department conducts annual monitoring for SGCN that require species-specific survey methods (e.g., Common Loon [*Gavia immer*] American Bittern [*Botaurus lentiginosus*], Burrowing Owl [*Athene cunicularia*], Long-billed Curlew [*Numenius americanus*], Mountain Plover [*Charadrius montanus*], Upland Sandpiper [*Bartramia longicauda*], and raptors), prints and distributes PIF educational materials, and provides point data via the Wildlife Observation System database. With funding and guidance from the IMBCR partnership, Bird Conservancy oversees and implements the program, conducts data analyses, maintains the Rocky Mountain Avian Data Center database, and produces an annual IMBCR report.

The IMBCR partnership's monitoring objectives using the IMBCR design (White et al. 2017) are to:

1. Provide robust density, population, and occupancy estimates that account for incomplete detection and are comparable at different geographic extents.
2. Provide long-term status and trend data for all regularly occurring breeding species throughout the study area.

3. Provide a design framework to spatially integrate existing bird monitoring efforts in the region to provide better information on distribution and abundance of breeding landbirds, especially for high priority species.
4. Provide basic habitat association data for most bird species to address habitat management issues.
5. Maintain a high-quality database that is accessible to all of our collaborators, as well as to the public, over the internet in the form of raw and summarized data.
6. Generate decision support tools that help guide conservation efforts and provide a better measure of conservation success.

METHODS

Bird Conservation Regions (BCRs) provide a spatially consistent framework for the IMBCR program (Figure 1). The IMBCR area of inference includes all or parts of 13 western states (Figure 2). Within the BCR sampling frame, all monitoring partners collaborated to define strata and super-strata based on smaller-scale areas to which we wanted to make inferences (e.g., National Forests, BLM lands, individual states). Within each stratum, the IMBCR design used a spatially balanced sampling algorithm (i.e., generalized random-tessellation stratification) to select sample units (Stevens and Olsen 2004). Bird Conservancy biometricians overlaid BCRs with 1 km^2 sample grids, randomly selected sample grids, and used a 4 x 4 point count array with 16 survey points spaced 250 m apart within each sample grid (Figure 3; Hanni et al. 2014). To estimate the variances of population parameters, a minimum of 2 sampling units within each stratum are required (White et al. 2017).

Prior to surveys, field technicians completed an intensive training program covering protocols, bird and plant identification, and distance estimation. Technicians used distance sampling (Buckland et al. 2001) and IMBCR sampling methods established by the Bird Conservancy (Hanni et al. 2014, 2015) to conduct point counts during the field season. They surveyed grids in the morning from 0.5 hour before sunrise to 1100 hours, and surveyed each count point for 6 minutes to facilitate estimation of site occupancy. For each bird detected, technicians recorded species, sex, horizontal distance from the observer, minute of detection, and type of detection (e.g., song, call, visual). Other data were also noted, such as the presence of migrants, flyovers, clusters, and species difficult to detect, as well as the presence of American pika (*Ochotona princeps*), Abert's squirrels (*Sciurus aberti*), and red squirrels (*Tamiasciurus hudsonicus*). Technicians recorded time, ambient temperature, cloud cover, precipitation, and wind speed at the start and end of each grid survey. They also recorded vegetation data within a 50-m radius of each survey point and included dominant habitat type and relative abundance; species, percent cover, and mean height of trees and shrubs; grass height; and ground cover types. Distance from a road, if within 100 m, was also noted.

Biometricians from the Bird Conservancy used Distance 6.0 to estimate detection probabilities (Buckland et al. 2001, Thomas et al. 2010). They used the RIMBCR package in Program R (R Core Team 2014) to estimate density, population size, and occupancy for species detected in individual strata or combinations of strata at various biologically meaningful spatial

scales (White et al. 2017). Lastly, they used a removal design to estimate detection probability for each species (MacKenzie et al. 2006).

RESULTS

In 2016, the IMBCR program encompassed 3 entire states (Colorado, Montana, and Wyoming); portions of 11 additional states (Arizona, Idaho, Kansas, Montana, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, and Utah); 2 entire USFS Regions (Regions 1 and 2); portions of 2 additional USFS Regions (Regions 3 and 4); all of BCR 17 (Badlands and Prairies); almost all of BCR 18 (Shortgrass Prairie); and portions of BCRs 9 (Great Basin), 10 (Northern Rockies), 11 (Prairie Potholes), 16 (Southern Rockies/Colorado Plateau), 19 (Central Mixed-grass Prairie), 33 (Sonoran and Mojave Deserts), and 34 (Sierra Madre Occidental; White et al. 2017; Figure 2).

Between 16 May and 19 July 2016, field technicians and biologists with Bird Conservancy and WYNDD completed 2,540 point counts on 198 of the 200 planned survey grids (99%) within the 37 strata in the 5 BCRs in Wyoming, covering a total of 253,747 km^2 (White et al. 2017; Table 1; Figures 1 and 4). Statewide results were obtained by compiling and jointly analyzing data from survey locations within the 37 different strata (White et al. 2017).

Field personnel detected a total of 185 species in 2016, including 47 SGCN (White et al. 2017). Bird Conservancy biometricians were able to estimate occupancy, or the proportion of 1 km^2 grid cells occupied, (Psi; ψ) for 155 of the 185 species (83.8%), 32 of which are SGCN (Table 2). Data provided robust occupancy estimates (CV <50%) for 87 of the 155 species (56.1%), including 22 SGCN (Table 2). Bird Conservancy biometricians were able to estimate density (*D*) and population size (*N*) for 152 of the 185 species (82.2%), 30 of which are SGCN (Table 3). Data provided robust density estimates (CV <50%) for 80 of the 155 species (51.6%), including 13 SGCN (Table 3).

Annual and multi-year reports, species accounts, and density estimate tables and graphs from the IMBCR program are available on the Rocky Mountain Avian Data Center web site (Bird Conservancy 2017). To view survey locations in Wyoming, occupancy and density results, and species counts across all years of the IMBCR program, follow this link http://www.rmbo.org/new_site/adc/QueryWindow.aspx#N4IgzgrgDgpgTmALnAhoiBbEAuEB1ATRAF8gAA and click the "Run Query" button highlighted in red near the top of the page. To view just the 2016 field season results, follow the link, select "Year" from the Filter drop down box on the top left of the screen, click the "Add" button, select 2016, click "Add Filter", and then click "Run Query" (White et al. 2017).

DISCUSSION

The methods employed by Bird Conservancy of the Rockies and project partners to monitor avian populations using the IMBCR design enable us to estimate occupancy, density, and population size for each species when sample sizes are large enough. These robust data not

only allow for continuous monitoring of species trends, but also provide information on species abundance and distribution, habitat associations, and evaluation of land management activities (White et al. 2017). The IMBCR program provides density and occupancy estimates for a number of avian SGCN at risk in Wyoming due to habitat loss or alteration or for which data on population and trends are lacking. Consequently, the IMBCR program provides the Department with an opportunity to monitor trends of avian SGCN that may be overlooked or under-represented by other survey techniques.

Currently, Bird Conservancy of the Rockies has completed the Avian Data Center automated analyses, and is working on posting all habitat data under the Monitoring Wyoming's Birds protocol from 2000-2009 to the current IMBCR grid-based design.

As in previous years, the 2016 IMBCR design will provide robust density and occupancy estimates for avian SGCN in Wyoming, which helps fill gaps in current monitoring efforts by the Department. Data collected on all species, including SGCN, help address a number of management challenges, including data deficiencies, habitat loss or degradation, and population declines. Specifically, the IMBCR program provides a quantified approach for monitoring numerous SGCN.

Three species, Brewer's Sparrow (*Spizella breweri*), Sagebrush Sparrow (*Artemesiospiza nevadensis*), and Sage Thrasher (*Oreoscoptes montanus*), are considered sagebrush obligates, and the Grasshopper Sparrow (*Ammodramus savannarum*), Lark Bunting (*Calamospiza melanocorys*), and McCown's Longspur (*Rhynchophanes mccownii*) are associated with grasslands. Both of these habitats are at high risk for degradation, alteration, or loss, with grasslands listed among the most imperiled habitats in the US and exhibiting dramatic declines in avian populations (WYPIF 2002, WGFD 2017). Although the Loggerhead Shrike (*Lanius ludovicianus*) is found across Wyoming in pine-juniper, woodland-chaparral, basin-prairie shrubland, and mountain-foothills shrubland habitats, the species is found in low numbers and the reasons for state and regional population declines are currently unknown (WGFD 2017). Clark's Nutcracker (*Aechmophorus clarkia*) and Red Crossbill (*Loxia curvirostra*) are also widespread in the state, occurring in mature coniferous forests (Orabona et al. 2016). However, monitoring data suggest that populations of both species are declining, and incompatible forest management practices and climate change are limiting factors (WGFD 2017). American Kestrels (*Falco sparverius*) are susceptible to secondary poisoning by pesticides during foraging, and a lack of nesting cavities and competition with non-native species for existing cavities can be problematic (Smallwood and Bird 2002). The MacGillivray's Warbler (*Geothlypis tolmiei*) is another well-distributed species in Wyoming, found at elevations below 2,743 m in aspen, cottonwood-riparian, and riparian shrubland habitats (Orabona et al. 2016). Monitoring of this species is important to determine the effects of habitat loss, degradation, and fragmentation; incompatible livestock grazing; and inappropriate land use practices on populations statewide (WGFD 2017). The Common Nighthawk (*Chordeiles minor*) is also well-distributed across the state in open and semi-open habitats below 2,590 m in elevation, and feeds in the air over most habitats, especially aquatic and agricultural areas (Orabona et al. 2016). Population trends for this species suggest declines, and insecticide use may be problematic (Sauer et al. 1996, WGFD 2017). By continuing to monitor Wyoming's breeding birds via the IMBCR program, results can

provide an indication of trends for many SGCN, as well as a host of more common species in the state.

The IMBCR design and hierarchical framework of nested strata provide accurate information about bird populations on multiple scales, from local management units to BCRs. Population estimates at the management unit scale can be used to support local management efforts, while regional- and BCR-level monitoring provides managers with dependable information about the status and changes of bird populations at ecologically relevant scales (NABCI 2009). Managers can also compare population estimates at the management unit scale to those at the BCR scale to provide a regional context for the estimates, allowing for informed conservation planning and an accurate assessment of conservation responsibility (White et al. 2017).

There are 5 major categories for management applications from IMBCR data (White et al. 2017):

1. The ability to compare estimates of bird populations in space and time. For example, estimates at the state and regional levels can be compared with stratum-level estimates to determine whether local populations are above or below estimates for the region.
2. Population estimates can help inform management decisions about where to focus conservation efforts. For example, managers can focus protection strategies on strata with large populations of avian species, and conservation actions can be targeted to those strata with lower populations. Managers could set thresholds that trigger specific management actions when populations reach preset levels.
3. The effectiveness of management actions within treatment areas can be evaluated by comparing stratum-level population estimates of those treatment areas to regional estimates. For example, population estimates within manipulated areas can be compared to regional estimates to determine if the treatment is beneficial or detrimental to the avian species present.
4. Annual density and occupancy estimates can be compared over time to determine if population changes are a result of population growth or decline and/or range expansion or contraction. For example, if occupancy rates of a particular species remains constant but population density declined over time, then declines in local abundance was the cause of the population change. Moreover, if both density and occupancy rates of a species declined, then range contraction was the cause of the change in population.
5. The area of land occupied by a particular species can be estimated by multiplying the size of the land area by the species' occupancy rate. For example, if the land area comprises 120,000 km^2 and the occupancy rate for a particular species is 0.57, managers can estimate that 68,400 km^2 of habitat within that land area are occupied by that species.

The IMBCR's spatially balanced sampling design is more efficient than simple random sampling and can increase precision in density, occupancy, and detection probability estimates (Stevens and Olsen 2004, White et al. 2017). Additionally, this sampling design provides the flexibility to generate population estimates at various scales relevant to land and wildlife management agencies, enabling managers to use population estimates to make informed management decisions about where to focus conservation efforts. It also allows sampling of all habitats, which enables managers to relate changes in bird populations to changes on the

landscape over time. These results support both local and regional conservation efforts in Wyoming. The IMBCR design can also be used in research applications as overlay or auxiliary projects, which incorporate detection data from the IMBCR program into the research project's analyses. Moreover, the IMBCR design allows us to monitor trends of avian SGCN that may be omitted or inadequately represented by other survey techniques, permits slight modifications to the design in order to investigate other priority species as needs arise, and reduces monitoring costs through coordination and collaboration with monitoring partners.

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Table 1. Planned and completed surveys, by stratum, conducted in Wyoming between 16 May and 19 July 2016 using the Integrated Monitoring in Bird Conservation Regions design.

BCR name	BCR number	Number of strata	Strata area (km^2)	Number of surveys planned	Number of surveys completed	Percent surveys completed (%)
Great Basin	9	1	119	2	2	100
Northern Rockies	10	23	165,332	120	120	100
Southern Rockies/Colorado Plateau	16	4	11,594	29	28	96.6
Badlands and Prairies	17	6	64,164	33	33	100
Shortgrass Prairie	18	3	12,258	16	15	93.8
Statewide total		37	253,467	200	198	99.0

Table 2. Estimated proportion of sample units occupied (ψ), standard error (SE), percent coefficient of variation (% CV), and number of grids with ≥1 detections (*n*) of 47 avian Species of Greatest Conservation Need on Integrated Monitoring in Bird Conservation Regions survey grids throughout Wyoming from 2010-2016. Occupancy estimates are considered robust if % CV <50%, and are noted in bold. Scientific names are presented below the table.

Species common name	Year	Psi *(ψ)*	SE	% CV	*n*
American Kestrel	**2010**	**0.483**	**0.036**	**8**	**12**
American Kestrel	2011	0.165	0.093	56	7
American Kestrel	**2012**	**0.073**	**0.018**	**25**	**12**
American Kestrel	**2013**	**0.174**	**0.077**	**44**	**8**
American Kestrel	**2014**	**0.191**	**0.093**	**49**	**8**
American Kestrel	**2015**	**0.208**	**0.082**	**40**	**14**
American Kestrel	**2016**	**0.052**	**0.021**	**40**	**10**
American Pipit	2010	0.011	0.006	59	4
American Pipit	2011	0.034	0.018	52	5
American Pipit	2012	0.029	0.015	54	4
American Pipit	**2013**	**0.04**	**0.014**	**35**	**6**
American Pipit	**2014**	**0.04**	**0.014**	**35**	**6**
American Pipit	**2015**	**0.065**	**0.017**	**27**	**10**
American Pipit	**2016**	**0.039**	**0.014**	**36**	**4**
Ash-throated Flycatcher	2010	0	0	71	1
Ash-throated Flycatcher	2015	0.022	0.021	96	1
Bewick's Wren	2010	0.024	0.023	95	1
Bewick's Wren	2014	0.02	0.013	65	2
Bewick's Wren	2015	0.018	0.017	96	1
Bewick's Wren	2016	0.035	0.02	56	3
Black Rosy-Finch	**2010**	**0**	**0**	**0**	**5**
Black Rosy-Finch	2012	0.028	0.015	55	3
Black Rosy-Finch	2013	0.036	0.02	57	5
Black-backed Woodpecker	2016	0.02	0.019	97	1
Black-throated Gray Warbler	2010	0.001	0.001	71	1
Black-throated Gray Warbler	2011	0.019	0.014	72	1
Black-throated Gray Warbler	2013	0.001	0.001	97	1
Black-throated Gray Warbler	2015	0.025	0.024	97	1
Blue Grosbeak	2010	0	0	96	1
Blue Grosbeak	2014	0.007	0.007	93	1
Blue Grosbeak	2015	0.007	0.007	95	1
Blue Grosbeak	2016	0.005	0.005	95	1
Blue-gray Gnatcatcher	2010	0.036	0.023	63	4
Blue-gray Gnatcatcher	**2011**	**0.035**	**0.016**	**47**	**5**

Table 2. Continued.

Species common name	Year	Psi *(ψ)*	SE	% CV	*n*
Blue-gray Gnatcatcher	2012	0.03	0.016	55	4
Blue-gray Gnatcatcher	**2013**	**0.044**	**0.022**	**50**	**6**
Blue-gray Gnatcatcher	**2014**	**0.039**	**0.016**	**41**	**6**
Blue-gray Gnatcatcher	**2015**	**0.054**	**0.024**	**45**	**6**
Blue-gray Gnatcatcher	**2016**	**0.065**	**0.032**	**49**	**7**
Brewer's Sparrow	**2010**	**0.541**	**0.051**	**9**	**80**
Brewer's Sparrow	**2011**	**0.505**	**0.052**	**10**	**77**
Brewer's Sparrow	**2012**	**0.533**	**0.049**	**9**	**87**
Brewer's Sparrow	**2013**	**0.602**	**0.048**	**8**	**97**
Brewer's Sparrow	**2014**	**0.554**	**0.056**	**10**	**83**
Brewer's Sparrow	**2015**	**0.586**	**0.039**	**7**	**121**
Brewer's Sparrow	**2016**	**0.622**	**0.044**	**7**	**101**
Burrowing Owl	2015	0	0	72	1
Bushtit	2016	0.048	0.052	109	1
Calliope Hummingbird	2010	0.002	0.002	108	1
Calliope Hummingbird	2012	0.028	0.025	89	2
Canyon Wren	2010	0.021	0.015	69	3
Canyon Wren	2015	0.008	0.007	93	1
Canyon Wren	2016	0.01	0.009	87	1
Chestnut-collared Longspur	2010	0.033	0.021	64	3
Chestnut-collared Longspur	2012	0.023	0.02	88	2
Chestnut-collared Longspur	2013	0.025	0.02	82	3
Chestnut-collared Longspur	2014	0	0	71	1
Chestnut-collared Longspur	2015	0.014	0.01	70	2
Clark's Nutcracker	**2010**	**0.138**	**0.026**	**19**	**24**
Clark's Nutcracker	**2011**	**0.182**	**0.016**	**9**	**33**
Clark's Nutcracker	**2012**	**0.216**	**0.039**	**18**	**42**
Clark's Nutcracker	**2013**	**0.183**	**0.04**	**22**	**52**
Clark's Nutcracker	**2014**	**0.139**	**0.027**	**20**	**43**
Clark's Nutcracker	**2015**	**0.149**	**0.033**	**22**	**50**
Clark's Nutcracker	**2016**	**0.127**	**0.021**	**17**	**35**
Common Nighthawk	2010	0.108	0.055	51	7
Common Nighthawk	**2011**	**0.2**	**0.076**	**38**	**21**
Common Nighthawk	**2012**	**0.175**	**0.034**	**20**	**18**
Common Nighthawk	**2013**	**0.341**	**0.074**	**22**	**41**
Common Nighthawk	**2014**	**0.155**	**0.071**	**46**	**11**
Common Nighthawk	**2015**	**0.212**	**0.052**	**24**	**33**
Common Nighthawk	**2016**	**0.235**	**0.093**	**40**	**15**

Table 2. Continued.

Species common name	Year	Psi *(ψ)*	SE	% CV	*n*
Common Yellowthroat	2010	0.08	0.05	63	7
Common Yellowthroat	**2011**	**0.007**	**0.002**	**34**	**7**
Common Yellowthroat	2012	0.059	0.038	63	7
Common Yellowthroat	2013	0.043	0.023	53	6
Common Yellowthroat	2014	0.002	0.001	74	2
Common Yellowthroat	**2015**	**0.038**	**0.016**	**42**	**6**
Common Yellowthroat	2016	0.059	0.035	59	5
Dickcissel	2014	0.006	0.006	94	1
Grasshopper Sparrow	**2010**	**0.128**	**0.036**	**28**	**27**
Grasshopper Sparrow	**2011**	**0.103**	**0.028**	**27**	**26**
Grasshopper Sparrow	**2012**	**0.107**	**0.03**	**28**	**16**
Grasshopper Sparrow	**2013**	**0.062**	**0.029**	**47**	**13**
Grasshopper Sparrow	**2014**	**0.085**	**0.028**	**33**	**15**
Grasshopper Sparrow	**2015**	**0.151**	**0.024**	**16**	**33**
Grasshopper Sparrow	**2016**	**0.092**	**0.027**	**29**	**15**
Great Blue Heron	2012	0.002	0.002	108	1
Great Blue Heron	2013	0.001	0.001	101	1
Great Blue Heron	2014	0.001	0.001	107	1
Great Blue Heron	2015	0.004	0.005	116	1
Great Blue Heron	2016	0.073	0.058	80	2
Greater Sage-Grouse	**2014**	**0.033**	**0**	**0**	**1**
Greater Sage-Grouse	2016	0.017	0.011	67	2
Juniper Titmouse	2016	0.018	0.017	97	1
Lewis's Woodpecker	2011	0.003	0.003	90	1
Lewis's Woodpecker	2014	0.002	0.002	105	1
Lewis's Woodpecker	2015	0.003	0.003	91	1
Loggerhead Shrike	**2010**	**0**	**0**	**0**	**6**
Loggerhead Shrike	2012	0.092	0.071	77	6
Loggerhead Shrike	2013	0.117	0.061	52	6
Loggerhead Shrike	**2014**	**0.115**	**0.053**	**46**	**6**
Loggerhead Shrike	**2015**	**0.327**	**0.088**	**27**	**25**
Loggerhead Shrike	**2016**	**0.2**	**0.06**	**30**	**13**
Long-billed Curlew	2015	0.01	0.009	98	1
Long-billed Curlew	2016	0.029	0.026	88	2
MacGillivray's Warbler	**2010**	**0.052**	**0.021**	**41**	**19**
MacGillivray's Warbler	**2011**	**0.066**	**0.028**	**43**	**15**
MacGillivray's Warbler	**2012**	**0.034**	**0.014**	**42**	**17**
MacGillivray's Warbler	**2013**	**0.05**	**0.017**	**34**	**27**

Table 2. Continued.

Species common name	Year	Psi *(ψ)*	SE	% CV	*n*
MacGillivray's Warbler	**2014**	**0.052**	**0.016**	**31**	**29**
MacGillivray's Warbler	**2015**	**0.102**	**0.018**	**17**	**45**
MacGillivray's Warbler	**2016**	**0.107**	**0.023**	**21**	**33**
McCown's Longspur	2010	0.045	0.023	52	5
McCown's Longspur	**2011**	**0.022**	**0.01**	**47**	**4**
McCown's Longspur	2012	0.045	0.023	50	6
McCown's Longspur	**2013**	**0.024**	**0.01**	**43**	**4**
McCown's Longspur	2014	0.019	0.01	54	3
McCown's Longspur	**2015**	**0.033**	**0.014**	**43**	**9**
McCown's Longspur	2016	0.018	0.009	52	4
Mountain Plover	2010	0	0	71	1
Mountain Plover	2013	0.003	0.002	62	2
Mountain Plover	2015	0.001	0.001	66	2
Mountain Plover	2016	0.013	0.008	64	3
Northern Goshawk	2012	0.031	0.027	87	3
Northern Pygmy-Owl	2013	0.001	0.001	110	1
Purple Martin	2014	0.001	0.001	82	1
Pygmy Nuthatch	2010	0.001	0.001	59	2
Pygmy Nuthatch	2011	0.008	0.004	58	2
Pygmy Nuthatch	**2012**	**0.004**	**0.002**	**44**	**4**
Pygmy Nuthatch	2013	0.002	0.001	68	2
Pygmy Nuthatch	**2014**	**0.005**	**0.002**	**46**	**4**
Pygmy Nuthatch	2015	0.018	0.017	95	2
Pygmy Nuthatch	2016	0.001	0.001	97	1
Red Crossbill	**2010**	**0.07**	**0.019**	**27**	**29**
Red Crossbill	**2011**	**0.126**	**0.015**	**12**	**23**
Red Crossbill	**2012**	**0.162**	**0.038**	**23**	**40**
Red Crossbill	**2013**	**0.096**	**0.023**	**24**	**50**
Red Crossbill	**2014**	**0.108**	**0.024**	**22**	**50**
Red Crossbill	**2015**	**0.084**	**0.012**	**14**	**44**
Red Crossbill	**2016**	**0.092**	**0.018**	**20**	**42**
Red-eyed Vireo	2012	0.003	0.002	72	1
Red-eyed Vireo	**2013**	**0.002**	**0.001**	**41**	**4**
Red-eyed Vireo	2014	0.002	0.001	82	1
Red-eyed Vireo	2015	0.002	0.001	82	1
Red-headed Woodpecker	2011	0.003	0.002	85	1
Red-headed Woodpecker	2013	0.001	0.001	98	1
Red-headed Woodpecker	2014	0.002	0.002	82	1

Table 2. Continued.

Species common name	Year	Psi *(ψ)*	SE	% CV	*n*
Red-headed Woodpecker	2015	0.012	0.006	50	5
Red-headed Woodpecker	2016	0	0	71	1
Rufous Hummingbird	2012	0.016	0.013	79	2
Rufous Hummingbird	2014	0.024	0.022	94	2
Rufous Hummingbird	2015	0.009	0.007	75	3
Sagebrush Sparrow	**2010**	**0.191**	**0.038**	**20**	**24**
Sagebrush Sparrow	**2011**	**0.161**	**0.029**	**18**	**23**
Sagebrush Sparrow	**2012**	**0.152**	**0.033**	**22**	**22**
Sagebrush Sparrow	**2013**	**0.144**	**0.032**	**22**	**20**
Sagebrush Sparrow	**2014**	**0.123**	**0.031**	**25**	**14**
Sagebrush Sparrow	**2015**	**0.144**	**0.026**	**18**	**23**
Sagebrush Sparrow	**2016**	**0.194**	**0.028**	**14**	**31**
Sage Thrasher	**2010**	**0.252**	**0.047**	**18**	**34**
Sage Thrasher	**2011**	**0.238**	**0.039**	**16**	**33**
Sage Thrasher	**2012**	**0.353**	**0.08**	**23**	**38**
Sage Thrasher	**2013**	**0.182**	**0.039**	**21**	**26**
Sage Thrasher	**2014**	**0.223**	**0.048**	**21**	**22**
Sage Thrasher	**2015**	**0.292**	**0.041**	**14**	**46**
Sage Thrasher	**2016**	**0.337**	**0.04**	**12**	**46**
Sharp-tailed Grouse	2016	0.004	0.004	96	1
Short-eared Owl	2015	0.026	0.017	65	5
Short-eared Owl	2016	0.015	0.012	81	2
Swainson's Hawk	2010	0.017	0.017	101	2
Swainson's Hawk	2012	0.003	0.003	98	2
Swainson's Hawk	2013	0.141	0.126	89	2
Swainson's Hawk	2014	0.071	0.071	101	1
Swainson's Hawk	2015	0.109	0.076	70	3
Swainson's Hawk	**2016**	**0.197**	**0.06**	**30**	**5**
Upland Sandpiper	2010	0.038	0.029	77	5
Upland Sandpiper	2011	0.024	0.02	83	6
Upland Sandpiper	2012	0.014	0.008	62	2
Upland Sandpiper	2014	0.076	0.044	58	4
Upland Sandpiper	**2015**	**0.049**	**0.02**	**41**	**8**
Upland Sandpiper	2016	0.026	0.02	80	3
Virginia's Warbler	2014	0.001	0.001	82	1
Virginia's Warbler	2015	0.001	0.001	71	1
Western Scrub-Jay	2015	0.009	0.009	98	1
Williamson's Sapsucker	2010	0.002	0.002	68	2

Table 2. Continued.

Species common name	Year	Psi *(ψ)*	SE	% CV	*n*
Williamson's Sapsucker	2011	0.006	0.003	51	3
Williamson's Sapsucker	2012	0.024	0.016	69	4
Williamson's Sapsucker	**2013**	**0.005**	**0.002**	**41**	**5**
Williamson's Sapsucker	**2014**	**0.007**	**0.003**	**40**	**6**
Williamson's Sapsucker	**2015**	**0.007**	**0.003**	**48**	**6**
Williamson's Sapsucker	2016	0.015	0.01	68	3
Willow Flycatcher	2010	0.06	0.04	67	4
Willow Flycatcher	2012	0.059	0.058	98	2
Willow Flycatcher	2013	0.001	0.001	97	1
Willow Flycatcher	2014	0.063	0.058	93	2
Willow Flycatcher	2015	0.024	0.021	88	3
Willow Flycatcher	2016	0.029	0.019	65	4

Index of Scientific Names:

American Kestrel	*Falco sparverius*
American Pipit	*Anthus rubescens*
Ash-throated Flycatcher	*Myiarchus cinerascens*
Bewick's Wren	*Thryomanes bewickii*
Black Rosy-Finch	*Leucosticte atrata*
Black-backed Woodpecker	*Picoides arcticus*
Black-throated Gray Warbler	*Setophaga virens*
Blue Grosbeak	*Passerina caerulea*
Blue-gray Gnatcatcher	*Polioptila caerulea*
Brewer's Sparrow	*Spizella breweri*
Burrowing Owl	*Athene cunicularia*
Bushtit	*Psaltriparus minimus*
Calliope Hummingbird	*Selasphorus calliope*
Canyon Wren	*Catherpes mexicanus*
Chestnut-collared Longspur	*Calcarius ornatus*
Clark's Nutcracker	*Nucifraga columbiana*
Common Nighthawk	*Chordeiles minor*
Common Yellowthroat	*Geothlypis trichas*
Dickcissel	*Spiza americana*
Grasshopper Sparrow	*Ammodramus savannarum*
Great Blue Heron	*Ardea herodias*
Greater Sage-Grouse	*Centrocercus urophasianus*
Juniper Titmouse	*Baeolophus ridgwayi*
Lark Bunting	*Calamospiza melanocorys*
Lewis's Woodpecker	*Melanerpes lewis*
Loggerhead Shrike	*Lanius ludovicianus*
Long-billed Curlew	*Numenius americanus*

MacGillivray's Warbler	*Geothlypis tolmiei*
McCown's Longspur	*Rhynchophanes mccownii*
Mountain Plover	*Charadrius montanus*
Northern Goshawk	*Accipiter gentilis*
Northern Pygmy-Owl	*Glaucidium gnoma*
Purple Martin	*Progne subis*
Pygmy Nuthatch	*Sitta pygmaea*
Red Crossbill	*Loxia curvirostra*
Red-eyed Vireo	*Vireo olivaceus*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Rufous Hummingbird	*Selasphorus rufus*
Sagebrush Sparrow	*Artemesiospiza nevadensis*
Sage Thrasher	*Oreoscoptes montanus*
Sharp-tailed Grouse	*Tympanuchus phasianellus*
Short-eared Owl	*Asio flammeus*
Swainson's Hawk	*Buteo swainsoni*
Upland Sandpiper	*Bartramia longicauda*
Woodhouse's Scrub-Jay	*Aphelocoma woodhouseii*
Williamson's Sapsucker	*Sphyrapicus thyroideus*
Willow Flycatcher	*Empidonax traillii*

Table 3. Estimated density (*D*; individuals per km^2), population size (*N*), percent coefficient of variation (% CV), and number of independent detections (*n*) of 43 avian Species of Greatest Conservation Need on Integrated Monitoring in Bird Conservation Regions survey grids throughout Wyoming from 2009-2016. Density estimates are considered robust if % CV <50%, and are denoted in bold. Scientific names are presented below the table.

Species common name	Year	*D*	*N*	% CV	*n*
American Kestrel	**2009**	**0.4**	**74454**	**30**	**29**
American Kestrel	**2010**	**0.49**	**122183**	**27**	**15**
American Kestrel	**2011**	**0.14**	**36494**	**46**	**11**
American Kestrel	**2012**	**0.06**	**15643**	**26**	**22**
American Kestrel	2013	0.13	32799	79	6
American Kestrel	2014	0.14	35683	55	16
American Kestrel	**2015**	**0.14**	**35447**	**36**	**40**
American Kestrel	**2016**	**0.13**	**32951**	**37**	**19**
American Pipit	2009	0.18	33292	61	41
American Pipit	2010	0.38	95953	63	51
American Pipit	2011	0.53	132753	60	40
American Pipit	2012	2.73	686292	76	29
American Pipit	2013	1.16	293037	74	48
American Pipit	2014	1.09	275038	71	48
American Pipit	2015	1.81	458381	57	102

Table 3. Continued.

Species common name	Year	*D*	*N*	% CV	*n*
American Pipit	2016	0.95	239567	58	31
American White Pelican	2014	0.01	1643	101	3
Ash-throated Flycatcher	2015	0.04	10838	97	2
Bewick's Wren	2010	0.77	192544	85	1
Bewick's Wren	2014	0.1	25016	69	2
Bewick's Wren	2015	1.15	291612	104	22
Bewick's Wren	2016	0.45	113787	67	9
Black-throated Gray Warbler	2010	0.01	1797	100	1
Black-throated Gray Warbler	2013	0	1102	101	1
Black-throated Gray Warbler	2015	0.13	32158	104	1
Blue Grosbeak	2009	0	216	100	1
Blue Grosbeak	2010	0	296	82	1
Blue Grosbeak	2014	0.01	3440	97	1
Blue Grosbeak	2015	0.01	2133	101	1
Blue Grosbeak	2016	0.02	5925	100	2
Blue-gray Gnatcatcher	2009	1.43	269874	76	6
Blue-gray Gnatcatcher	2010	1.27	318756	53	12
Blue-gray Gnatcatcher	2011	0.43	108050	57	5
Blue-gray Gnatcatcher	2012	0.97	243383	62	13
Blue-gray Gnatcatcher	2013	0.63	158532	60	4
Blue-gray Gnatcatcher	2014	0.7	178240	71	10
Blue-gray Gnatcatcher	2015	0.44	110559	56	6
Blue-gray Gnatcatcher	2016	1.11	280556	63	15
Brewer's Sparrow	**2009**	**44.26**	**8328561**	**24**	**828**
Brewer's Sparrow	**2010**	**29.75**	**7481986**	**13**	**804**
Brewer's Sparrow	**2011**	**30.69**	**7707408**	**15**	**824**
Brewer's Sparrow	**2012**	**22.57**	**5670208**	**15**	**873**
Brewer's Sparrow	**2013**	**24.2**	**6134460**	**16**	**1235**
Brewer's Sparrow	**2014**	**31.76**	**8048826**	**19**	**907**
Brewer's Sparrow	**2015**	**44.27**	**11220044**	**12**	**1875**
Brewer's Sparrow	**2016**	**40.32**	**10219451**	**11**	**1563**
Burrowing Owl	2014	0	240	99	1
Burrowing Owl	2015	0	64	89	2
Bushtit	2016	0.21	52852	101	1
Canyon Wren	2009	0	408	70	2
Canyon Wren	2010	0.07	17526	99	7
Canyon Wren	2012	0	35	100	1
Canyon Wren	2013	0	79	100	1

Table 3. Continued.

Species common name	Year	*D*	*N*	% CV	*n*
Canyon Wren	2015	0	1125	98	1
Canyon Wren	2016	0.04	9241	93	10
Chestnut-collared Longspur	**2010**	**0.44**	**109983**	**54**	**6**
Chestnut-collared Longspur	2012	1.2	302303	106	9
Chestnut-collared Longspur	2013	0.14	35401	102	4
Chestnut-collared Longspur	2014	0	380	137	8
Chestnut-collared Longspur	2015	1.1	278706	97	29
Clark's Nutcracker	**2009**	**1.25**	**234659**	**44**	**88**
Clark's Nutcracker	**2010**	**2.18**	**549376**	**38**	**96**
Clark's Nutcracker	**2011**	**1.66**	**417934**	**33**	**170**
Clark's Nutcracker	**2012**	**1.38**	**346559**	**27**	**226**
Clark's Nutcracker	**2013**	**1.6**	**404832**	**34**	**187**
Clark's Nutcracker	**2014**	**1.07**	**271885**	**24**	**358**
Clark's Nutcracker	**2015**	**0.76**	**192744**	**25**	**261**
Clark's Nutcracker	**2016**	**0.97**	**244981**	**34**	**222**
Common Nighthawk	2009	0.14	26178	60	11
Common Nighthawk	2010	0.36	90051	56	13
Common Nighthawk	**2011**	**0.98**	**246880**	**38**	**45**
Common Nighthawk	**2012**	**0.52**	**130127**	**31**	**51**
Common Nighthawk	**2013**	**0.59**	**149366**	**33**	**68**
Common Nighthawk	**2014**	**0.12**	**29903**	**39**	**35**
Common Nighthawk	**2015**	**0.47**	**120131**	**28**	**87**
Common Nighthawk	**2016**	**0.23**	**59010**	**37**	**52**
Common Yellowthroat	2009	0.44	82067	58	57
Common Yellowthroat	2010	0.74	186002	53	17
Common Yellowthroat	**2011**	**0.06**	**15226**	**23**	**22**
Common Yellowthroat	2012	0.36	91027	71	16
Common Yellowthroat	2013	0.06	15387	78	7
Common Yellowthroat	2014	0.09	23075	72	6
Common Yellowthroat	**2015**	**0.13**	**33977**	**43**	**10**
Common Yellowthroat	2016	0.15	37189	59	9
Dickcissel	2014	0.01	3420	107	1
Golden Eagle	2014	0	465	101	1
Golden Eagle	2015	0.01	2793	73	6
Golden Eagle	2016	0.01	3159	113	1
Grasshopper Sparrow	**2009**	**2**	**376107**	**37**	**45**
Grasshopper Sparrow	**2010**	**3.35**	**843508**	**31**	**98**
Grasshopper Sparrow	**2011**	**3.96**	**994665**	**24**	**185**

Table 3. Continued.

Species common name	Year	*D*	*N*	% CV	*n*
Grasshopper Sparrow	**2012**	**2.82**	**708620**	**32**	**103**
Grasshopper Sparrow	2013	1.01	256991	51	52
Grasshopper Sparrow	**2014**	**1.65**	**418926**	**42**	**66**
Grasshopper Sparrow	**2015**	**5.32**	**1348656**	**26**	**178**
Grasshopper Sparrow	**2016**	**2.58**	**654819**	**26**	**110**
Great Blue Heron	2012	0.04	8854	86	3
Great Blue Heron	2013	0	206	104	1
Great Blue Heron	2014	0	123	103	1
Great Blue Heron	2015	0	894	78	4
Great Blue Heron	2016	0.01	3422	78	2
Greater Sage-Grouse	2016	0.08	19414	73	7
Juniper Titmouse	2016	0.24	61905	101	2
Lewis's Woodpecker	2014	0	473	101	1
Loggerhead Shrike	**2009**	**0.24**	**44929**	**38**	**12**
Loggerhead Shrike	**2010**	**0.1**	**23917**	**47**	**8**
Loggerhead Shrike	**2011**	**0.24**	**59225**	**39**	**14**
Loggerhead Shrike	2012	0.11	28062	54	8
Loggerhead Shrike	2013	0.16	39347	50	8
Loggerhead Shrike	2014	0.13	31918	55	7
Loggerhead Shrike	**2015**	**0.4**	**102032**	**30**	**42**
Loggerhead Shrike	**2016**	**0.6**	**151109**	**38**	**32**
Long-billed Curlew	2011	0.16	41209	86	3
Long-billed Curlew	2012	0.14	34494	108	3
Long-billed Curlew	2015	0.24	61444	81	7
Long-billed Curlew	2016	0.1	26033	98	6
MacGillivray's Warbler	2009	3.44	646770	59	48
MacGillivray's Warbler	2010	1.36	341027	81	29
MacGillivray's Warbler	2011	0.72	179700	55	21
MacGillivray's Warbler	2012	0.47	118881	77	28
MacGillivray's Warbler	**2013**	**0.96**	**243351**	**40**	**62**
MacGillivray's Warbler	**2014**	**0.5**	**125930**	**29**	**67**
MacGillivray's Warbler	**2015**	**2.01**	**509810**	**38**	**106**
MacGillivray's Warbler	**2016**	**0.58**	**147723**	**25**	**70**
McCown's Longspur	2009	2.69	505993	60	26
McCown's Longspur	2010	1.7	427797	50	34
McCown's Longspur	2011	1.65	414502	68	50
McCown's Longspur	2012	2.41	604745	60	117
McCown's Longspur	2013	2.2	558239	65	105

Table 3. Continued.

Species common name	Year	*D*	*N*	% CV	*n*
McCown's Longspur	2014	0.4	100987	101	16
McCown's Longspur	2015	4.06	1028926	54	112
McCown's Longspur	2016	1.24	314551	70	68
Mountain Plover	2013	0	863	80	3
Mountain Plover	2014	0.14	34447	89	17
Mountain Plover	2015	0	381	102	3
Mountain Plover	2016	0.18	45424	72	29
Purple Martin	2014	0	787	103	1
Pygmy Nuthatch	2009	0.06	11493	61	4
Pygmy Nuthatch	2010	0.03	6868	81	2
Pygmy Nuthatch	2011	0.08	19321	77	2
Pygmy Nuthatch	2012	0.08	18969	81	8
Pygmy Nuthatch	2013	0.01	1980	72	2
Pygmy Nuthatch	2014	0.04	9243	61	5
Pygmy Nuthatch	2015	0.06	14766	72	5
Red Crossbill	2009	0.82	153889	50	55
Red Crossbill	**2010**	**0.71**	**178661**	**42**	**44**
Red Crossbill	**2011**	**1.31**	**329432**	**25**	**51**
Red Crossbill	**2012**	**5.85**	**1469709**	**49**	**83**
Red Crossbill	**2013**	**1.59**	**403246**	**30**	**121**
Red Crossbill	**2014**	**1.42**	**359045**	**24**	**114**
Red Crossbill	**2015**	**0.59**	**149998**	**22**	**116**
Red Crossbill	**2016**	**1.65**	**417140**	**29**	**116**
Red-eyed Vireo	2012	0.05	12694	103	4
Red-eyed Vireo	2013	0.02	4466	57	10
Red-eyed Vireo	2014	0.01	3477	96	4
Red-eyed Vireo	2015	0.09	21815	99	12
Red-headed Woodpecker	2013	0.01	2746	91	2
Red-headed Woodpecker	2014	0.01	3358	101	6
Red-headed Woodpecker	2015	0.04	9708	44	12
Red-headed Woodpecker	2016	0	14	65	1
Rufous Hummingbird	2014	0.23	58264	118	1
Rufous Hummingbird	2015	0.38	97314	136	1
Sagebrush Sparrow	**2009**	**5.57**	**1047864**	**18**	**281**
Sagebrush Sparrow	**2010**	**5.01**	**1260838**	**23**	**252**
Sagebrush Sparrow	**2011**	**5.79**	**1453124**	**21**	**271**
Sagebrush Sparrow	**2012**	**4.25**	**1067892**	**30**	**254**
Sagebrush Sparrow	**2013**	**2.49**	**631410**	**27**	**320**

Table 3. Continued.

Species common name	Year	*D*	*N*	% CV	*n*
Sagebrush Sparrow	**2014**	**3.02**	**764327**	**25**	**234**
Sagebrush Sparrow	**2015**	**6.08**	**1541390**	**32**	**507**
Sagebrush Sparrow	**2016**	**8.52**	**2159500**	**18**	**665**
Sage Thrasher	**2009**	**2.78**	**522260**	**16**	**231**
Sage Thrasher	**2010**	**2.63**	**661911**	**18**	**284**
Sage Thrasher	**2011**	**2.31**	**581212**	**13**	**405**
Sage Thrasher	**2012**	**2.37**	**594478**	**17**	**252**
Sage Thrasher	**2013**	**1.22**	**310125**	**23**	**411**
Sage Thrasher	**2014**	**1.76**	**444993**	**14**	**278**
Sage Thrasher	**2015**	**3.07**	**778800**	**18**	**485**
Sage Thrasher	**2016**	**2.93**	**741614**	**14**	**715**
Sharp-tailed Grouse	2013	0	485	101	2
Sharp-tailed Grouse	2015	0.01	2385	98	1
Sharp-tailed Grouse	2016	0.06	16313	102	6
Swainson's Hawk	2009	0.09	16237	57	9
Swainson's Hawk	2010	0.01	3587	77	4
Swainson's Hawk	2011	0.02	4496	71	3
Swainson's Hawk	2012	0	794	80	3
Swainson's Hawk	2013	0.03	8687	70	3
Swainson's Hawk	2014	0.05	12241	91	4
Swainson's Hawk	2015	0.07	17890	77	6
Swainson's Hawk	2016	0.07	17841	57	13
Upland Sandpiper	2010	0.15	38587	71	12
Upland Sandpiper	2011	0.12	30357	54	22
Upland Sandpiper	2012	0.02	4554	70	3
Upland Sandpiper	2013	0.06	14010	87	8
Upland Sandpiper	2014	0.15	37022	68	19
Upland Sandpiper	**2015**	**0.16**	**40730**	**42**	**36**
Upland Sandpiper	**2016**	**0.14**	**36718**	**39**	**23**
Virginia's Warbler	2014	0.01	1267	103	1
Virginia's Warbler	2015	0.01	2184	88	1
Woodhouse's Scrub-Jay	2015	0.02	4988	101	1
Williamson's Sapsucker	2012	0.09	23458	73	7
Williamson's Sapsucker	2013	0.01	3461	61	4
Williamson's Sapsucker	2014	0.05	12272	51	11
Williamson's Sapsucker	2015	0.03	7745	81	4
Williamson's Sapsucker	2016	0.28	70741	70	7

Table 3. Continued.

Species common name	Year	*D*	*N*	% CV	*n*
Willow Flycatcher	2013	0.01	2429	107	1
Willow Flycatcher	2014	0.21	52528	95	3
Willow Flycatcher	2015	0.44	111217	96	6
Willow Flycatcher	2016	0.28	71228	78	7

Index of Scientific Names:

American Kestrel	*Falco sparverius*
American Pipit	*Anthus rubescens*
American Pelican	*Pelecanus erythrorhynchos*
Ash-throated Flycatcher	*Myiarchus cinerascens*
Bewick's Wren	*Thryomanes bewickii*
Black-throated Gray Warbler	*Setophaga virens*
Blue Grosbeak	*Passerina caerulea*
Blue-gray Gnatcatcher	*Polioptila caerulea*
Brewer's Sparrow	*Spizella breweri*
Burrowing Owl	*Athene cunicularia*
Bushtit	*Psaltriparus minimus*
Canyon Wren	*Catherpes mexicanus*
Chestnut-collared Longspur	*Calcarius ornatus*
Clark's Nutcracker	*Nucifraga columbiana*
Common Nighthawk	*Chordeiles minor*
Common Yellowthroat	*Geothlypis trichas*
Dickcissel	*Spiza americana*
Golden Eagle	*Aquila chrysaetos*
Grasshopper Sparrow	*Ammodramus savannarum*
Great Blue Heron	*Ardea herodias*
Greater Sage-Grouse	*Centrocercus urophasianus*
Juniper Titmouse	*Baeolophus ridgwayi*
Lewis's Woodpecker	*Melanerpes lewis*
Loggerhead Shrike	*Lanius ludovicianus*
Long-billed Curlew	*Numenius americanus*
MacGillivray's Warbler	*Geothlypis tolmiei*
McCown's Longspur	*Rhynchophanes mccownii*
Mountain Plover	*Charadrius montanus*
Purple Martin	*Progne subis*
Pygmy Nuthatch	*Sitta pygmaea*
Red Crossbill	*Loxia curvirostra*
Red-eyed Vireo	*Vireo olivaceus*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Rufous Hummingbird	*Selasphorus rufus*
Sagebrush Sparrow	*Artemesiospiza nevadensis*
Sage Thrasher	*Oreoscoptes montanus*

Swainson's Hawk	*Buteo swainsoni*
Upland Sandpiper	*Bartramia longicauda*
Virginia's Warbler	*Oreothlypis virginiae*
Woodhouse's Scrub-Jay	*Aphelocoma woodhouseii*
Williamson's Sapsucker	*Sphyrapicus thyroideus*
Willow Flycatcher	*Empidonax traillii*

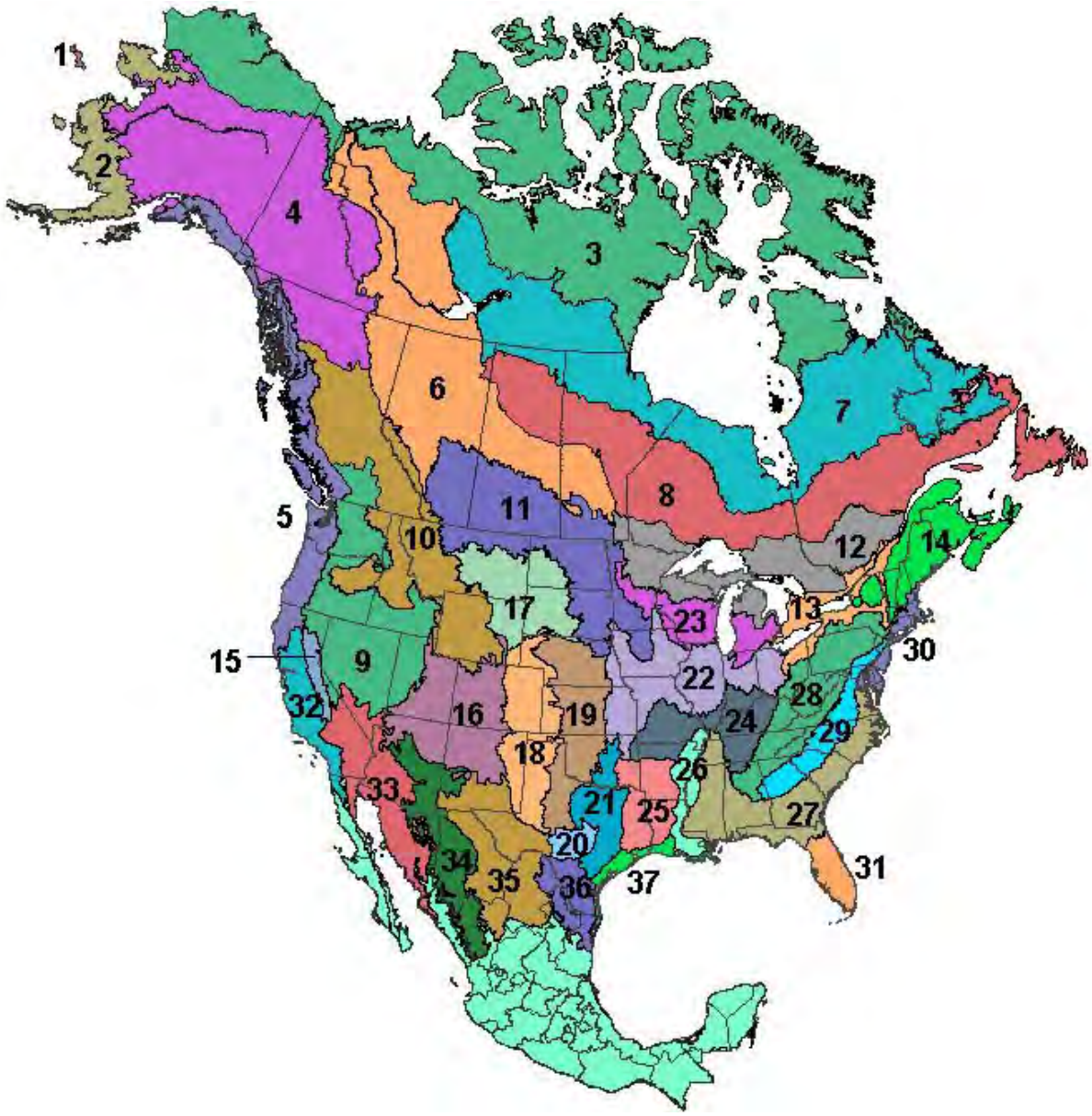

Figure 1. The North American Bird Conservation Region (BCR) map, excluding Hawaii and Mexico (Bird Studies Canada and NABCI 2014). Portions of BCRs that occur in Wyoming are: 9 – Great Basin, 10 – Northern Rockies, 16 – Southern Rockies/Colorado Plateau, 17 – Badlands and Prairies, and 18 – Shortgrass Prairie. Surveys were conducted in all BCRs in Wyoming in 2016.

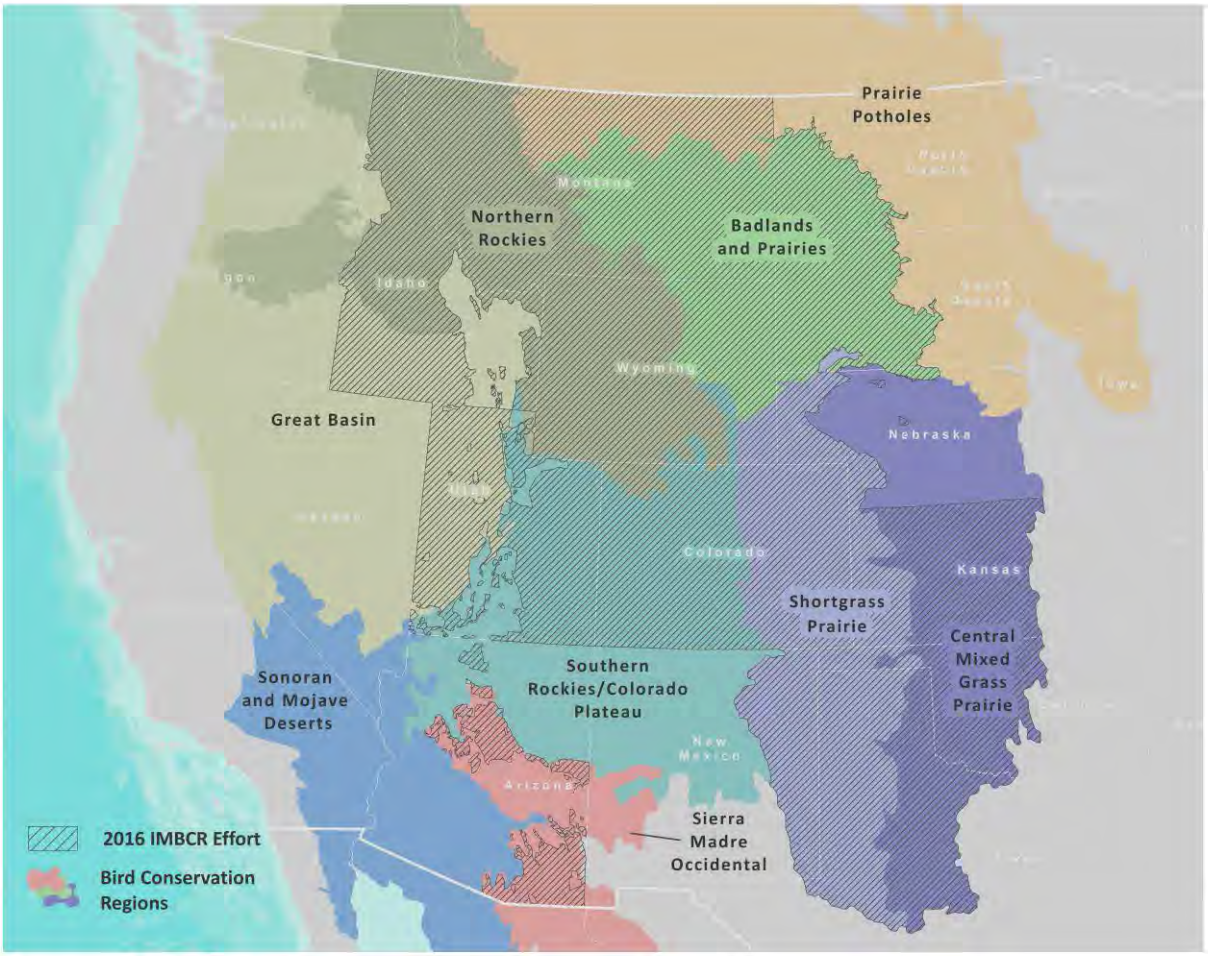

Figure 2. Spatial extent (hashed areas) of the IMBCR program in 2016 (White et al. 2017).

Figure 3. Example of the 1 km^2 sampling unit using the IMBCR design (White et al. 2017).

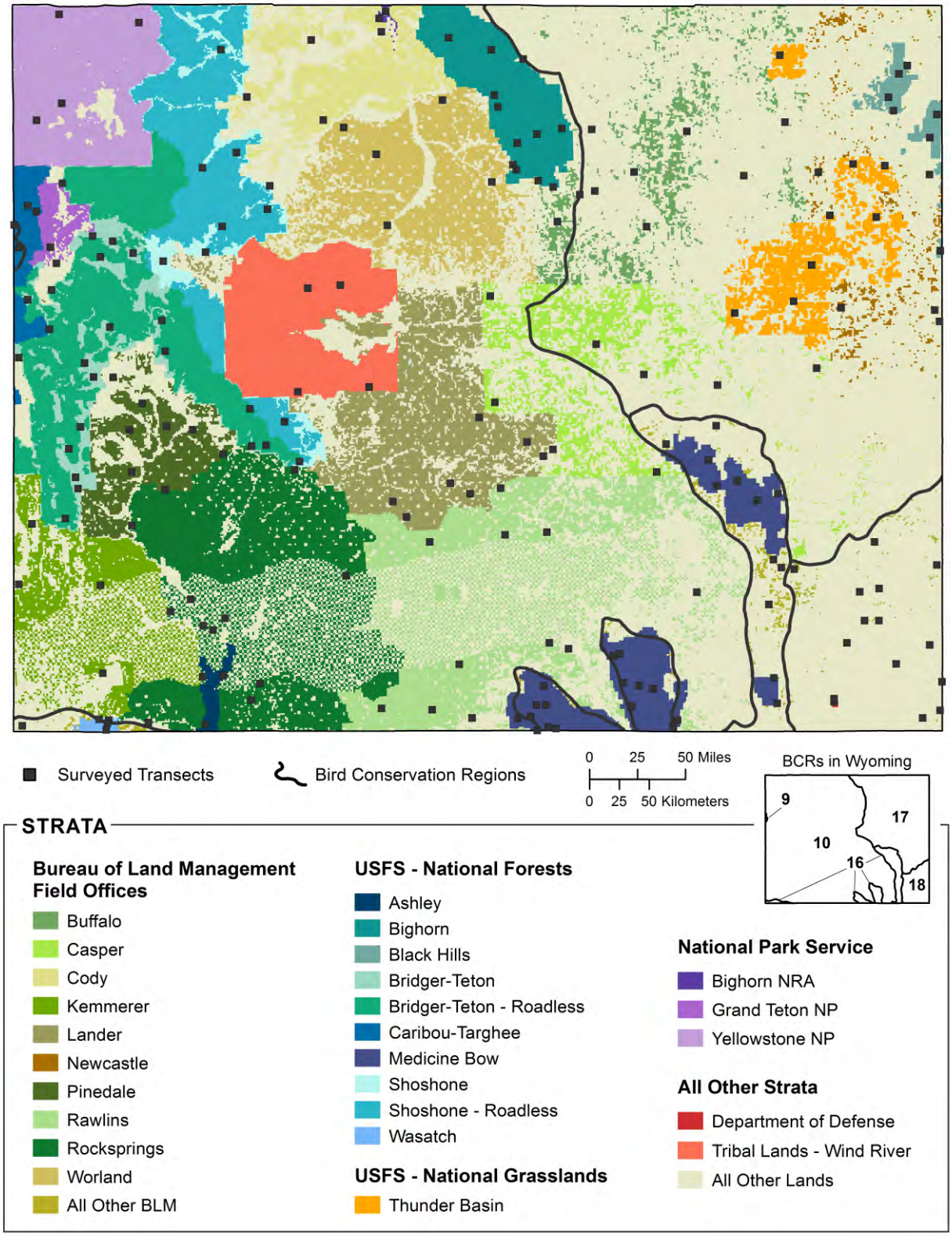

Figure 4. Integrated Monitoring in Bird Conservation Regions strata and survey grid locations in Wyoming, 2016 (White et al. 2017).

SPECIES OF GREATEST CONSERVATION NEED – MAMMALS

SURVEILLANCE OF HIBERNATING BATS AND *PSEUDOGYMNOASCUS DESTRUCTANS* SCREENING AT CAVES AND ABANDONED MINES IN WYOMING

STATE OF WYOMING

NONGAME MAMMALS: Species of Greatest Conservation Need – Bats

FUNDING SOURCE: United States Fish and Wildlife Service State Wildlife Grant
Wyoming State Legislature General Fund Appropriations

PROJECT DURATION: Annual

PERIOD COVERED: 11 March 2016 – 15 March 2016

PREPARED BY: Laura Beard, Nongame Biologist

ABSTRACT

Wyoming bat species that hibernate in caves and abandoned mines are at risk of contracting white-nose syndrome as the causative fungus, *Pseudogymnoascus destructans*, continues to spread throughout the continent. Three species of bats found in Wyoming are known to be particularly vulnerable to white-nose syndrome in their eastern range: little brown myotis (*Myotis lucifugus*), northern long-eared myotis (*M. septentrionalis*), and American perimyotis (*Perimyotis subflavus*). Populations of bats in caves and abandoned mines in Wyoming are orders of magnitude smaller than those in eastern North America, making it difficult to determine if white-nose syndrome will affect populations at the same scale, should the fungus be introduced into the state. A major objective of the Zone of Integration Project (ZOIP) is to census hibernating bats and monitor for the potential arrival of the fungus in Wyoming. During the winter of 2016-2017, we successfully surveyed 11 sites for hibernating bats, and documented 5 previously unknown hibernacula. One previously un-surveyed site was occupied by Townsend's big-eared bats (*Corynorhinus townsendii*). The other 4 previously un-surveyed sites had western small-footed bats (*M. ciliolabrum*) present, and 1 of these contained American perimyotis. This is only the 2nd recorded American perimyotis hibernaculum in the state. We also worked to identify 2 hibernacula to be gated in 2017, fulfilling another objective of the ZOIP. Beginning in 2014, we have participated in a national effort to identify *P. destructans* infected sites. Twelve sites in 7 counties have been surveyed. Thus far, no sites in Wyoming have tested positive for the fungus.

INTRODUCTION

Bats that hibernate in caves and abandoned mines in North America are at risk of contracting white-nose syndrome (WNS), a disease that is causing major declines in bat populations in the eastern US and Canada. WNS is caused by the fungus *Pseudogymnoascus destructans,* which infects the skin of hibernating bats, resulting in a conspicuous white fungal growth on hairless membranes, such as the face and wings. Mortality due to WNS results from a cascade of physiological disturbances, beginning with increased energy use and changes in blood chemistry that lead to increased water, electrolyte, and fat reserve loss, ultimately resulting in death (Verant et al. 2014). The detection of *P. destructans* in a hibernaculum can precede mortality due to WNS by 1 or 2 hibernation seasons, because the time between infection and the end of hibernation increases as the fungus spreads throughout the hibernaculum. A bat that encounters the fungus close to the end of hibernation may have sufficient reserves to survive until prey is available in the spring. The infection is cleared by the bat's immune system soon after the end of hibernation. As of 16 March 2017, WNS has been confirmed in 30 states and 5 Canadian provinces, and *P. destructans* has been found in 2 additional states (USFWS 2017). In the winter of 2015, *P. destructans* was found in a cave in eastern Nebraska, and WNS was confirmed in a mine in eastern Nebraska in February of 2017 (Kane 2017). This is currently the nearest detection of the fungus to Wyoming (USFWS 2017).

Four species found in Wyoming are known to be vulnerable to WNS in the East: little brown myotis (*Myotis lucifugus*); American perimyotis (*Perimyotis subflavus*), formerly the eastern pipistrelle or tri-colored bat (*Pipistrellus subflavus)*; northern long-eared myotis (*M. septentrionalis*); and big brown bat (*Eptesicus fuscus*; Coleman and Reichard 2014). The Virginia big-eared bat (*Corynorhinus townsendii virginianus)*, a subspecies of Townsend's big eared bat (*C. townsendii)*, is known to carry the fungus while exhibiting no ill effects (Coleman and Reichard 2014). In Wyoming, Townsend's big-eared bats have been observed sharing hibernacula with little brown and western small-footed myotis (*M. ciliolabrum*), making them a possible vector of infection for vulnerable species. Northern long-eared myotis and American perimyotis are rare in Wyoming; however, the little brown myotis and big brown bat are widespread. The little brown myotis is one of the most commonly captured and reported bat species in the state (Filipi et al. 2009; Johnson and Grenier 2010a, b; Cudworth et al. 2011; Abel and Grenier 2012b, c; Yandow and Grenier 2013, 2014; Yandow and Beard 2015). It is unknown how WNS will affect the rest of Wyoming's bat species, as they have yet to be exposed to the fungus. Some western species of myotis are considered analogous to an eastern species, such as the long-eared myotis (*M. evotis)* to the northern long-eared myotis, with an important difference being that the western bats consistently roost in much smaller numbers than their eastern counterparts (Knudsen et al. 2013). This pattern holds true for the eastern and western populations of little brown myotis, as well. For example, there are 88 known little brown myotis roosts in Wyoming; however, survey data suggest the majority of these roosts support <50 individuals each. As the number of bats present at a roost site can affect the speed at which *P. destructans* is able to spread between individuals, this difference in roosting density may impact the reservoir competence of western roosts (Langwig et al. 2012). One management action that may mitigate the effects of WNS on Wyoming's bats is the construction of bat friendly gates to eliminate human disturbance in sensitive roosting areas and reduce the chance of accidental

introduction of the fungus by humans. An objective during the 2016-2017 hibernation season was to evaluate sites for gating, based on this and previous seasons' data.

In the 2016-2017 winter season, our goals were to census hibernating bats before the arrival of WNS, to collect samples from hibernacula in Wyoming to test for the presence of *P. destructans*, and to identify 2 sites for the installation of bat friendly gates.

METHODS

During the winter of 2016-2017, we conducted hibernation surveys in cave and abandoned mine sites in the southeast corner of the state, eastern side of the Bighorn Mountains in north central Wyoming, and in the Black Hills. At sites visited during the hibernation season, we counted individual bats and attempted to identify each bat to species. We adhered to all WNS survey and decontamination protocols outlined in the National WNS Decontamination Protocol (USFWS 2016).

Since 2014, we have participated in the US Fish and Wildlife Service WNS surveillance program, using hibernation surveys to collect samples to be tested for the presence of *P. destructans*. Using the National Wildlife Health Center's substrate protocol due to the low numbers of hibernating bats at most of our sites, we swabbed hibernating bats, cave walls, and the cave floor for the presence of *P. destructans* (USGS National Wildlife Health Center 2016). All samples were sent to the National Wildlife Health Center for genetic analysis designed to detect *P. destructans*

RESULTS

In the winter of 2016-2017, 5 mine adits, 1 bunker, and 6 natural caves were surveyed for the presence of hibernating bats; all survey results are shown in Table 1. In total, 62 hibernating bats were found, including 22 Townsend's big-eared bats, 31 western small footed myotis, 5 big brown bats, 2 American perimyotis, and 2 myotis that were unidentifiable to species.

Five mine adits were surveyed. In 4 of these adits (Sites 618, 619, 620, and 621), we found hibernating western small footed myotis (Table 1). Within site 621, we also observed 2 hibernating American perimyotis. This observation represents the seco2nd confirmed American perimyotis hibernaculum in the state. Site 617 had no bats present at the time of survey. None of the adits surveyed had previously been evaluated for use by bats.

One artificial roost (bunker) was surveyed. Site 600 is an abandoned concrete bunker that was surveyed for the first time during the winter of 2015-2016 (Beard 2015). We surveyed the site again in order to test for *P. destructans*, as we found a sizeable population of myotis here on the initial survey. The site had western small-footed bats, a myotis that was unidentifiable to species, and a Townsend's big-eared bat present (Table 1).

Of the 6 natural caves surveyed, bats were observed in 4 (Sites 133, 131, 615, and 94). Sites 133, 131, and 94 were previously known hibernacula, while site 615 had never been surveyed in the winter. All 4 sites had Townsend's big-eared bats; Site 131 and 133 had western small footed myotis; and Site 133 had big brown bats (Table 1). Site 448 had no bats during the winter; however, it did have a single American perimyotis present when visited a few months earlier in the fall.

We sampled for *P. destructans* at Sites 133, 131, 600, and 621 (samples from sites 600 and 621 were combined); all results were negative. An additional site, a mine adit in Fremont County, was surveyed and swabbed by Bat Conservation International during the hibernation season; it tested negative for the fungus (S. Thomas and A. Ballman, personal communication). Eleven sites have been tested in Wyoming in the 4 years since the effort began; all have been negative for the fungus (Figure 1).

DISCUSSION

Hibernation counts in previously known hibernacula are similar to previous surveys in both species and numbers of bats recorded. Many natural sites have areas that are inaccessible to surveyors, making it possible for bats to be present, but hidden in the hibernacula. Bats are known to arouse periodically during hibernation, and movement within the roost could result in different population counts at different times during a single winter. Bat activity in temperate zones throughout the winter has been previously documented, and recent work in Yellowstone National Park has recorded bat activity throughout the winter, raising the possibility that bats are moving between hibernacula during the winter in the rest of Wyoming as well (Boyles et al. 2006, Johnston et al. 2017). Given the large, irregular gaps between hibernation survey years, as well as variation in survey timing, there are insufficient data to evaluate trends in bat populations at these sites. Consistent, long-term monitoring of important hibernacula and a greater understanding of the timing of arousals within and movement between hibernacula would be useful in monitoring Wyoming's hibernating bat population.

Two caves and 2 mine structures were tested for *P. destructans*. Both caves are located in Sheridan County. The majority of samples taken from both caves were from the substrate rather than from bats, as there were few bats in Site 131 and few accessible bats in site 133. In Site 133, soil samples were taken from directly underneath bats, when possible, to maximize chances of *P. destructans* detection (USGS 2016). The mine structures are approximately 400 m apart: Site 600 is a bunker and Site 621 is an adit inside an old wooden garage. Only 2 samples were taken from within Site 621, which is insufficient to exclude a false negative; these samples were combined with the 28 samples from Site 600. This deviation from protocol was warranted due to suspected bat movement between sites and because Site 621 is only the 2nd recorded hibernation site of the American perimyotis in the state. This bat is known to be especially venerable to WNS, and Wyoming is at the far western edge of the range of this species; therefore, while this adit had only 3 bats present (2 *P. subflavus* and 1 *M. ciliolabrum*; Table 1), including samples from Site 621, along with the more populated Site 600, seemed appropriate in this case. Environmental samples were taken at each site, in addition to the swabs taken from bats. Environmental samples are not as effective in early detection of *P. destructans* as samples

from bats and false negatives are possible with either sample type; therefore, we cannot conclusively state that *P. destructans* exists nowhere in Wyoming. However, the negative results in the southeastern corner of the state are encouraging, as these caves represent the closest sites to the current leading edge of WNS in Nebraska (USFWS 2017). Negative *P. destructans* test results, in addition to the lack of any signs of WNS or abnormal mortality of hibernating bats reported in the state, supports the national surveillance team's assertion that Wyoming is still free of WNS (USFWS 2017).

Systematic monitoring of bat populations in the state is important for the effective implementation of management responses to all conservation threats to bats, including WNS. Detection of *P. destructans* within the state should trigger the prearranged set of responses designed to mitigate the effects of WNS on hibernating bats (Abel and Grenier, 2012a). Both the monitoring of bat populations and the early detection of *P. destructans* are confounded by the fact that Wyoming's bats do not conform to expected patterns of behavior established by studying eastern populations. Current tests for *P. destructans* increase in effectiveness when 25 bats are tested, but very few of Wyoming's hibernacula host that many individuals. Large congregations of myotis have not been found in the state, which complicates any effort to monitor the population by making hibernacula counts alone insufficient as a monitoring method for the population as a whole. Our ability to predict the threat posed by WNS and to respond to any threat to bats is limited by our understanding of their year-round habitat use. Future work should concentrate on locating and quantifying critical roosting habitat of myotis species in Wyoming in order to monitor and mitigate the effect of WNS and other threats to the bat population.

As part of this project, 2 hibernacula will be protected from human disturbance by the installation of bat friendly gates, both of which will be completed during the summer and fall of 2017. Site 600 is an artificial structure; however, the relatively high numbers of myotis that have been found hibernating there and the increasing human visitation to the historic site where the roost is located make it a priority for protection. Site 494 is a natural cave that has had moderate bat use during the winter. Its proximity to many artificial roosts, which can be subject to subsidence or closure due to safety concerns, suggests that it could serve as an alternative roost for displaced bats in the future if the considerable human disturbance in evidence there can be reduced. By gating these 2 sites, we hope to reduce human disturbance to support hibernating populations of bats before the arrival of WNS, and to reduce the chance of human introduction of the causal fungus into the state.

ACKNOWLEDGEMENTS

Funding for this project was provided by USFWS State Wildlife Grants and Wyoming State Legislature General Fund Appropriations, for which we are grateful. Sampling equipment and sample analysis was provided by the National Wildlife Health Lab at the US Geological Survey. Bat Conservation International and the BLM sampled the site in Fremont County. We thank private landowners for granting access to several sites for this project. We also extend a special thanks to T. Pinter (USFS) and WGFD personnel B. Zinke and M. Voelker for their assistance in the field.

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Table 1. Site number, type of roost, known hibernacula and historically hibernating species, species observed, total number of bats observed, and swabs taken for *Pseudogymnoascus destructans* testing during the most recent hibernacula survey at sites successfully surveyed from November 2016 – February 2017 in Wyoming. COTO = Townsend's big-eared bat (*Corynorhinus townsendii*); MYCI = western small-footed myotis (*Myotis ciliolabrum*); MYLU = little brown myotis (*M. lucifugus*); MYSPP = myotis, not identifiable to species; PESU = American perimyotis (*Perimyotis subflavus*); EPFU= big brown bat (*Eptesicus fuscus)*.

Site #	Site type	Previously recorded hibernacula (species historically present)	Bat species – current survey (#)	Total bats – current survey	*P. destructans* swabs
94	Cave	Yes (COTO,EPFU, MYCI)	COTO (2)	2	
131	Cave	Yes (COTO, EPFU, MYCI, MYLU)	COTO (1), MYCI (1)	2	yes
133	Cave	Yes (COTO, EPFU, MYCI,MYLU,MYSPP)	COTO (11), EPFU (5), MYCI (6), MYSPP (1)	23	yes
448	Cave	Yes (PESU)	0	0	
600	Bunker	Yes (EPFU, MYCI)	MYCI (20), COTO (1), MYSPP (1)	22	yes
615	Cave	No	COTO (7)	7	
616	Cave	No	0	0	
617	Mine	No	0	0	
618	Mine	No	MYCI (1)	1	
619	Mine	No	MYCI (1)	1	
620	Mine	No	MYCI (2)	2	
621	Mine	No	MYCI (1), PESU (2)	2	yes, combined with site 600

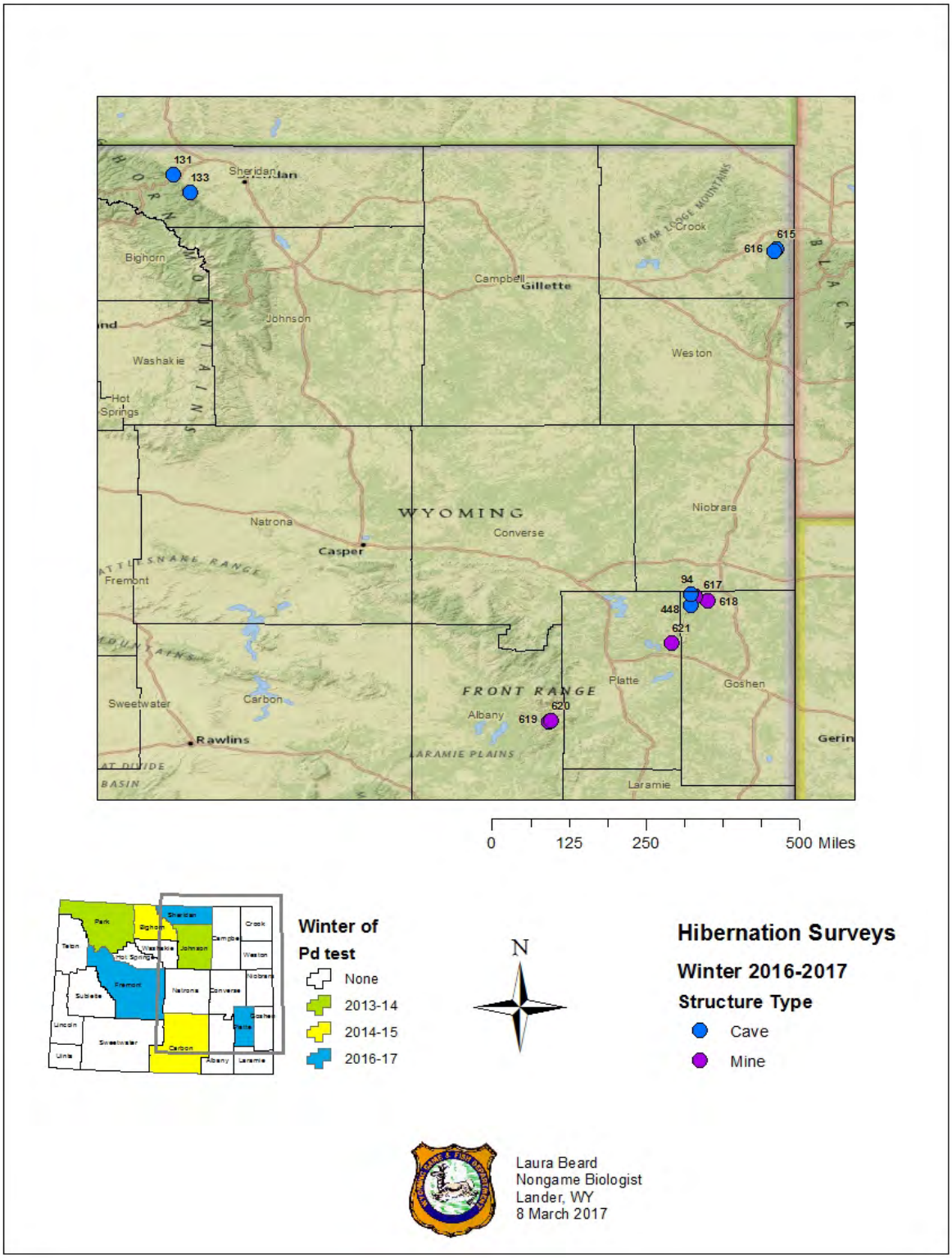

Figure 1. Cave and mines visited from November 2016 to February 2017 in Wyoming. Reference map shows counties containing sites tested for the presence of *Pseudogymnoascus destructans* (Pd), color coded by year; all tests have been negative.

CAPTURE AND ACOUSTIC BAT SURVEYS IN THE ZONE OF INTEGRATION WITH NEBRASKA

STATE OF WYOMING

NONGAME MAMMALS: Species of Greatest Conservation Need – Bats

FUNDING SOURCE: United States Fish and Wildlife Service State Wildlife Grant

PROJECT DURATION: 1 October 2014 – 30 September 2017

PERIOD COVERED: April 1 2016 – August 30 2016

PREPARED BY: Laura Beard, Nongame Biologist

ABSRACT

The eastern portion of Wyoming and the western portion of Nebraska are part of a zone of integration (ZOI) of eastern and western bat species. Previous statewide bat surveys by the Wyoming Game and Fish Department have focused on habitat types that are lacking in the ZOI, which is dominated by grasslands, sage steppe, and xeric forests. By conducting bat surveys in the ZOI, we hoped to gain information on a number of species rarely captured or recorded by focusing on their known ranges and habitats. This project was designed to extend our knowledge both of bat use of this area and of these habitat types. We used the randomized, spatially balanced selection master list developed for the North American Bat Monitoring Protocol to select our sample cells. This method was successful in selecting sites within previously underrepresented habitat types. We surveyed for one night per cell using mist nets and acoustic recording equipment at the best available site in each sample cell. We captured or recorded 11 bat species, including 6 of the 8 Species of Greatest Conservation Need known to inhabit the ZOI. At the completion of this 2-year project, we hope to have a better understanding of bat distribution in the ZOI.

INTRODUCTION

The eastern portion of Wyoming and the western portion of Nebraska are part of a zone of integration (ZOI) of eastern and western bat species that stretches north to south from Canada to Mexico, roughly following the western edge of the Great Plains. There are several species present in the state whose ranges terminate at their northern edge in Wyoming, and though the distribution of these species does not correspond perfectly to the ZIO, they are thought to prefer the open habitat most commonly found there. Populations occurring at the edge of the geographic range of the species can be important to species persistence due to their localized

resilience and genetic variability (Fraser 1999). Population resilience and genetic variability are believed to be important to the survival of bat species encountering *Pseudogymnoascus destructans* (Pd), the fungal pathogen that causes white nose syndrome (WNS; Maslo and Fefferman 2015). The portion of the ZOI found in Nebraska and Wyoming is a potential second route for the transmission of WNS to western bat species, as the fungus has progressed to the eastern edge of Nebraska. The first known introduction of *P. destructans* to western species occurred in March of 2016, when a mortality due to WNS was confirmed in a little brown myotis in Washington State (Sleeman 2016). Currently, no new species have been found with either *P. destructans* or clinical symptoms of WNS due to this jump by the pathogen.

Previous statewide bat surveys by the Wyoming Game and Fish Department (Department) have focused on forested or rocky habitat, which excludes large portions of potential habitat in eastern Wyoming. Several species of bat found in Wyoming have a strong association with previously under-surveyed habitat (e.g., grasslands and shrub steppe), or are narrowly distributed in the state. Some of these species are thought to be uncommon in the state, as well. All of these factors have contributed to a dearth of information about these species in Wyoming. The capture and acoustic surveys carried out as part of the ZOI Project are intended to supplement earlier surveys geographically and provide information on species that were underrepresented in previous surveys.

METHODS

We chose 100 km^2 sampling cells using the spatially balanced master sample grid found in the sampling design of the North American Bat Monitoring Program 3.3 (NABat; Loeb et al. 2015). Within each cell, we choose the single best available capture site based on 1) physical and legal accessibility by survey personnel, 2) habitat conducive to high bat activity, and 3) suitability for mist net and/or detector deployment. If a cell was inaccessible due to inability to contact the landowner, or if the landowner declined to grant permission to survey, the cell was replaced by the next cell on the master sample list for the ZOI. Likewise, cells with no trappable surface water or flyways were not sampled.

We captured bats using mist nets (Avinet, Inc., Dryden, NY) at 29 sites (Hester and Grenier 2005). At each of these sites, we deployed a Petterson's D500X acoustic detector to supplement the capture survey. On several capture nights, we deployed a second detector at a site within the same NA Bat sampling cell, but distinct from the trap site. The second detector was placed so that it increased our sampling area, often monitoring a different habitat feature from the one being trapped. This allowed us to increase our chances of detecting all species of bats in the area. We combined data from all acoustic surveys for each sampling grid. Grids were grouped into degrees of Latitude and Longitude (latilong degrees) for entry into the Atlas of Birds, Mammals, Amphibians, and Reptiles in Wyoming (Orabona 2016).

At each survey site, we used a GPS (GPSMap 62S, Garmin International, Inc. Olathe, KS) to record location and elevation. We characterized features such as vegetation, rock features, distance to nearest water, and the type of water features present. For capture sites, we

also recorded weather conditions, including temperature, barometric pressure, wind, relative humidity, and cloud cover, at the beginning and end of each survey.

Capture Surveys

We used mist nets to capture bats and investigate bat activity, diversity, reproductive status, and morphology. We chose mist net configurations to optimize capture potential by using a combination of single high (2.6-m) or triple high (7.8-m) nets with varying lengths (2.6, 6, 9, 12, and 18 m) at each netting site. The number, size, and placement of nets depended on local topography and habitat characteristics, such as water flow rate, water depth, vegetation, and other local features. We opened the mist nets ≤30 minutes after sunset and kept them open for 3 hours, unless our survey was truncated because of weather (Abel and Grenier 2013). When a new species was captured within the last 30 minutes of a survey, we kept nets open until 30 minutes after the time of capture (Abel and Grenier 2013).

We checked nets every 10-15 minutes and removed captured bats from the nets as quickly as possible. We put each captured bat into a cloth bag for processing. We used techniques outlined by Abel and Grenier (2013) to record species, sex, reproductive status, and age. We used the Dichotomous Key to Bats of Wyoming (Hester and Grenier 2005) to identify species. Early in the season (i.e., during June and early July), we gently palpated the lower abdominal area to check for pregnancy. We also assessed female reproductive status by looking for evidence of current or post-lactation. Females bearing young have large, hard, and hairless nipples, while females without young have hairy and inconspicuous nipples. Males were classified as reproductive if testes were descended and swollen. We classified each bat as adult or juvenile by illuminating the wing and examining the epiphyseal plates for ossification. We also measured forearm length and ear length and determined wing damage score according to Reichard and Kunz (2009). We followed the National White-Nose Syndrome Decontamination Protocol – Version 04.12.2016 (USFWS 2016) and decontaminated equipment at the end of each survey.

To summarize capture data, we counted the number of captures for each site and calculated the approximate number of net meter hours by multiplying the length of nets used during a survey by the number of survey hours. We calculated captures per unit effort for each grid by dividing the number of captures by net meter hours, and multiplying by 100 to provide an index of bat activity. We also calculated species diversity for each grid. We report mean (±SE) for all data. Known ranges were generated for each species using the maximum extent of national range layers available from USGS, and Wyoming-specific range layers available from the Wyoming Natural Diversity Database (WYNDD).

Acoustic Surveys

We deployed detectors near water and in potential flyways where we expected high bat activity. At least one acoustic detector was placed in association with the nets each trap night. The microphone was positioned 3 m above the ground. We programmed detectors to start recording at sunset, and record for 4 hours. In several instances, we extended recording time until sunrise.

For acoustic analysis, we used the Sonobat Batch Attributer utility to attribute metadata to the existing call files, and Sonobat Batch Scrubber 3 to remove noise files. Calls of good quality resulted in classification from Sonobatch with discriminate probability >0.90. We followed the Species Accepted level of certainly as classified by Sonobatch, unless manual classification was warranted. We manually classified all call files that Sonobat identified as any species uncommon to Wyoming. We also manually classified calls when the program identified a species that had not been previously detected in a particular area. After any necessary manual classification, we calculated the number of classified files per survey hour during the standard 4-hour survey period as an index of activity and the number of species detected for species diversity.

RESULTS

In 2016, we surveyed 29 sites located within the ZOI in the eastern 1/3 of Wyoming (Figure 1). A majority of sites were comprised of mixed-grass prairie habitats or riparian areas within mixed grass prairie habitats. We surveyed exclusively over or alongside open water. The majority (16) of our sites were ponds, 11 sites were streams, 1 site included both a stream and a pond, and 1 site was a lake. Approximately 1/2 (15 of 29) of the sites selected were on public land. The average elevation of sites surveyed in 2016 was 1,549.8 m (± 40.4 m). We documented 11 species of bats through capture, acoustic detection, or both, including 6 of the 8 Species of Greatest Conservation Need (SGCN) known to live in the ZOI (Table 1, Figure 1). We report activity indexes for both capture and acoustic results (Figure 2).

At the 29 sites that we mist netted in 2016, we captured 225 bats representing 9 different species (Table 1, Figures 3-10, Figure 12). We used 44.8 net meters (±1.3 m) per survey, and surveyed for 2.9 hours (±0.1 hours) each night. We captured an average of 7.8 individuals (±1.8; range = 0-29) per survey night. In order of number of individuals captured, species captured were big brown bat (*Eptesicus fuscus;* 47 individuals), little brown myotis (*Myotis lucifugus;* 43 individuals), silver-haired bat (*Lasionycteris noctivagans;* 37 individuals), hoary bat (*Lasiurus cinereus;* 34 individuals), Northern long-eared myotis (*Myotis septentrionalis;* 20 individuals), long-legged myotis (*Myotis volans,* 17 individuals), Western small-footed myotis (*Myotis ciliolabrum*; 14 individuals) long-eared myotis (*myotis evotis;* 5 individuals), and eastern red bat (*Lasiurus borealis;* 1 individual). Additionally, 7 myotis escaped before they could be indentified to species. Six bats escaped the nets before they could be identified at all. Sex ratio of captured bats was slightly in favor of males, with 119 males (52.9% of captures) to 100 females (44.4% of captures) captured. Six bats escaped before sex could be determined. Most captured bats (91.1%; 205 individuals) were adults, while only 5.8% (13 individuals) were juveniles. Seven bats escaped before age could be determined.

Acoustic Surveys

We conducted acoustic surveys at 32 locations; however, difficulties with new equipment resulted in partial or full data loss at 7 of those sites (Figure 2). Acoustic data were successfully collected in 23 distinct grid cells, with 2 acoustic sites operating concurrently in 3 cells. Ten resident species were detected acoustically, including 2 that were not captured this season, Yuma myotis (*Myotis yumanensis*) and fringed myotis (*M. thysanodes*). In addition to equipment

difficulties, an upgrade in software to enable us to detect more of the eastern Wyoming bat species resulted in some inconsistencies in the current version of the acoustic analysis software in which the software might classify calls of marginal quality differently in subsequent runs. As this can result in the call count for some species, and thus the species activity index, changing, we have chosen to report only species presence and total acoustics activity indexes here. Figures 3-13 show locations where we detected each species with acoustic equipment. Acoustic detections contributed to 6 status updates in the Department's Atlas of Birds, Mammals, Amphibians, and Reptiles in Wyoming (Orabona 2016; Table 2).

DISCUSSION

A major objective of this survey effort was to inventory habitat types that were underrepresented in the previous 2 survey efforts, which focused on forested and rocky habitat. The majority of our sites (19 of 29) were located in grassland habitats or riparian zones within grasslands. Grassland habitat has been the least represented habitat type during the previous 8 years of surveys (e.g., forest bat inventory 2008-2011; western cliff and canyon bat inventory 2012-2013 [Filipi et al. 2009; Johnson and Grenier 2010a, b; Cudworth et al. 2011, Abel and Grenier 2012a, b; Yandow and Grenier 2013, 2014; Yandow and Beard 2015; Beard 2016]). There are several instances of grassland sites with high acoustic activity rates, but very low capture rates (Figure 2). This disparity between acoustic activity rates and capture rates demonstrates the inequality of the effects of environmental factors, such as wind and moonlight, on the 2 survey methods. Capture surveys are important in understanding bat populations and a "bat in the hand" is the standard for species detection; however, mist netting is very susceptible to avoidance by bats at open sites, such as grassland ponds. In open habitat, such as that found in the ZOI, the use of acoustic equipment to bat monitor populations is recommended.

One of our goals in surveying previously underrepresented habitat was to gather more information on some of the more rare or less widely distributed species in the state including Townsend's big-eared bat (*Corynorhinus townsendii*), pallid bat (*Antrozous pallidus*), fringed myotis, and long-legged myotis. Neither the Townsend's big-eared bat nor the pallid bat were detected this year, though they have been detected recently within the ZOI (Yandow and Beard 2015, Beard 2016). Fringed myotis were detected acoustically in 2 sampled cells within the species' known range (Figure 11). Yuma myotis was detected acoustically outside of the species known range (Figure 13). As the Yuma myotis is easily confused with the little brown myotis in hand, it is possible that the species has been mis-identified in the past. Positive verification of Yuma myotis areas outside of their established range should include DNA analysis due to similarity of this species to little brown myotis. We were able to capture or acoustically detect long-legged myotis in 17 sampling cells, including a capture of this known forest dweller in one of our grassland grids. This bat may have commuted from a roost in an unseen patch of forest, or may have found the small stand of deciduous trees adjacent to the trapping site sufficient for its roosting needs. Future work documenting bat movement and use of landscape features would be useful in managing bats in open habitat.

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Table 1. Demographics of bats captured in eastern Wyoming, May-August 2016 (*n* = 219). Data are summarized by species. Reproductive status is represented by the following abbreviations: N = Non-reproductive, D = Reproductive (males), PP = Possibly Pregnant, P = Pregnant, L = Lactating, PL = Post Lactating.

Species	Total captures	Sex		Age		Reproductive status					
		F	M	A	J	NR	D	PP	P	L	PL
Eptesicus fuscus	45	16	29	40	5	12	23	2	1	6	1
Lasiurus borealis	1		1	1			1				
Lasiurus cinereus	34	11	23	34		15	9	1		9	
Lasionycteris noctivagans	36	10	26	29	7	21	10			3	2
Myotis ciliolabrum	13	11	2	13		5		1		7	
Myotis evotis	5	3	2	5		1	1			3	
Myotis lucifugus	43	24	19	42	1	32	8		2	1	
Myotis septentrionalis	20	13	7	19		8			3	9	
Myotis volans	17	7	10	17		13	1			2	1
Myotis spp.	5	5	0	5		3		4		1	0
Percent of total captures (*n* = 225)		44.4	52.9	91.1	5.8	48.9	23.6	1.8	2.7	18.2	1.8

Table 2. Updates to the Atlas of Birds, Mammals, Amphibians, and Reptiles in Wyoming (Orabona et al. 2016) from surveys in eastern Wyoming, May-August 2016. Updates are presented by latilong, based on individuals captured and summarized by species. B = breeding, including dependent young, juvenile animals, lactating or post-lactating females; O = observed, but due to mobility of the species and lack of factors listed under "B", breeding cannot be assumed; b = animals were observed and, due to limited mobility, breeding is assumed; a = the species was detected with acoustic equipment and additional verification is warranted; __ = no verified records.

Species	Latilong degree block	Current status	Updated status
Eptesicus fuscus	13	h	a
Lasiurus cinereus	13	h	a
Lasionycteris noctivagans	13	__	a
Myotis ciliolabrum	13, 14	h, a	a, B
Myotis volans	13	a	O

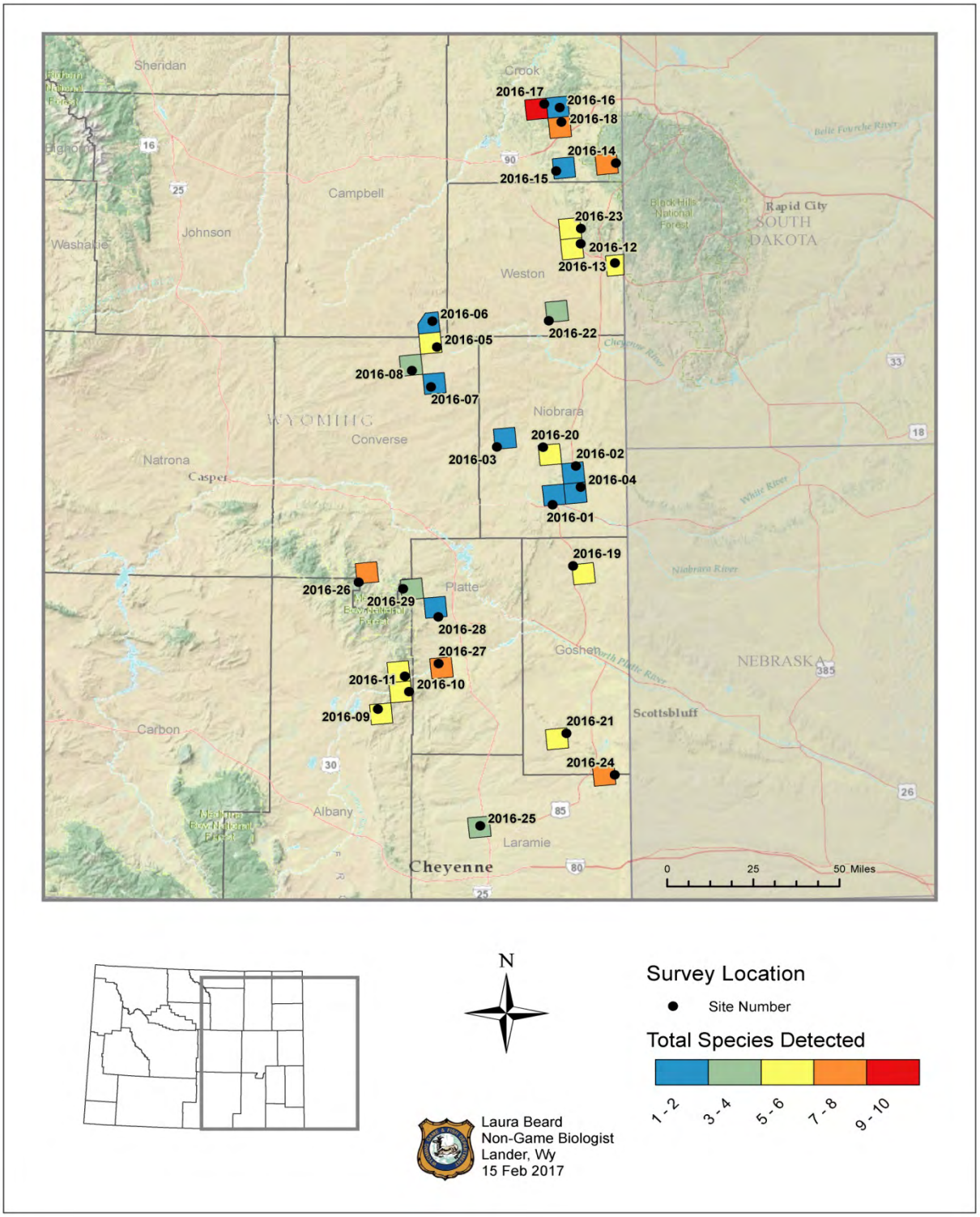

Figure 1. Location of survey sites and sampling grid cells surveyed throughout eastern Wyoming, May-August 2016. Colors correspond to the number of species of bats detected (acoustic and live-captures) within each grid cell surveyed.

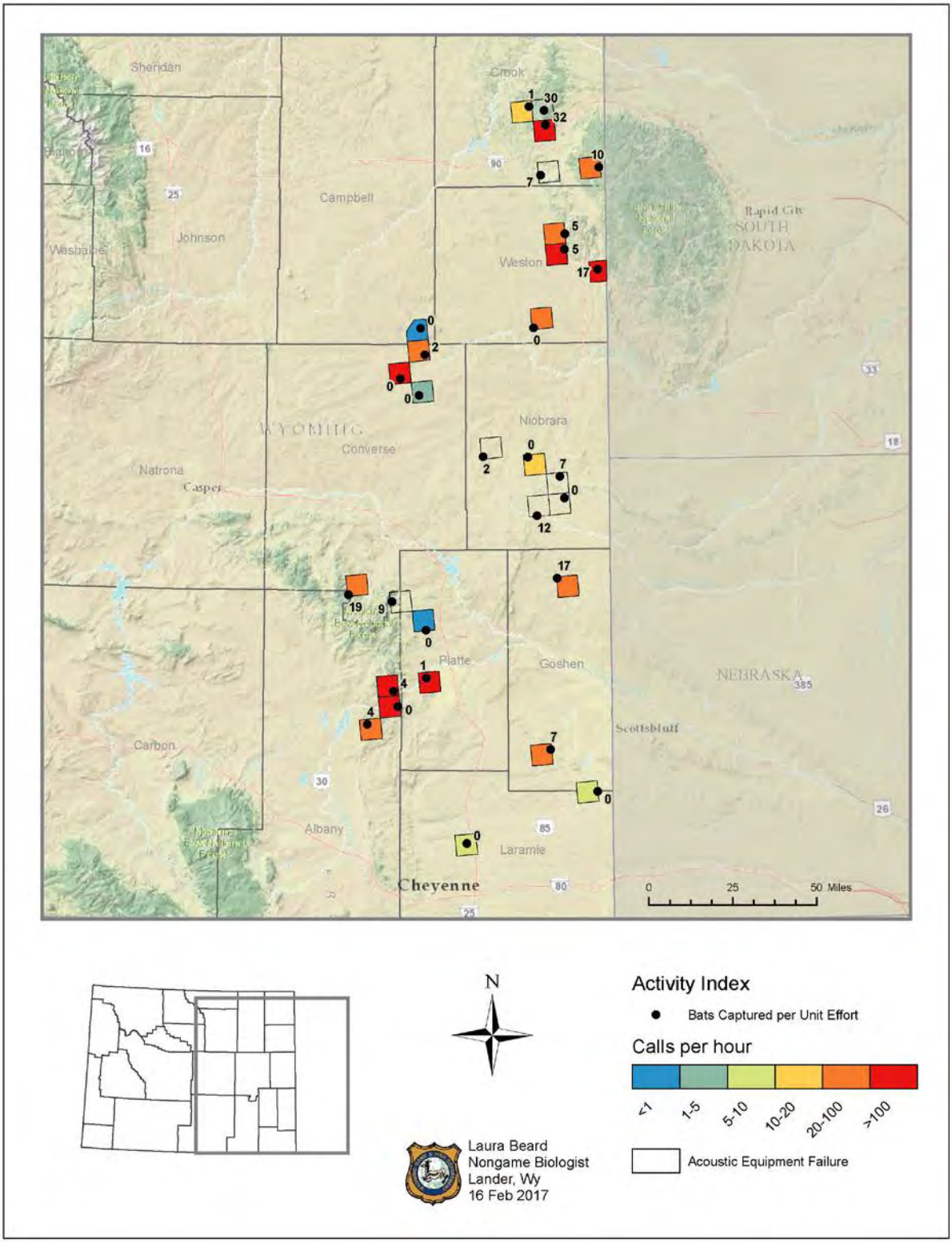

Figure 2. Location of grid cells surveyed throughout eastern Wyoming, May-August 2016. Colors correspond to calls per hour for each grid cell. Labels indicate bats captured per net meter hour (unit effort).

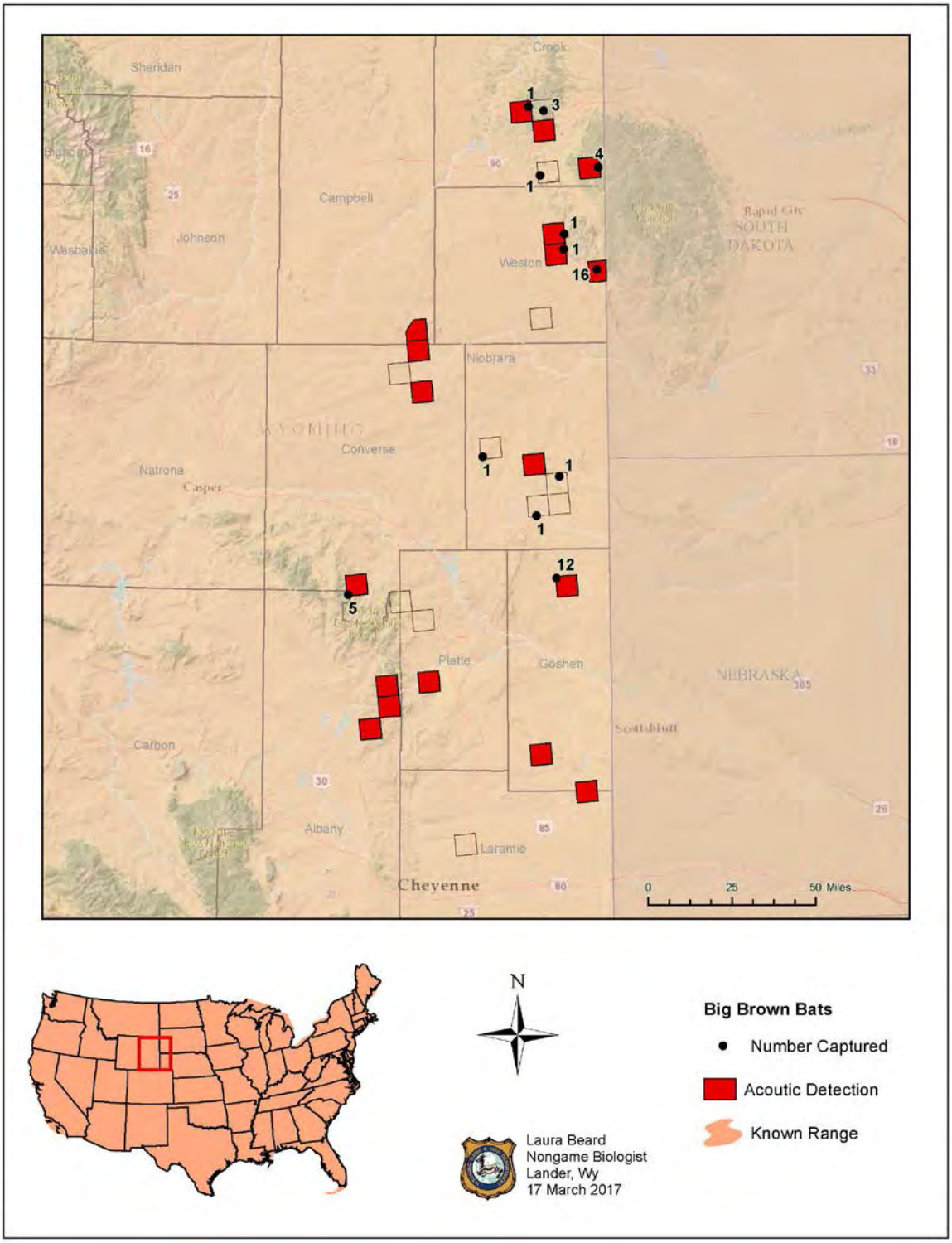

Figure 3. Locations where big brown bats (*Eptesicus fuscus*) were captured and detected in eastern Wyoming, May-August 2016. Dots within each grid cell represent netting locations and corresponding labels refer to the number of captured individuals for this species. Filled grid cells indicate detection calls attributable to the species.

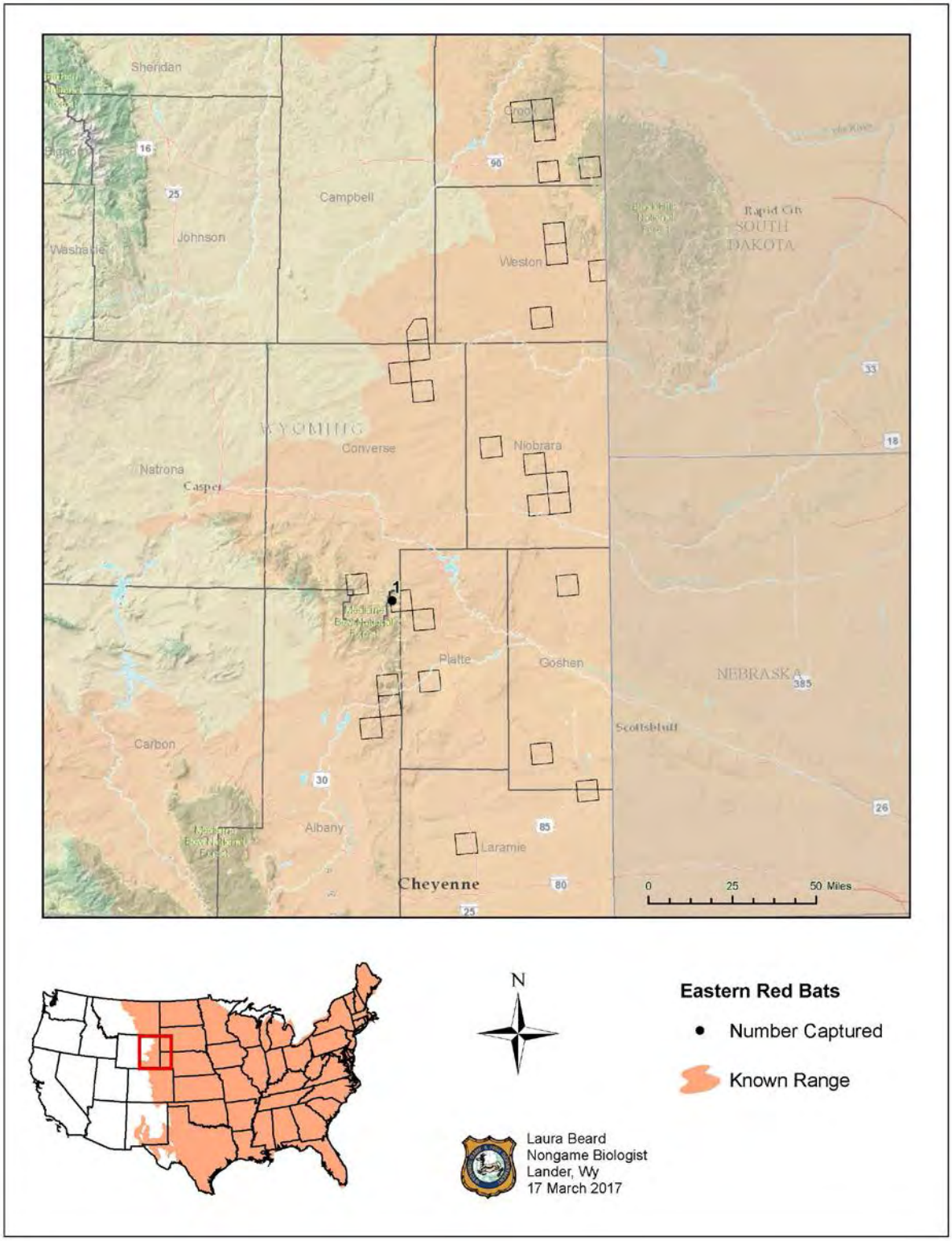

Figure 4. Locations where eastern red bats (*Lasiurus borealis*) detected in eastern Wyoming, May-August 2016. Dots within each grid cell represent netting locations and corresponding labels refer to the number of captured individuals for this species.

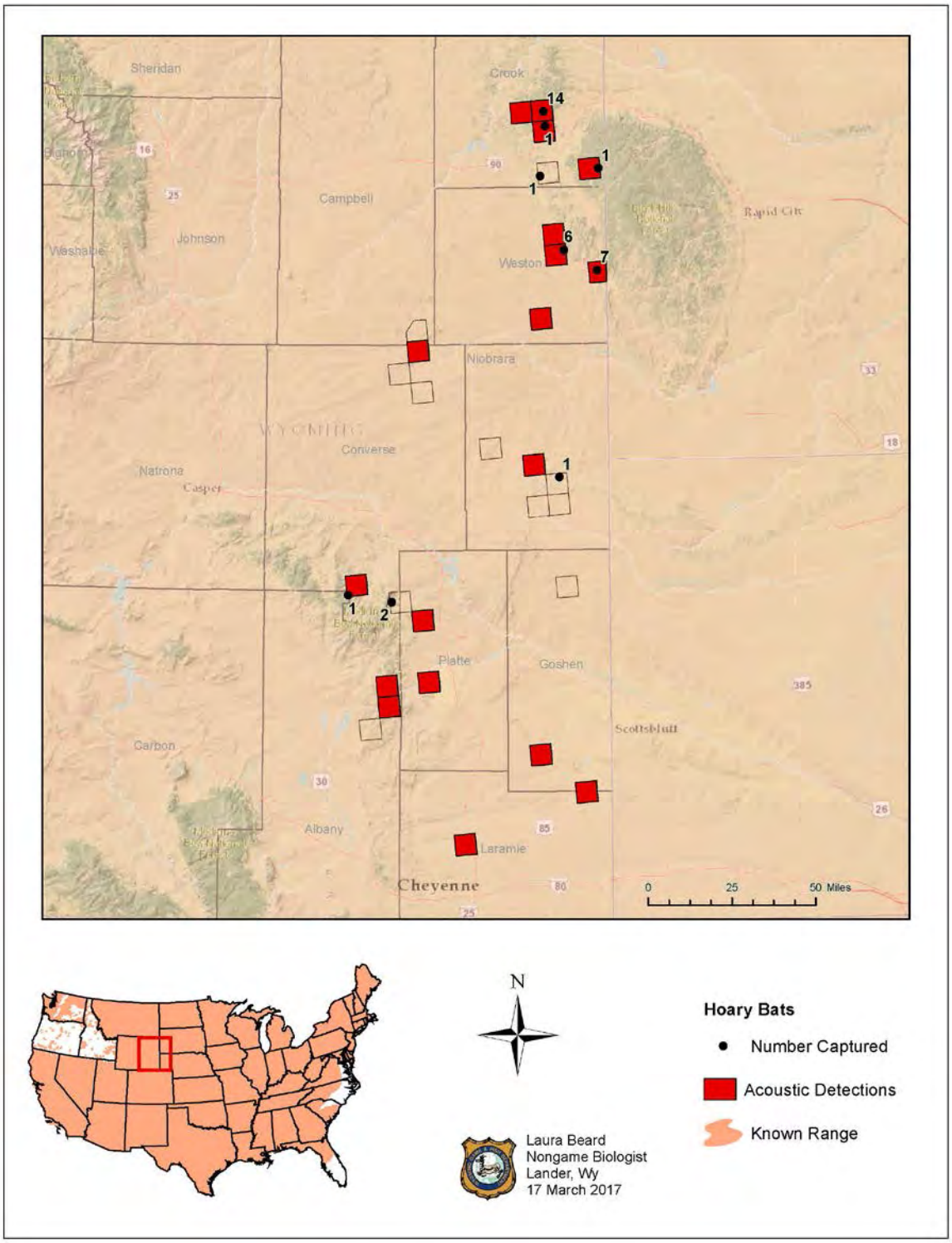

Figure 5. Locations where hoary bats (*Lasiurus cinereus*) were captured and detected in eastern Wyoming, May-August 2016. Dots within each grid cell represent netting locations and corresponding labels refer to the number of captured individuals for this species. Filled grid cells indicate detection calls attributable to the species.

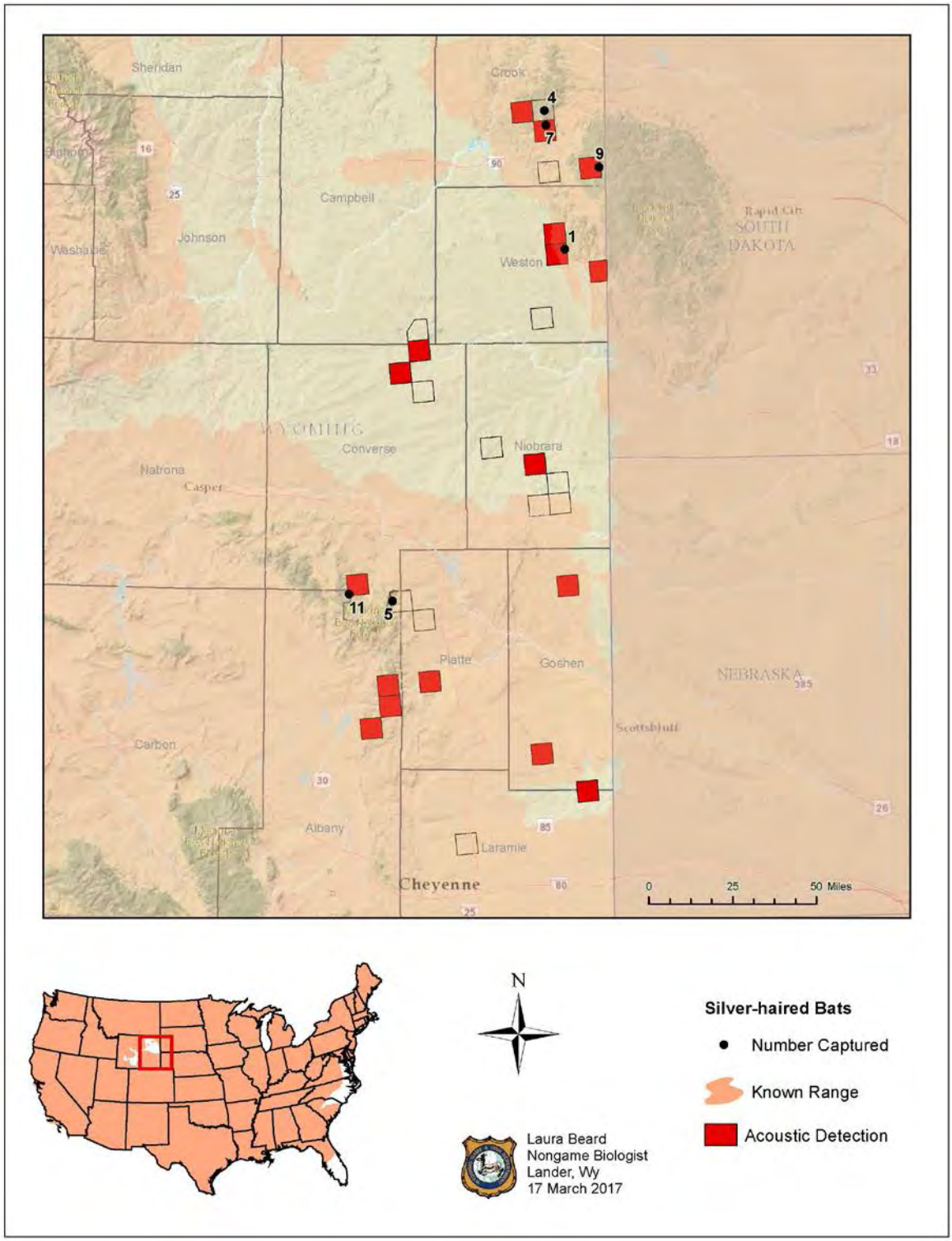

Figure 6. Locations where silver-haired bats (*Lasionycteris noctivagans*) were captured and detected in eastern Wyoming, May-August 2016. Dots within each grid cell represent netting locations and corresponding labels refer to the number of captured individuals for this species. Filled grid cells indicate detection calls attributable to the species.

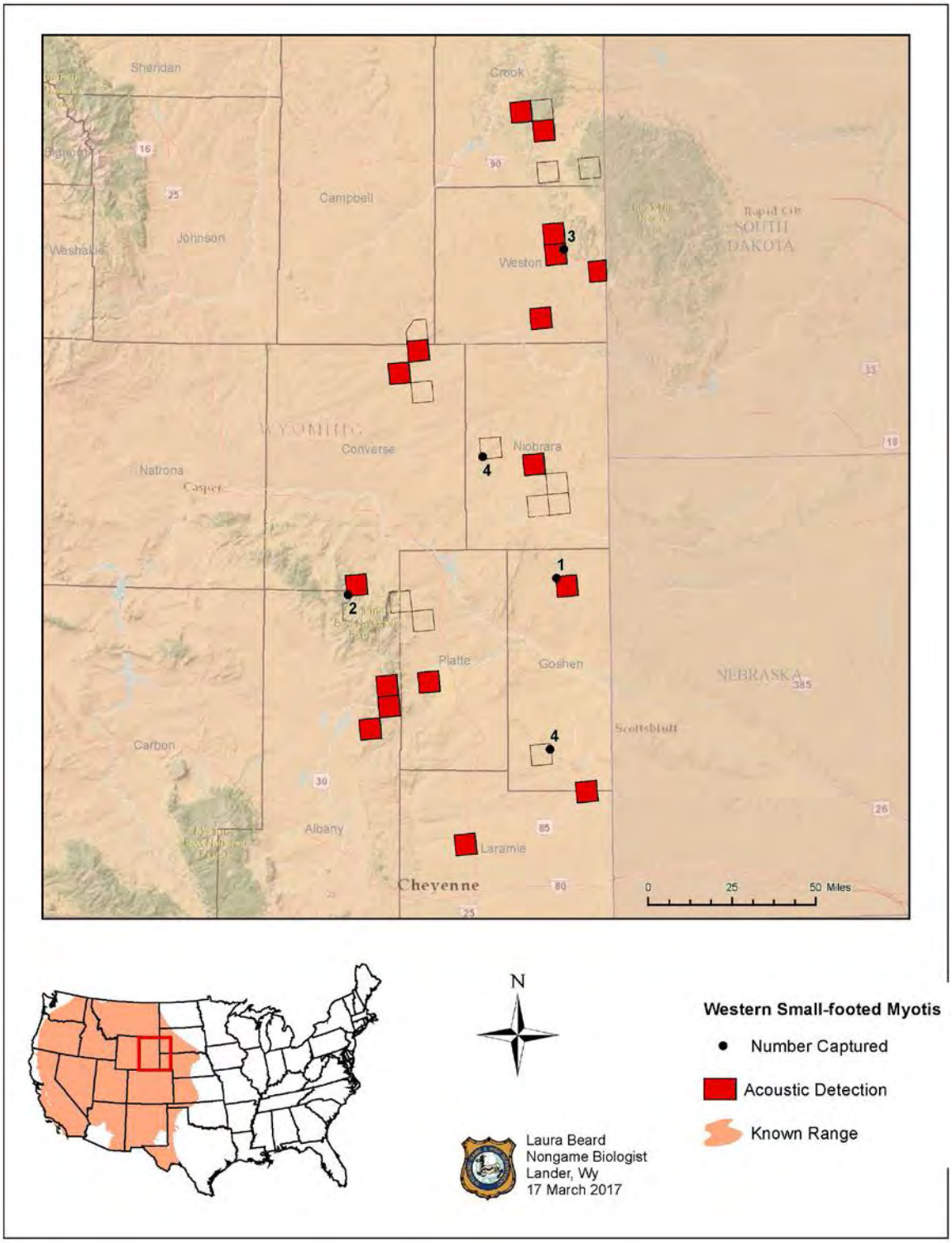

Figure 7. Locations where western small-footed myotis (*Myotis ciliolabrum*) were captured and detected in eastern Wyoming, May-August 2016. Dots within each grid cell represent netting locations and corresponding labels refer to the number of captured individuals for this species. Filled grid cells indicate detection calls attributable to the species.

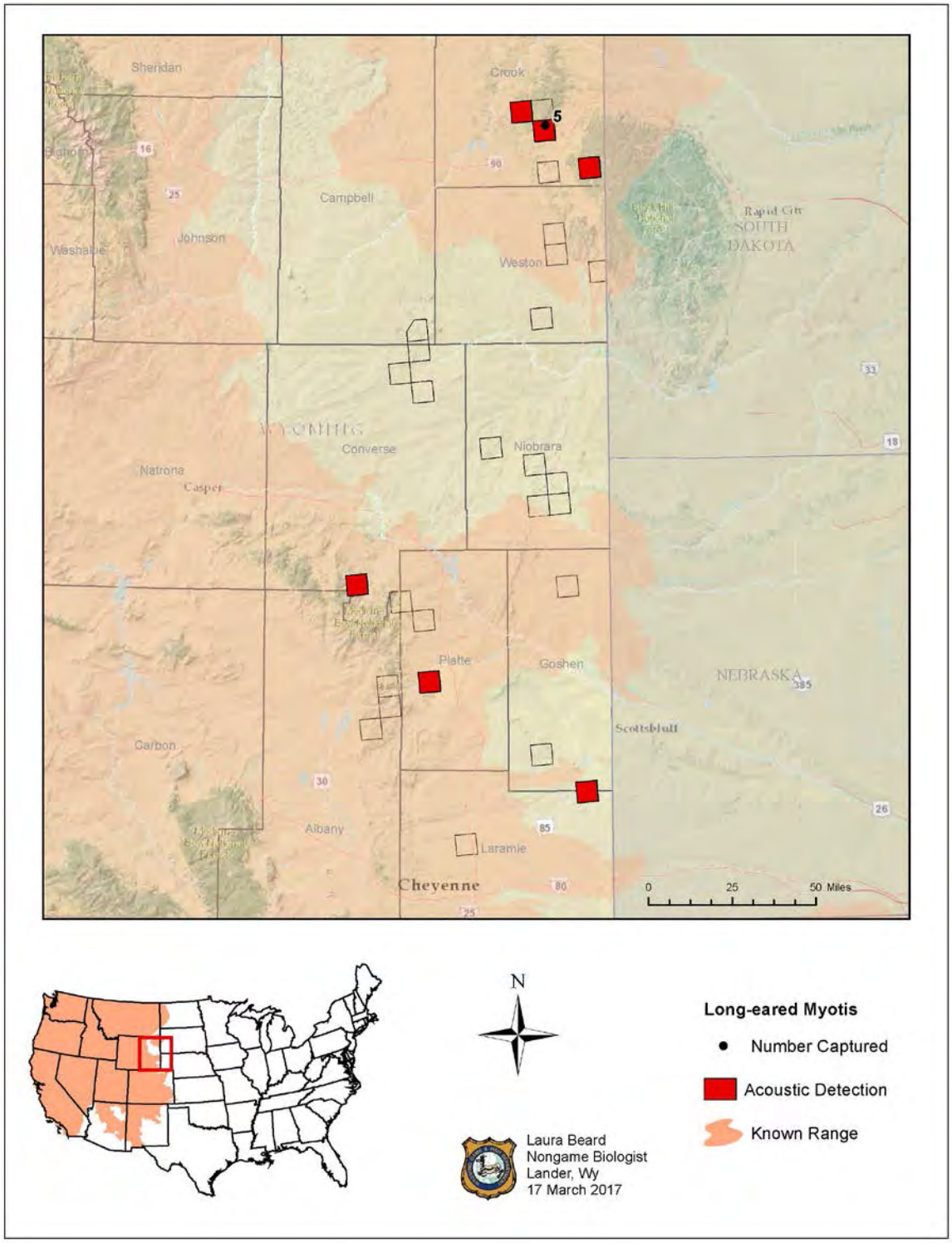

Figure 8. Locations where long-eared myotis (*Myotis evotis*) were captured and detected in eastern Wyoming, May-August 2016. Dots within each grid cell represent netting locations and corresponding labels refer to the number of captured individuals for this species. Filled grid cells indicate detection calls attributable to the species.

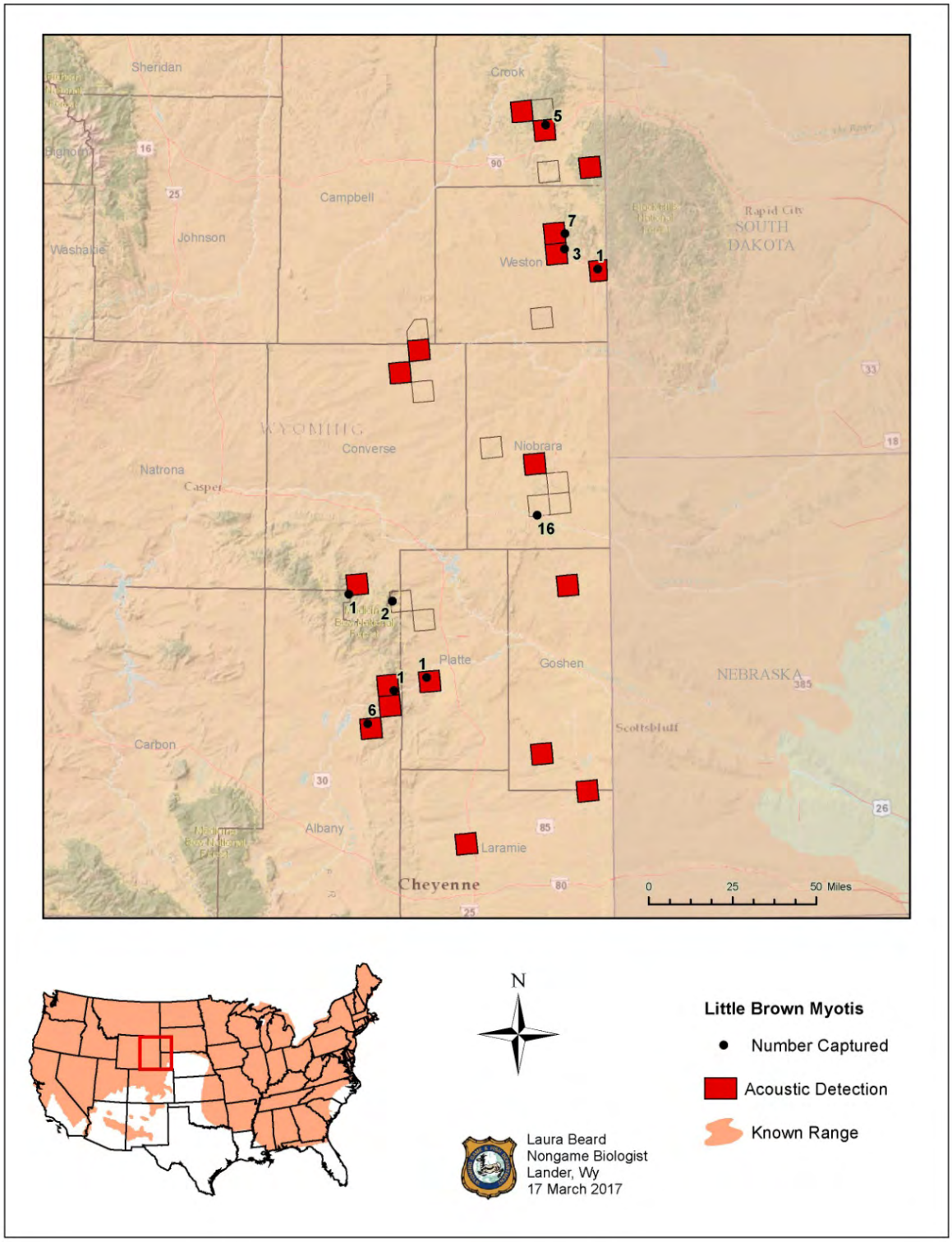

Figure 9. Locations where little brown myotis (*Myotis lucifugus*) were captured and detected in eastern Wyoming, May-August 2016. Dots within each grid cell represent netting locations and corresponding labels refer to the number of captured individuals for this species. Filled grid cells indicate detection calls attributable to the species.

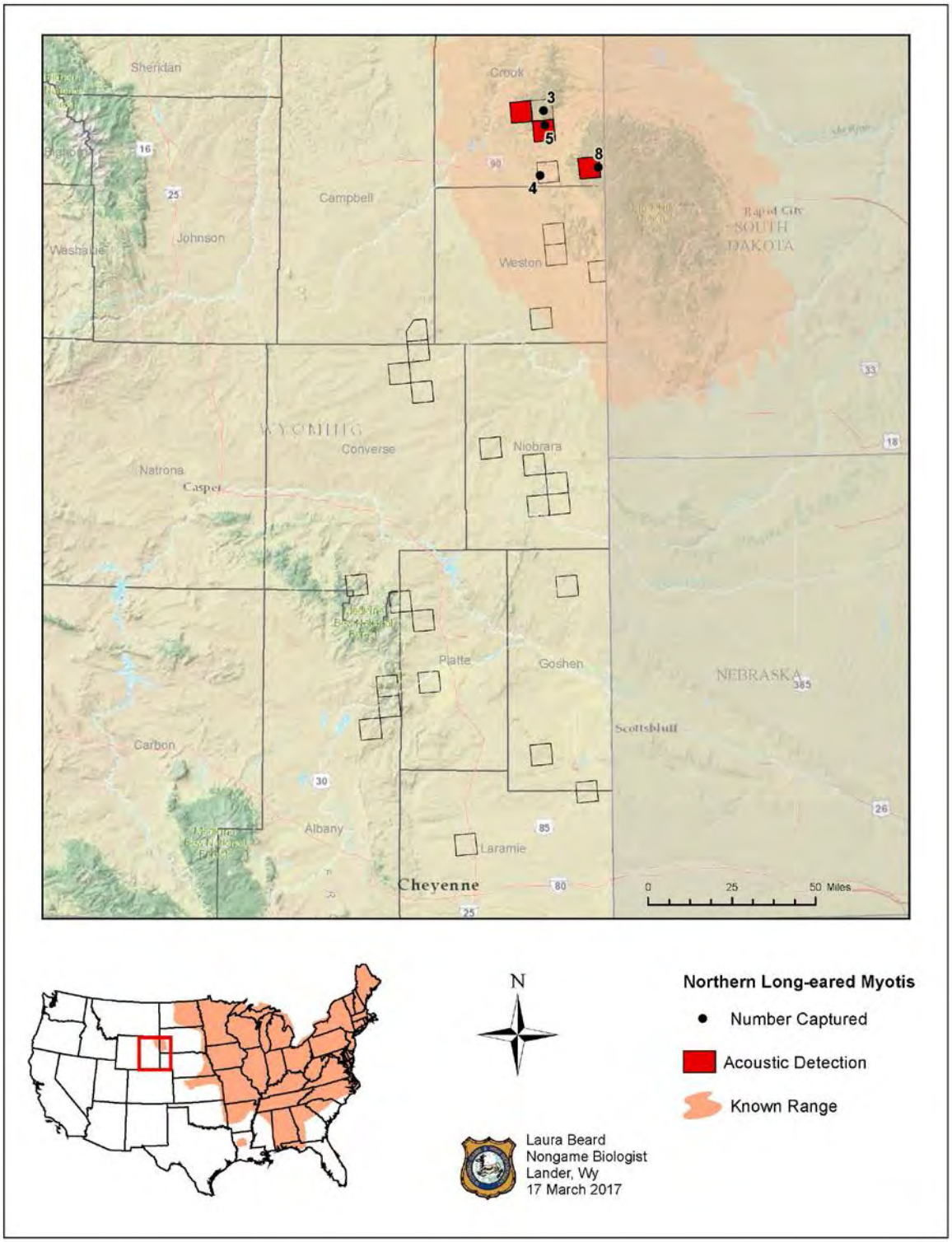

Figure 10. Locations where northern long-eared myotis (*Myotis septenrionalis*) were captured and detected in eastern Wyoming, May-August 2016. Dots within each grid cell represent netting locations and corresponding labels refer to the number of captured individuals for this species. Filled grid cells indicate detection calls attributable to the species.

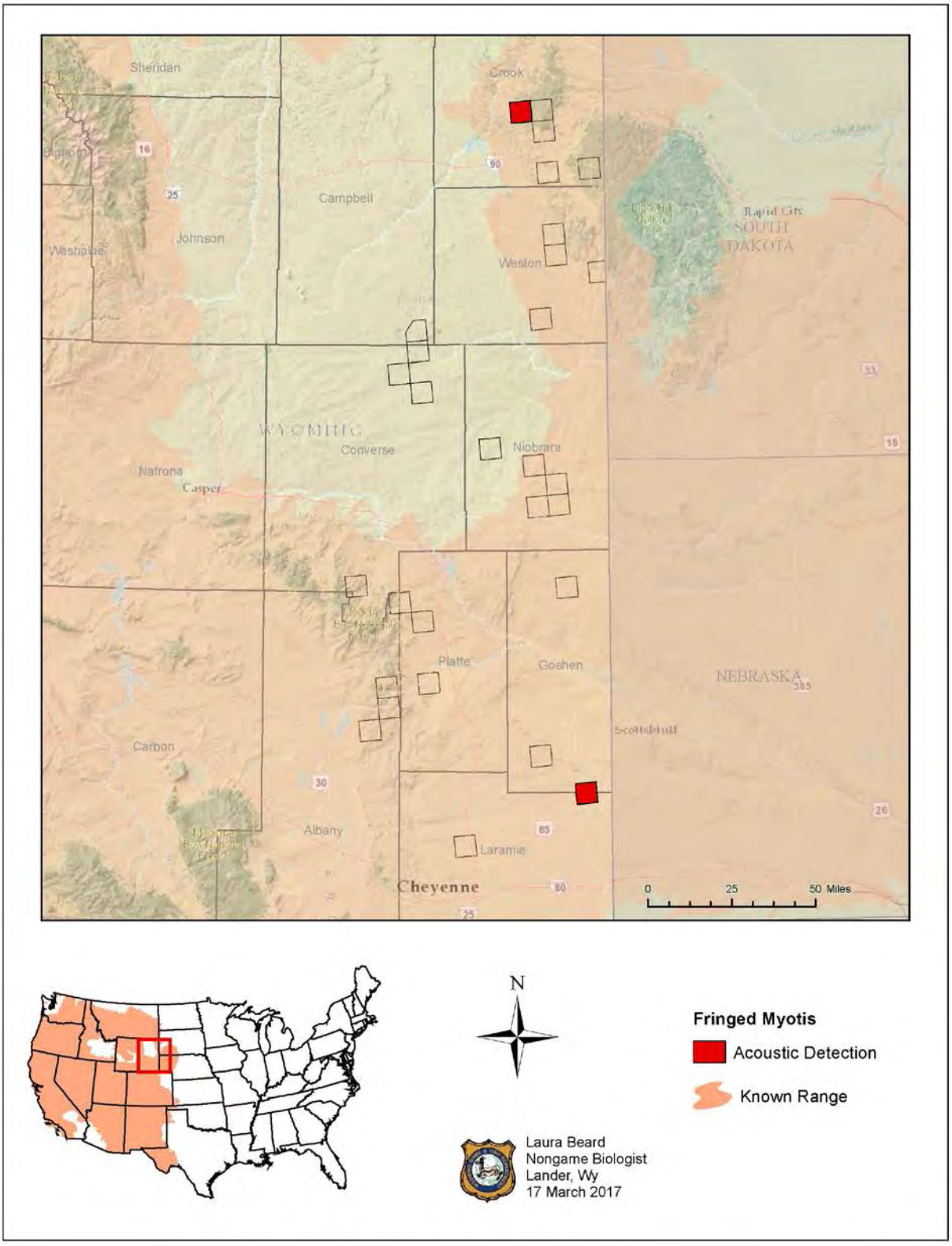

Figure 11. Locations where fringed myotis (*Myotis thysanodes*) were detected in eastern Wyoming, May-August 2016. Filled grid cells indicate detection calls attributable to the species.

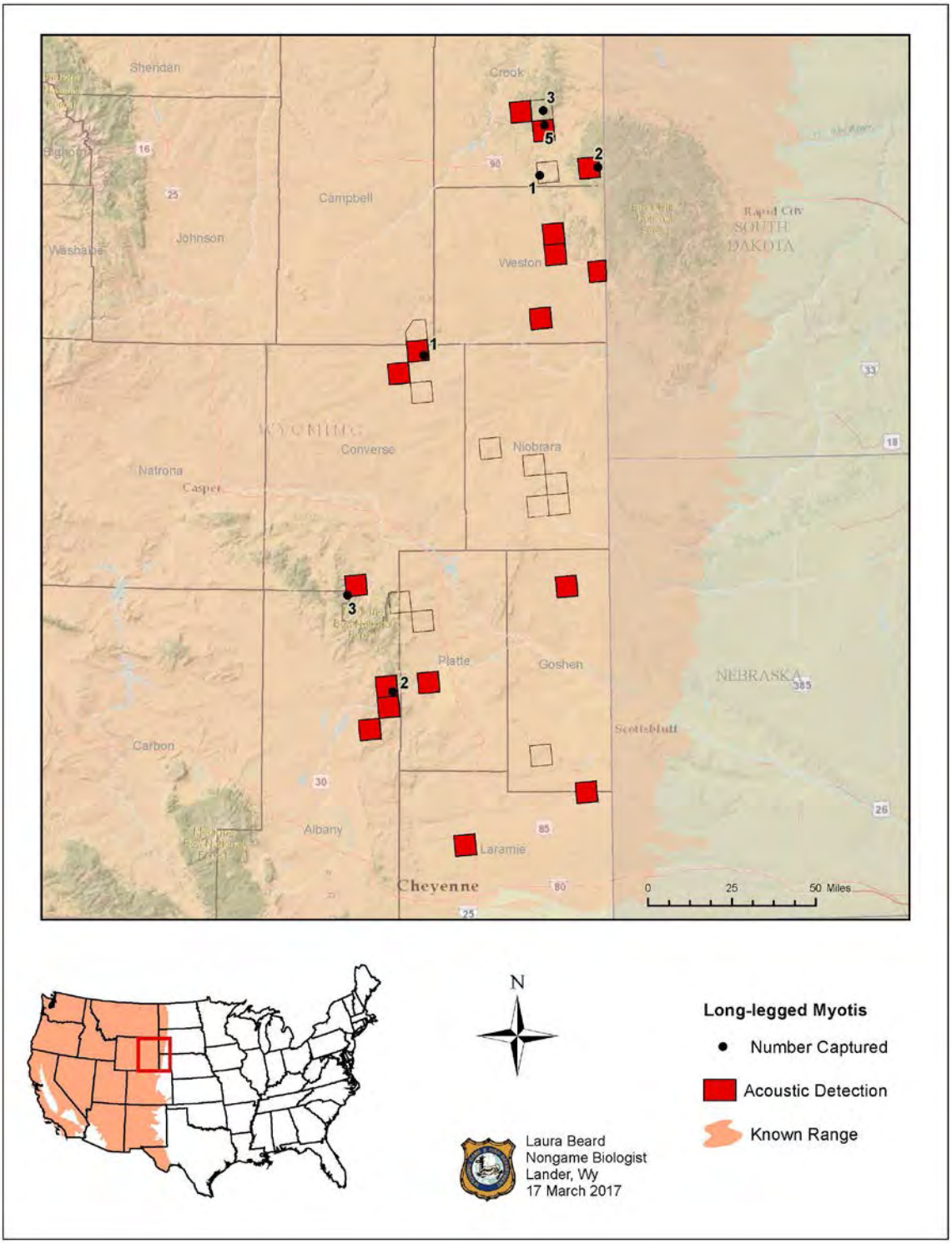

Figure 12. Locations where long-legged myotis (*Myotis volans*) were captured and detected in eastern Wyoming, May-August 2016. Dots within each grid cell represent netting locations and corresponding labels refer to the number of captured individuals for this species. Filled grid cells indicate detection calls attributable to the species.

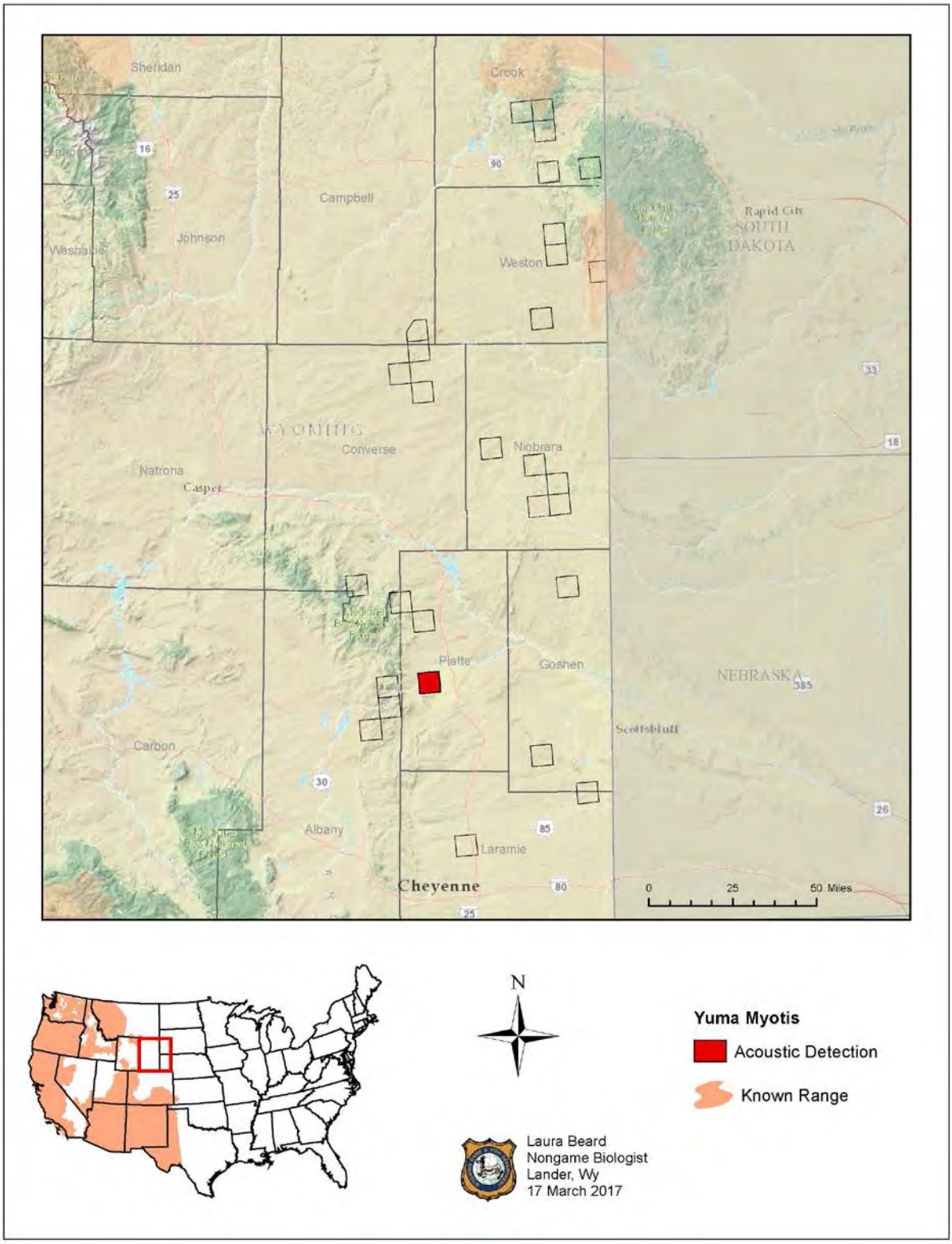

Figure 13. Locations where Yuma myotis (*Myotis yumanensis*) were detected in eastern Wyoming, May-August 2016. Filled grid cells indicate detection calls attributable to the species.

AN INVESTIGATION OF MAMMALS USING PINYON-JUNIPER HABITAT IN SOUTHWESTERN WYOMING

STATE OF WYOMING

NONGAME MAMMALS: Species of Greatest Conservation Need – Canyon Deermouse, Cliff Chipmunk, Piñon Deermouse

FUNDING SOURCE: United States Fish and Wildlife Service State Wildlife Grant
Wyoming State Legislature General Fund Appropriations

PROJECT DURATION: 1 July 2015 – 30 June 2018

PERIOD COVERED: 3 April 2016 – 30 October 2016

PREPARED BY: Leah Yandow, Nongame Biologist

ABSTRACT

Pinyon-juniper woodlands are one of the most widespread plant communities in North America and support a diverse and distinct suite of wildlife. Changes in climate, fire regimes, and land use over the last several decades have made this system particularly vulnerable to habitat loss and fragmentation. In Wyoming, pinyon-juniper is dominated by Utah juniper (*Juniperus osteosperma*) and restricted to the southwestern portion of the state. Such woodlands are host to several Species of Greatest Conservation Need whose most northern portion of their range occurs there. We initiated a project to address knowledge gaps about several Species of Greatest Conservation Need that use juniper habitat. Our efforts to detect these species were twofold. First, we conducted small mammal trapping within rocky and cliffy juniper areas to target cliff chipmunk (*Neotamias dorsalis*), piñon deermouse (*Peromyscus truei*), and canyon deermouse (*P. crinitus*). We also deployed and baited remote cameras to detect ringtail (*Bassariscus astitutus*) and western spotted skunk (*Spilogale gracilis*). During our first season of the study, we detected all 3 target small mammals and one western spotted skunk. Data will be analyzed within occupancy modeling frameworks to test for effects of habitat characteristics on occupancy rates upon completion of the 2nd field season. This comprehensive effort to detect species in juniper woodlands in southwestern Wyoming will add to our understanding of species using this habitat and the value of juniper habitat characteristics.

INTRODUCTION

Utah juniper (*Juniperus osteosperma*) occurs in patches throughout south and central Wyoming, and has been slowly moving north and eastward in a long-term expansion beginning

1,000s of years ago (Jackson et al. 2002, Miller et al. 2008). Today, the largest and potentially most biologically meaningful area of juniper in Wyoming is the expanse in the southwestern part of the state around Flaming Gorge Reservoir. There, wildlife diversity is distinct; several birds, mammals, and reptiles are unique to the area (WGFD 2017), and the northern extents of many species' ranges occur in the region where juniper and rocky sandstone outcrops dominate the landscape within a mosaic of sagebrush. Furthermore, alongside the long-term expansion of juniper northward, changes in juniper distribution has occurred at a smaller scale due to shorter-term factors: recent climate change, range management activities, and energy development all influence juniper woodland habitat and its inhabitants in southwestern Wyoming (Rehfeldt et al. 2006, WGFD 2017). Among these inhabitants are 3 species of small mammals that are restricted to the rocky habitats in southwestern Wyoming, all of which are classified as Species of Greatest Conservation Need (SGCN) by the Wyoming Game and Fish Department (Department): cliff chipmunk (*Neotamias dorsalis*; NSS3, Tier II), pinyon deermouse (*Peromyscus truei*; NSS3, Tier II), and canyon deermouse (*Peromyscus crinitus*; NSS3, Tier II).

Little is known about the range and status of these species in Wyoming. In fact, most information comes from the work of a 2-year Master of Science thesis funded in part by the Department in the late 1990s to learn more about the distribution and habitat associations of the species (Rompola 2000). Results from this work have been essential to our understanding of the species' distributions and have allowed us to make assumptions regarding implications of management actions for the residents of juniper habitat in southwestern Wyoming.

In Wyoming, cliff chipmunks were found across the study area at 86% of the sites surveyed in 1999 (Rompola 2000), all of which were considered cliff and rock sites, with cliff sites supporting higher densities of cliff chipmunks than rock habitat. Cliff chipmunks also showed a strong relationship with sites with low bare ground cover, tall shrubs, and high grass cover (Rompola and Anderson 2004). In contrast, in a different part of their range, but also on the periphery, cliff chipmunks showed a preference for high bare ground and low shrub and herbaceous cover. The species was also highly associated with mature juniper stands (Rodhouse et al. 2010). Conversely, the piñon deermouse is considered a true juniper specialist and has only been recorded in juniper woodlands in the most southern reaches of southwestern Wyoming (Hoffmeister 1951). In Wyoming, captures of the species were associated with sites further from the edge of juniper and rock outcrops and at sites with low forb cover, high canopy cover, and low density of rock outcrops (Rompola 2000, Rompola and Anderson 2004). Like the cliff chipmunk, piñon deermouse has been associated with sites having low herbaceous and shrub cover and more bare ground (Rodhouse et al. 2010). Finally, the canyon mouse is a cliff specialist and highly associated with rock, talus, and cliff features; plant diversity and structure have little or no influence on distribution (Johnson and Armstrong 1987). However, in southwestern Wyoming, they have been found at sites with high tree density and high rock and forb cover (Rompola and Anderson 2004). Previous captures found canyon mice only in the central part of our study area.

In addition to the 3 small-mammal species, 2 medium-sized mammals, ringtail (*Bassariscus astutus*) and western spotted skunk (*Spilogale gracilis*), putatively use juniper woodland habitat in southwestern Wyoming and are occasionally, but rarely, documented there, with historical records of each species within the study area. In other parts of their range,

western spotted skunk use rocky juniper habitat, among other habitat types, and ringtail are more likely to be found in riparian woodlands and canyons. Both species are classified as SGCN in Wyoming, with the distribution of both species in Wyoming not well known.

The 3 small mammal target species in this project are thought to be doing well in more southerly parts of their range. For example, none of these SGCN in Wyoming has conservation status in the core of their ranges, including Utah or Colorado (Utah Wildlife Action Plan Joint Team 2015, Colorado Parks and Wildlife 2015, Buskirk 2016). However, populations at the periphery of their ranges have considerable conservation value, where both individuals and populations add to the genetic diversity of the species as a whole and may have special traits that allow them to thrive or survive at the edge of their range. In the northern hemisphere, for example, populations at the northern boundary of their range often have a higher tolerance for harsh climates than populations at the more southern parts of their range where climates are milder. In this project, we are targeting these species at the northern edge of their ranges to understand more about their status in Wyoming and determine which factors limit their distributions in an effort to inform management decisions. Objectives of this project are to 1) inventory juniper woodlands in southwestern Wyoming around the Flaming Gorge Recreation Area within the distributional ranges of the 3 small and 2 medium-sized mammalian SGCN, 2) determine if there is an effect of stand maturity on occupancy rates and small-mammal diversity, 3) identify habitat cover types that best predict occupancy for each juniper-obligate small mammal species, and 4) document other mammalian SGCN using juniper habitat in southwestern Wyoming (i.e., western spotted skunk and ringtail).

METHODS

The study area was defined within the juniper-obligate bird study area (Yandow 2017) located around the Flaming Gorge region, south of Interstate 80 in southwestern Wyoming (Figure 1). The area is marked by rocky juniper terrain, wildfire scars, high grassy plateaus, large greasewood (*Sarcobatus vermiculatus*) and shrubland drainages, and intermixed with extensive patches of sagebrush (*Artemesia tridentata*).

Prior to fieldwork, we selected survey sites based on a 1 km x 1 km grid system that covered the study area. We eliminated any grid cells that had private landownership and, therefore, included grid cells made up of Bureau of Land Management (BLM), state, US Forest Service, Rock Springs Grazing Association, Anadarko, and Union Pacific lands for which we could obtain access permission. Using data delineated by the 2015 Census Bureau, we eliminated grid cells that were not within 200 m of a road. Using data from Wyoming Oil and Gas Conservation Commission, we also eliminated grid cells that had producing oil or gas wells. We used National Agriculture Imagery Program imagery from 2012 to visually assess each available grid cell for the presence of rocks and cliffs. Each grid cell that had rocky features present was retained for a subsequent spatially-balanced random selection using the Generalized Random Tessellation Stratified (GRTS) method (Stevens and Olsen 2004). From all potential grid cells, we used GRTS to select 60 grid cells for survey and 20 additional grid cells for potential survey in 2016 and 2017. Because each chronological set of grid cells is spatially balanced, we started with the first grid cell and attempted to survey each subsequent grid cell.

Small mammals require vegetation for food and cover; therefore, we only surveyed grid cells that had a combination of tree, shrub, and ground cover. We did not survey grid cells that lacked vegetation or where access was extremely difficult or unsafe. We generated points for each selected grid cell consisting of 16 points spaced 250 m apart and 125 m from the edge of the grid in a 4 x 4 fashion. For each grid cell that was selected for survey, we subjectively chose 3 out of the 16 points for setting up small mammal trapping areas. When selecting points for trapping areas, we aimed to sample a diverse suite of sites by choosing 1 rock or cliff area; 1 area with mature juniper woodland when available; and 1 area with rock or cliff, juniper, or shrubland for each grid cell. We assumed trapping areas were independent samples because we selected trapping areas further than the length of the home ranges of each of our target species (≥350 m; Hoffmeister 1981, Johnson and Armstrong 1987, Hart 1992, Rodhouse et al. 2010). Our study design will allow us to document these rare small mammals across the study area and test relationships between occupancy and habitat attributes.

We deviated from the site selection protocol at the end of the season because we had yet to capture canyon deermice and we wanted to see if we could document the species in the study area. We targeted the 2 quarter-sections within the study area where canyon deermice were detected historically (Rompola 2000). We set up 2 trapping areas with the same layout as all other trapping areas (6 x 6 and 20 m apart; see below) in locations where we expected to capture the species based on its ecology and habitat attributes of the landscape.

We conducted small mammal trapping surveys from 16 July through 2 September 2016 throughout the study area. We placed live traps (Model 339A non-folding traps; H.B. Sherman Traps, Inc., Tallahassee, FL) every 20 m in a 6 x 6 grid to obtain a high sample size with low effort per sample for each trapping area (Rompola and Anderson 2004, Cudworth et al. 2013, Rodhouse et al. 2010, Harkins and Ben-David 2015). We baited traps with a mixture of peanut butter, 3-way grain, and black oil sunflower seed wrapped in wax paper. We also placed poly-fil in each trap for bedding. We opened traps 3-6 hours before sunset and trapped for 4 consecutive nights for a total of 144 trap nights per trapping area, except for 2 of the subjectively chosen sites where we had 3 consecutive nights and 108 trapping nights. We checked and closed traps starting at 0700. We recorded weather conditions each morning, including wind speed, sky cover, and temperature. For each capture, we recorded species, age, sex, and reproductive status. For target species, we recorded UTM coordinates of trap location and morphometric measurements, including tail length, hind foot length, ear length, and weight. We affixed an ear tag (model 1005-1; National Band and Tag Co., Newport, KY) on all individuals of target species. We released animals at the same location where they were captured.

For documenting western spotted skunk and ringtail, we deployed remote cameras from 30 July through 2 September, and retrieved cameras on 29 September 2016. We deployed 1 camera for each grid cell (i.e., 1 camera per 3 small mammal trapping areas) whenever possible. We pointed each camera at a bait tree where we secured a can of cat food and dispensed a splash of bobcat urine for scent lure. We used photograph data to document what species are using this habitat; we did not set up this portion of the study to be evaluated using occupancy modeling.

RESULTS

We set up 38 small mammal trapping areas over the course of the field season and captured 984 individuals (Figure 1). Captures of the 3 target species together made up about 11% of all captures: piñon deermouse (7%), cliff chipmunk (4%), and canyon deermouse (0.3%; Table 1). The majority of captures were North American deermouse (*Peromyscus maniculatus*; 81%). We also captured, in order of number of captures: least chipmunk (*Tamias minimus)*, bushy-tailed woodrat (*Neotoma cinerea*), Ord's kangaroo rat (*Dipodomys ordii*), golden-mantled ground squirrel (*Callospermophilus lateralis*), and Great-Basin pocket mouse (*Perognathus parvus*; Table 1).

Of the 38 trapping areas surveyed for small mammals, we captured ≥1 of the target species at 15 sites (39%). We found canyon deermice at 2 of 5 trapping areas placed within 400 m of sites where the species was previously captured (Rompola and Anderson 2004). These sites were among the rockiest sites surveyed throughout the season. Piñon deermice were captured within the southern portion of the study area, including in 2 of 8 sites in the Sage Creek drainage, which is the furthest north detection of the species in Wyoming that we are aware of. We captured cliff chipmunk at 7 of 38 sites, which were all in the most southern portion of the study area (Figure 2). Means for sites where distance to juniper edge were significantly different between sites where piñon deermouse was captured and sites where they were not captured (t_{36} = -3.0; $P < 0.01$). Sample sizes for canyon deermouse were very small, and we only captured the species at sites that were subjectively chosen. However, the 2 sites where we found canyon deermouse had the 2 smallest mean distances to cliffs, and were significantly different than mean distance to cliffs for sites where we did not capture the species ($t_{35} = 5.38$; $P < 0.01$). Similarly, mean sagebrush cover was lower at sites where we captured canyon deermouse compared to sites where we did not capture the species ($t_{36} = 4.7$; $P < 0.01$; Table 2).

We deployed 11 cameras for ≥28 days and ≤61 days. In total, we deployed cameras for 526 days, assuming each camera was working properly for the length of time it was deployed. Cameras took 1,763 photos while deployed. Of our 2 nongame target species (i.e., ringtail and western spotted skunk), we captured 1 western spotted skunk on camera in addition to red fox (*Vulpes vulpes*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), elk (*Cervus canadensis*), pronghorn (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), jackrabbit spp. (*Lepus spp.*), cottontail spp. (*Sylvilagus spp.*), and Golden Eagle (*Aquila chrysaetos*; Table 3, Figure 2).

DISCUSSION

We captured ≥1 of the target species at nearly 40% of the sites surveyed this year. However, capture success would likely improve if more sites were within true rock and cliff habitat. The site selection method we used to visually assess imagery for rocky habitat occasionally missed large areas of rock and cliff habitat that were then not considered for survey. Additionally, by constraining the selection by distance to roads, we greatly limited the potential grid cells available to survey. However, there were also large areas close to roads that were missed, likely due to the difficulty of assessing the availability of rock through aerial imagery. In future efforts, a more effective method for selecting sites within target habitat may be to

delineate rock and cliff areas in the field and then perform a stratified random selection for survey sites, rather than using GRTS for rock and cliff habitat type.

We captured canyon deermice only at hand-picked sites within 400 m of where they were previously captured. The 2 sites with canyon deermice were the rockiest sites of all the sites trapped, which reinforces the idea that we likely missed important areas of habitat during site selection, particularly for this species. Given what we know about the areas where we found canyon deermice, there are several other places within the study area, both surveyed and not surveyed, that appear to be suitable or at least have similar habitat attributes. Canyon deermice are restricted to possibly isolated patches of rocky habitat in this region of Wyoming (Rompola 2000), and their limited distribution range-wide has been previously recognized (Johnson and Armstrong 1987). However, dispersal limitations, microhabitat, and microclimate may limit this species more than other similar species. Competition with other *Peromyscus* spp. has also been proposed as a primary limiting factor for canyon deermouse (Svihla and Svihla 1929). Using systematic and randomized methods to better target rock and cliff habitat in subsequent surveys may reveal other sub-populations in the study area, thus allowing for a better understanding of factors influencing presence and occupancy for this rare species.

As expected, we captured piñon deermice primarily in old, multi-story woodland in the southern portion of the study area, which coincides with findings from previous work (Rompola 2000). We also found piñon deermice at 2 sites in the Sage Creek drainage, which is, to our knowledge, the furthest north that this species has been documented in Wyoming and may mark a range expansion for piñon deermouse. In previous work, piñon deermouse has shown a negative relationship with distance to rock. Therefore, in order to target trapping efforts for both canyon and piñon deermouse, trapping sites should include areas that are extremely rocky and sites that have old-growth juniper woodlands without rock outcrops.

Results from the late 1990s suggest cliff chipmunks were once widespread across the study area (Rompola and Anderson 2004). Although we surveyed very similar types of sites as the previous study, we had substantially fewer captures, with cliff chipmunks apparently limited to the most southern portion of the study area. Further work is needed to determine if this is related to survey effort or a retraction of their range at the periphery. Although we expected to find cliff chipmunks highly associated with cliff and rock features, we instead saw no significant difference between habitat attributes of sites where we found cliff chipmunks and sites where we did not find them. Cliff chipmunks generally spend more time closer to their nesting sites during parturition and while raising young, and range further from the rocky sites later in the summer (Rompola 2000). This seasonal surveying difference could account for why we found no significant relationship in our data from our surveys, which took place in late summer, although our dataset is small after only a year of data collection.

The camera data collection effort was not a main objective of the project, but rather an opportunity that used minimal survey effort to get an idea of the broader mammalian community using juniper woodland habitat, with an emphasis on rare mesocarnivores. From this effort, we were able to capture western spotted skunk at 1 camera, which documents this species using rocky juniper habitat in the study area. The fact that we did not capture ringtails on camera is unsurprising, as ringtails are a very rare species in the region.

This project will continue into a 2nd field season, and we expect to continue to document the target species in the study area in order to perform occupancy analyses on small mammal species. As the new and renewed challenges of climate change, fire suppression, and energy development evolve, there is ample need to update and add to our understanding of these SGCN. With more information about the distributions and limitations of each species, we can make predictions about where these species occur, and continue to inform management regarding their needs and conservation requirements.

ACKNOWLEDGEMENTS

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Table 1. Species captured during small mammal surveys in southwestern Wyoming from 16 July through 2 September 2016. Target species are shown in bold. Historical percentages are from Rompola (2000) and include all habitat types trapped during 1998 and 1999. Historical data were not available for non-target species.

Scientific name	Common name	Captures	Sites detected (n=38)	% sites detected	% historical detection
Peromyscus crinitus	**Canyon deermouse**	**3**	**2***	**5***	**8**
Peromyscus truei	**Piñon deermouse**	**66**	**13**	**34**	**21**
Tamias dorsalis	**Cliff chipmunk**	**44**	**7**	**18**	**92**
Tamias minimus	Least chipmunk	27	4	10	-
Peromyscus maniculatus	North American deermouse	799	37	97	-
Neotoma cinerea	Bushy-tailed woodrat	21	10	26	-
Perognathus parvus	Great-Basin pocket mouse	2	1	3	-
Dipodomys ordii	Ord's kangaroo rat	18	5	13	-
Callospermophilus lateralis	Golden-mantled ground squirrel	2	2	5	-

*We subjectively selected sites where we captured canyon deermouse because of our interest to document the species in the study area. Data will not be used during occupancy modeling analyses because site selection methods deviated from the protocol used for all other sites.

Table 2. Mean ($\overline{X}$) and standard error (SE) for each habitat attribute at sites where each target small mammal species were ($\overline{X}_D$) and were not ($\overline{X}_N$) detected during surveys in southwestern Wyoming from 16 July through 2 September 2016. Means that are significantly different are signified by an asterisk.

Habitat attribute	*Peromyscus crinitus*		*Peromyscus truei*		*Tamias dorsalis*	
	$\overline{X}_N$	$\overline{X}_D$	$\overline{X}_N$	$\overline{X}_D$	$\overline{X}_N$	$\overline{X}_D$
Distance to cliff	129.7 (22.9)	6 (0.3)*	127.3(21.7)	115.4(51.3)	122.4(19.4)	126.8(90.7)
Distance to rock	52.6 (12.4)	2 (0.3)	60.9(17.4)	28.8(6.8)	54.9(14.4)	27.8(7.8)
Distance to edge	18.8 (26.1)	101 (36.7)	-19.6(32.7)	105.4(25.7)*	7.6(29.0)	92.2(34.7)
Rocky cover	2.6(0.7)	15(2.7)	2.9(0.9)	3.9(1.5)	3.6(1.0)	1.8(0.5)
Juniper cover	5.4(0.8)	7.2 (4.5)	4.0(0.8)	8.5(1.2)	5.3(0.8)	6.6(1.5)
Sagebrush cover	4.8(0.8)	0.5 (0.5)*	6.2(0.9)	1.3(0.3)	5.1(0.8)	1.9(0.7)
Herbaceous cover	8.9(1.4)	3.3 (2.3)	11.1(1.8)	3.7(1.0)	9.2(1.6)	5.9(2.0)

Table 3. Species detected during opportunistic deployment of remote cameras in southwestern Wyoming from 30 July through 29 September 2016 in rocky juniper (*Juniperus osteosperma*) habitat.

Scientific name	Common name	Sites detected (*n*=11)	% sites detected
Bassariscus astutus	Ringtail	0	0
Spilogale gracilis	Western spotted skunk	1	9
Vulpes vulpes	Red fox	4	36
Canis latrans	Coyote	6	54
Lynx rufus	Bobcat	3	27
Cervus canadensis	Elk	2	18
Antilocapra americana	Pronghorn	1	9
Odocoileus hemionus	Mule deer	5	45
Lepus spp.	Jackrabbit spp.	3	27
Sylvilagus spp.	Cottontail spp.	5	45
Aquila chrysaetos	Golden Eagle	1	9

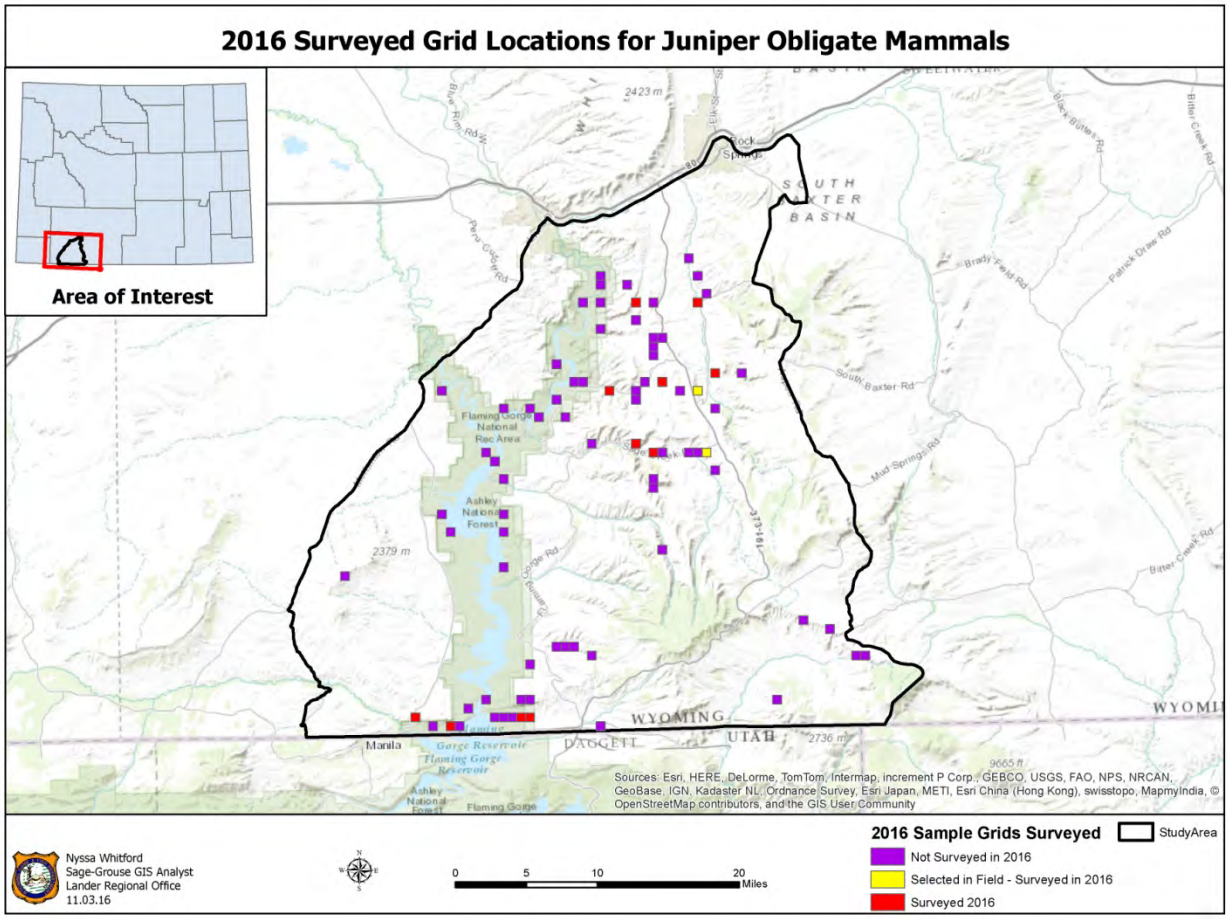

Figure 1. Grid cells surveyed for small mammals in piñon-juniper (*Pinus edulis-Juniperus osteosperma*) forests in southwestern Wyoming from 16 July through 2 September 2016. Grid cells that were randomly selected for survey are depicted in red, those that were subjectively selected for survey are shown in yellow, and those that were not surveyed are shown in purple.

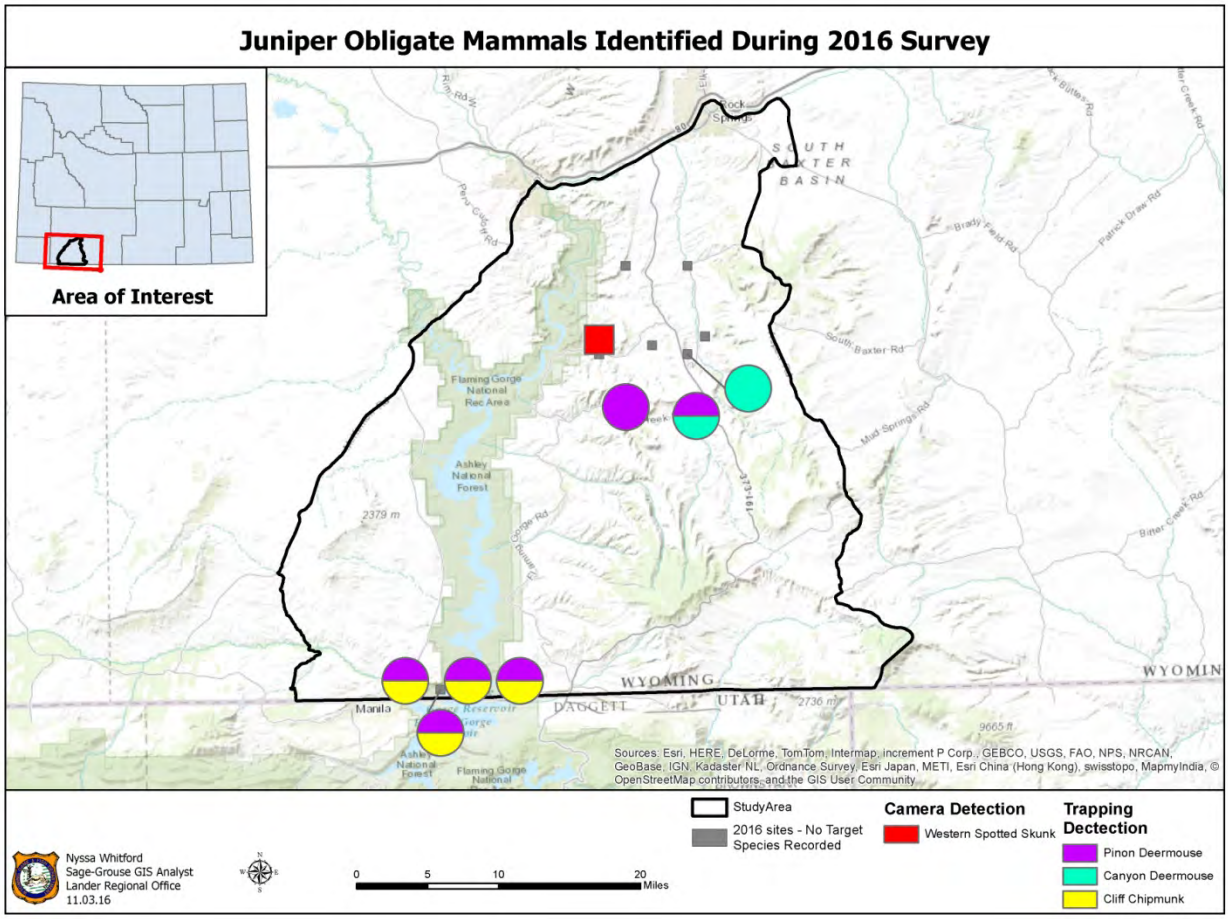

Figure 2. Target species detected in piñon-juniper (*Pinus edulis-Juniperus osteosperma*) forests in southwestern Wyoming from 16 July through 2 September 2016. Sites where piñon deermice (*Peromyscus truei*) were captured are shown in purple, sites where canyon deermice (*P. crinitus*) were captured are shown in teal, and sites were cliff chipmunks (*Tamias dorsalis*) were captured are show in yellow. The red square depicts the only detection of western spotted skunk (*Spilogale gracilis*) on a remote camera.

WYOMING POCKET MOUSE PROJECT

STATE OF WYOMING

NONGAME MAMMALS: Species of Greatest Conservation Need – Great Basin pocket mouse, Hispid pocket mouse, Olive-backed pocket mouse, Plains harvest mouse, and Silky pocket mouse

FUNDING SOURCE: Wyoming Governor's Endangered Species Account Fund

PROJECT DURATION: 15 March 2015 – 30 June 2017

PERIOD COVERED: 16 May 2016 – 26 August 2016

PREPARED BY: Kristina Harkins, Ph.D. Candidate, University of Wyoming
Dr. Merav Ben-David, Professor, University of Wyoming
Dr. Doug Keinath, Supervisory Fish and Wildlife Biologist, USFWS

ABSTRACT

Relative to other mid-latitude ecosystems, the sagebrush "sea" is often considered homogenous with little variation in vegetation structure and community composition. Nonetheless, soil composition, water, and nutrient availability can create variation on a local scale and result in diverse small mammal communities. Differences in community structure can further increase diversity as a result of biotic interactions, such as competition. Our recent discovery of a high diversity of small mammals inspired us to evaluate the effects of abiotic and biotic interactions on diversity of small mammals in the sagebrush sea. Using soil, vegetation, and small mammal data collected in summer 2015 and 2016 in 99 sites across Wyoming, we will assess the relative importance of biotic and abiotic factors in structuring small mammal communities in the sagebrush sea with isotopic and modeling approaches. Understanding the factors that influence diversity of small mammal communities in the Intermountain West will likely provide useful information for developing monitoring protocol for rare species, identify areas that merit special protection, and help conservation organizations and industry develop collaborative and sustainable plans for the sagebrush sea.

INTRODUCTION

Relative to other mid-latitude ecosystems, the sagebrush "sea" is often considered homogenous with little variation in vegetation structure and community composition (Xian et al. 2012). This low variation mostly results from slow responses of the plant community to large-scale disturbances such as fire. Nonetheless, soil composition, water, and nutrient availability

can create variation on a local scale (Parmenter and MacMahon 1983, Bradley 2010). Local variation may lead to diverse small mammal communities within the perceived homogeneous sagebrush sea. Habitat structure plays a crucial role in the composition and stability of small mammal communities (Ernest et al. 2008). However, a vast body of literature, accumulated over decades, documents the effects of biotic interactions (largely competition) on community composition, diversity, and species abundance (Schlesinger 1996). Thus, the diversity of small mammal communities in the sagebrush sea may be higher than expected based on habitat alone. During our recent large-scale studies (2015 and 2016) on the distribution and abundance of rare pocket mice (e.g., olive-backed pocket mouse [*Perognathus fasciatus*], Great Basin pocket mouse [*P. parvus*], and silky pocket mouse [*P. flavus*]; WGFD 2017) in Wyoming, we discovered unexpected variation in small mammal diversity. The distribution of these small granivores and their habitat associations are poorly documented, and their responses to the presence of competitors are unknown. In other systems, competition among guild members in small mammal communities can influence the abundance of dietary specialists and rare species by compressing their realized niches (White 2008). Experimental manipulations of desert rodents in the American Southwest have shown that the presence of interspecific competition can play a major role in organizing these communities and influencing species densities (Brown and Munger 1985). Thus, the habitat availability and inter-species interactions combined drive the species diversity within small mammal communities. Understanding the impacts of these processes on rare species will allow for better conservation planning for these species.

Further, the recent unprecedented increase in energy development, which largely occurs in the same habitats occupied by these rare small mammals, can have negative effects on these species. Recent studies have shown that this type of spatially extensive industrial development benefits generalist small mammals, including North American deermice (*Peromyscus maniculatus*; Abernethy 2011). Considering global and national demand for energy resources, it is likely that development will continue to expand throughout the American and Canadian West. Responses of wildlife to energy development are complex, variable, and scale-specific. For example, in Montana and Wyoming, studies have found that Greater Sage-Grouse (*Centrocercus urophasianus*) populations are declining due to fidelity of adult birds to traditional nesting areas that have been impacted by gas fields (Naugle et al. 2011). Similarly, pronghorn (*Antilocapra americana*) migration corridors have been severed due to energy development (Hebblewhite 2011). In addition to reduction in habitat availability and connectivity, disturbances from energy development can facilitate habitat alteration through invasive plant species. The effects of habitat alteration on biodiversity have not been fully considered (Naugle 2011), especially for species that are rare and considered poor competitors. Due to the risk of habitat destruction from energy development and potential increases in generalist competitors as a result of bioinvasions of non-native plants, there is a need to better define the distribution and habitat associations of small mammal species that are rare and difficult to detect. It is also imperative to quantify dietary overlap and niche partitioning between dietary specialists and generalists in these communities.

Our project centers on the following goals: 1) To create small mammal survey protocols that can be easily replicated and are designed to optimize the detection of rare and difficult to detect species (e.g., pocket mice); 2) To develop an occupancy-based monitoring plan for target species, which will result in baseline occupancy estimates across Wyoming's basins and allow

accurate evaluation of habitat associations that account for low detectability; and 3) To clarify habitat associations of the target species in Wyoming; the expected result will be improved habitat data for the sensitive and rare species surveyed in this project.

METHODS

We selected sites on public land in Wyoming that are <2,400 m in elevation and have <30% canopy cover. Original sites were randomly selected using the Generalized Random Tessellation Stratified sampling function in R and stratified by the 3 basin ecoregions in Wyoming (High Plains, Northwest Great Plains, and Wyoming Basin). Once initial sites were established, we identified additional paired sites using ArcGIS so that 2 sites could be surveyed simultaneously.

In 2015, with the aid of 3 technicians, we sampled 47 locations across Wyoming; an additional 52 sites were sampled in 2016 (Figure 1). At each site we established a 4 x 20 trapping grid with 25 m spacing. To test for the best protocol for increasing trap success for rare and difficult to detect species, we placed 1 Sherman live trap (H. B. Sherman Traps, Inc., Tallahassee, FL) and 1 Havahart trap (Woodstream Corporation, Knoxville, TN) at each grid point. We also used 3 bait types: peanut butter and oats, horse feed with molasses, and sterilized bird seed. Sites were trapped for 4 consecutive nights, with animals processed in the morning. Individuals were marked with ear tags unless the ear was too small, in which case the individual was tagged using a passive integrated transponder (PIT tag; AVID Microchip I.D. Systems, Folsom, LA). Measurements were taken to identify species and for all pocket mice species and sagebrush voles (*Lemmiscus curtatus*).

To determine occupancy and habitat associations for our target species, an array of vegetation and habitat variables were collected in the field and completed in the lab. Variables such as percent shrub cover, percent bare ground, species composition, dominant species, and shrub height were collected in the field using the Bureau of Land Management's line-point intercept method. Additionally, plant species richness was evaluated using plant clippings from each site that were collected to be used for stable isotope analysis. Soil samples were collected at each site and analyzed for salinity, pH, soil texture, and organic carbon. Occupancy modeling will be single-species, single-season analysis (MacKenzie et al. 2006).

In both years, we collected hair samples from each live-trapped individual for stable isotope analysis (Ben-David and Flaherty 2012). In addition, samples of potential dietary items (e.g., seeds, vegetation, insects) were collected from each site and preserved for analysis. We will quantify the dietary contribution of the various food items to the diet of the various small mammals using Bayesian mixing models by Stock and Semmens (2015). We will also estimate niche size and overlap among species using kernel estimators described by CAE (unpublished data). This will be followed by a series of hierarchical modeling approaches (Nupp and Swihart 2000, Lieb et al. 2012) to determine the relative importance of biotic and abiotic factors.

RESULTS

During the 2015 and 2016 field seasons, we captured 5,956 individuals of 19 species (10,893 captures; Table 1). There was a dramatic decrease in individual and total captures for most species in 2016 compared to 2015; only hispid pocket mouse (*Chaetodipus hispidus*), northern grasshopper mouse (*Onychomys leucogaster*), and thirteen-lined ground squirrel (*Ictidomys tridecemlineatus*) did not decrease capture numbers. Three new species were trapped in 2016 that were not captured in 2015: Wyoming ground squirrel (*Urocitellus elegans*), silky pocket mouse (*Perognathus flavus*), and long-tailed weasel (*Mustela frenata*). There was high spatial and temporal variation in species diversity across sites (Figure 2). Analyses of trap and bait preferences for pocket mice and other species of conservation concern are in progress. In March, as part of an occupancy modeling workshop, we will analyze the pocket mice data and begin writing the pertinent manuscripts above.

For the expansion of this project to a Ph.D., we started the stable isotope analyses on small mammal hair. Preliminary results suggest high species and spatial variation (Figure 3). Our goal is to quantify the dietary contribution of the various food items to the diet of small mammals using Bayesian mixing models (Stock and Semmens 2015) and estimate niche size and overlap among species using kernel estimators (CAE, unpublished data). We intend to relate the variation in small mammal diversity to abiotic factors, community composition, and niche partitioning.

DISCUSSION

The goal of this large-scale project, which constitutes a Master of Science thesis, is to evaluate habitat requirements and occupancy of these rare specialist species. The discovery of high diversity of small mammals inspired us to expand our investigation from solely exploring the effects of soil composition, habitat structure, and climatic effects on pocket mice, to evaluate the additional effects of biotic interactions on diversity of small mammals in the sagebrush sea by transitioning into a Ph.D. in Ecology. We believe this study will provide both theoretical insights and valuable management implications, given that more diverse ecosystems exhibit higher resilience to change and disturbance (Hooper et al. 2012) and sagebrush habitats are under pressure from continued energy development. To assess the effects of biotic interactions on small mammal diversity in sagebrush ecosystems, we will address the following questions using a combination of stable isotope analyses and various modeling approaches:

1. How do soil composition (e.g., grain size, moisture, salinity), terrain (e.g., aspect, slope), and nutrient availability affect plant community composition? How do these factors vary across the different Basins in Wyoming?
2. What is the relationship between soil, plant communities, and climatic factors and the diversity of small mammals?
3. How does the composition of the small mammal community influence niche partitioning? How do these interactions change with the abundance of common and rare species?
4. What is the relative effect of abiotic and biotic factors in structuring the small mammal communities of the sagebrush sea?

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Table 1. Number of individuals and total captures for each species during 2015 and 2016. Note the dramatic decrease in individual and total captures for most species in 2016 compared to 2015, and the 3 species trapped in 2016 that were not captured in 2015.

Species	Scientific Name	2015		2016	
		Individuals	Total	Individual	Total
North American deermouse	*Peromyscus maniculatus*	2,776	5,399	1,198	2,550
Ord's kangaroo rat	*Dipodomys ordii*	516	881	227	422
Western harvest mouse	*Reithrodontomys megalotis*	159	290	45	99
Olive-backed pocket mouse	*Perognathus fasciatus*	130	187	92	155
Least chipmunk	*Tamias minimus*	110	132	63	91
Sagebrush vole	*Lemmiscus curtatus*	170	188	23	24
Plains harvest mouse	*Reithrodontomys montanus*	101	140	4	5
Prairie vole	*Microtus ochrogaster*	91	98	15	15
Thirteen-lined ground squirrel	*Ictidomys tridecemlineatus*	43	57	42	47
Northern grasshopper mouse	*Onychomys leucogaster*	28	35	30	46
Hispid pocket mouse	*Chaetodipus hispidus*	5	6	17	29
Microtus vole species	*Microtus spp.*	12	18	3	3
Bushy-tailed woodrat	*Neotoma cinerea*	9	11	5	6
Great Basin pocket mouse	*Perognathus parvus*	9	12	1	1
Wyoming ground squirrel	*Urocitellus elegans*	0	0	9	10
Long-tailed vole	*Microtus longicaudus*	7	7	1	2
Plains pocket mouse	*Perognathus flavescens*	5	8	0	0
Escaped animal	Unknown	5	5	0	0
Montane vole	*Microtus montanus*	1	1	2	3
Cottontail rabbit species	*Sylvilagus spp.*	2	2	1	1
Silky pocket mouse	*Perognathus flavus*	0	0	1	2
Shrew species	*Sorex spp.*	1	1	0	0
Long-tailed weasel	*Mustela frenata*	0	0	1	1
Unknown squirrel	Sciuridae	0	0	1	1
Totals		4,179	7,478	1,782	3,517

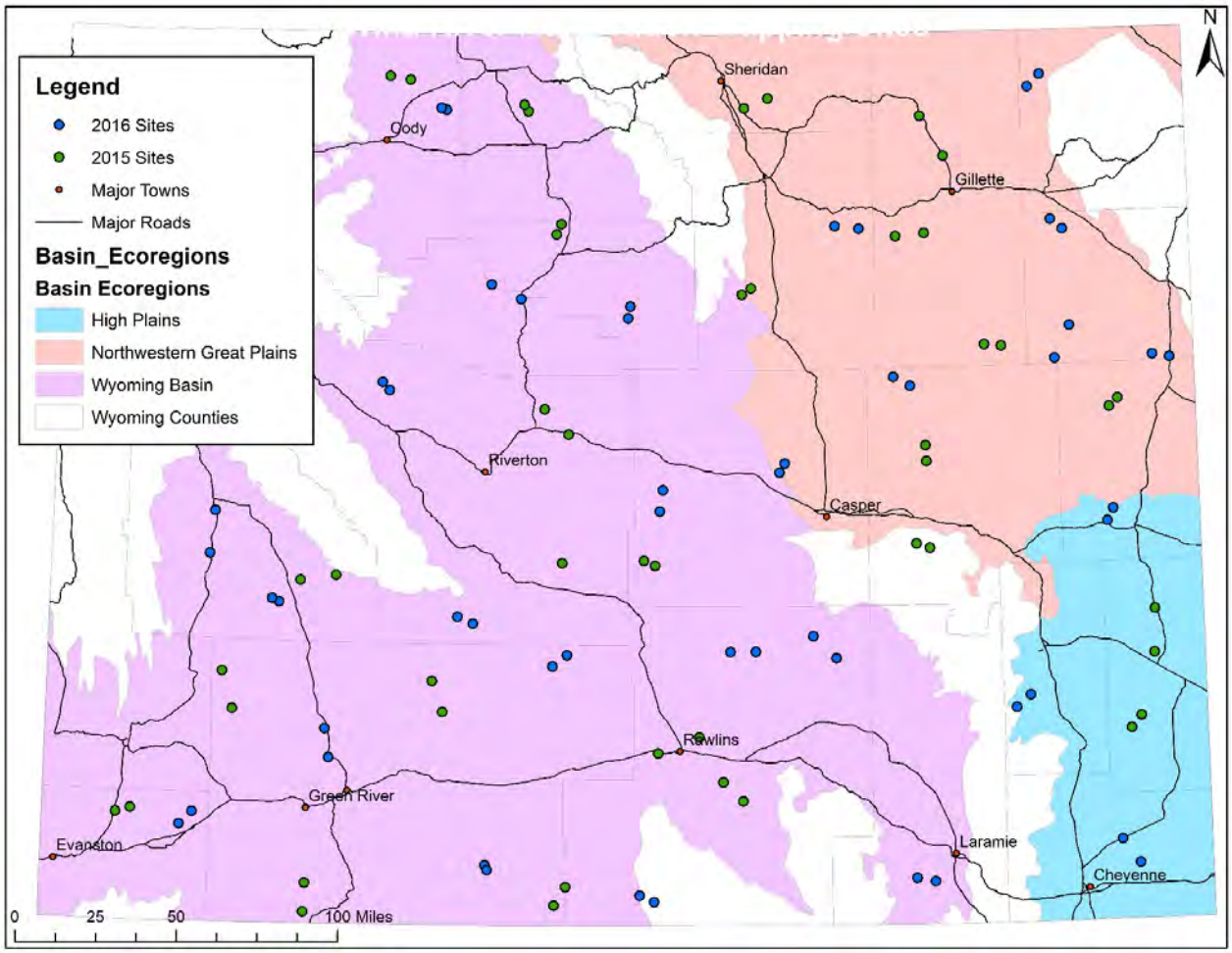

Figure 1. Small mammal sampling sites (47 in 2015 and 52 in 2016) in sagebrush habitats in Wyoming, 2015-2016 We stratified sites by ecoregion, and limited sites to public lands <2,400 m in elevation and with <30% canopy cover.

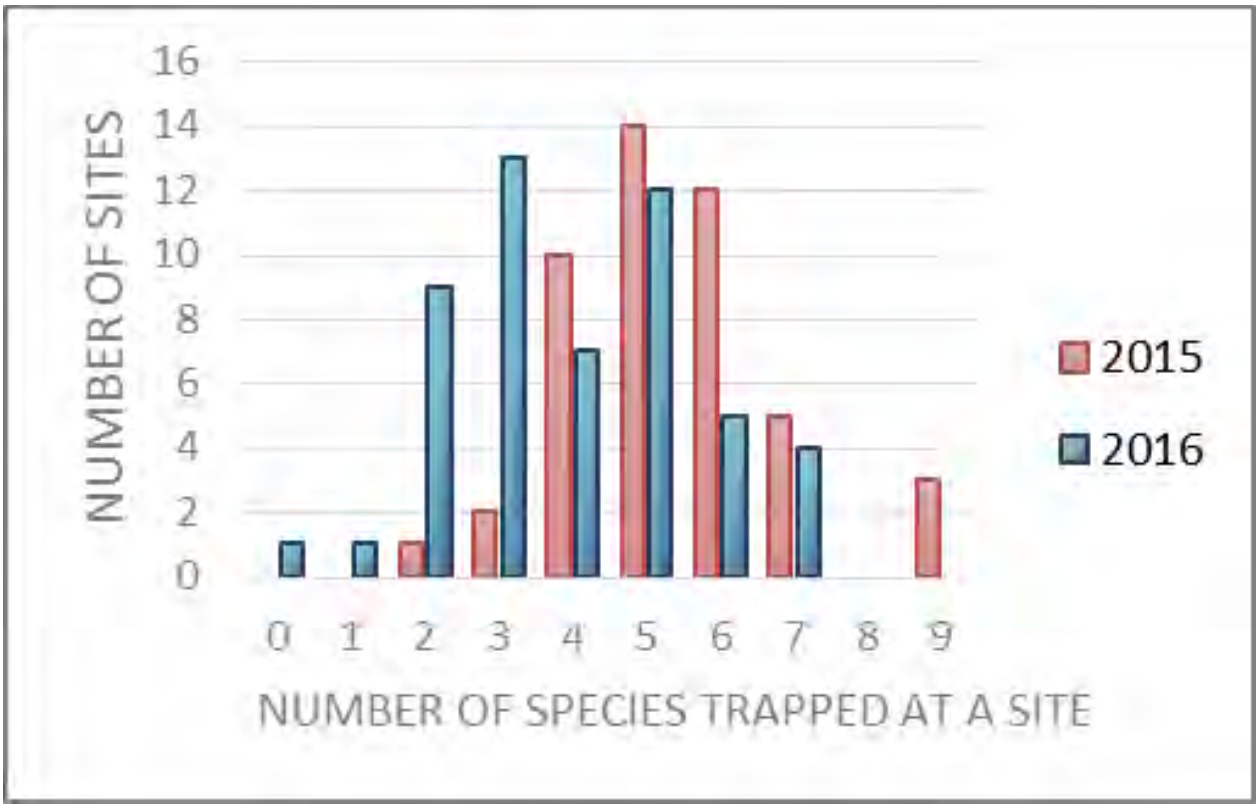

Figure 2. The number of unique species we trapped at a site was greater in 2015 than in 2016. In 2015, we captured a total of 4,179 unique individuals. In 2016, the number of unique individuals dropped to 1,782. The decrease in captures also resulted in a decrease in species richness per site.

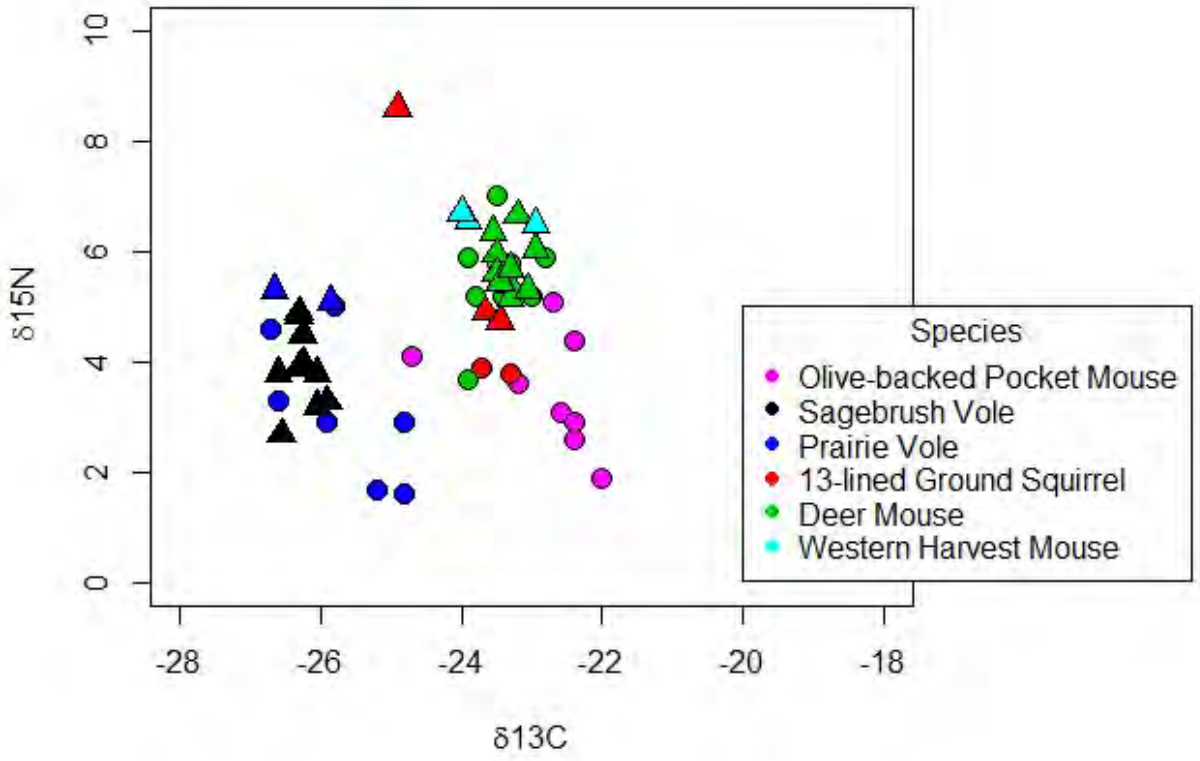

Figure 3. $\delta^{13}C$ and $\delta^{15}N$ of hair samples we collected at 2 sites (circles and triangles) in Wyoming in summer 2015, suggesting species and spatial variation.

STATUS OF THE WATER VOLE (*MICROTUS RICHARDSONI*) IN THE BIG HORN MOUNTAINS OF WYOMING

STATE OF WYOMING

NONGAME MAMMALS: Species of Greatest Conservation Need – Water Vole

FUNDING SOURCE: United States Fish and Wildlife Service State Wildlife Grant
Wyoming State Legislature General Fund Appropriations
United States Forest Service – Bighorn National Forest

PROJECT DURATION: 1 July 2015 – 30 June 2017

PERIOD COVERED: 1 May 2016 – 31 October 2016

PREPARED BY: Brian M. Zinke, Nongame Biologist
Gary P. Beauvais, Director, Wyoming Natural Diversity Database

ABSTRACT

The water vole (*Microtus richardsoni*) is a habitat specialist confined to alpine and subalpine streams. Due to its limited mobility, habitat specificity, small population sizes, and vulnerability, especially in the Big Horn Mountains, the water vole is listed as a Sensitive Species by the US Forest Service and a Species of Greatest Conservation Need by the Wyoming Game and Fish Department. We conducted live-trapping surveys in the Big Horn Mountains in 2016 as a follow-up to our 2014 surveys to increase records and create a baseline for future monitoring. Of the 28 sites surveyed in 2016, we detected water voles at 4. We detected water voles in 3 hydrologic unit codes that previously had no records of water voles, including the first 2 records from within the Cloud Peak Wilderness Area. Despite these new areas of detection, we captured 75% fewer water voles than in 2014, even though we had a greater survey effort. Water vole relative abundance did not increase with overall small mammal relative abundance, and no juveniles were captured. We resurveyed 3 sites where water voles had been detected in 2014, but had no repeat detections. We also resurveyed 6 historic sites, detecting water voles at only 1 site. The effects of livestock grazing and willow cover are of interest, but we still lack sufficient data to make any strongly supported conclusions on these variables. We suggest ways to improve survey efforts, including the use of more refined habitat criteria and shifting the timing of surveys. Decreasing relative abundance, lack of detections at historic sites, and indications of an under-saturated population are causes for concern. Between the 2014 and 2016 efforts, we have surveyed 21 of 33 hydrologic unit codes with sufficient water vole habitat, giving us a high level of confidence in this assessment. As such, we recommend that the water vole remain a high priority species in the Big Horn Mountains.

INTRODUCTION

The ebb and flow of historic glaciation cycles often left remnant populations of species restricted to mountain top refugias (Hafner and Sullivan 1995, Jannett 1999, Murray 1999, Smith 1999). Small mammals were particularly susceptible to these isolation events were due to their limited long-distance mobility. The water vole (*Microtus richardsoni*) is one such species (Hoffman and Koeppl 1985). Occurring at elevations between 914-3,201 m in the US, the water vole occupies a highly discontinuous range of mountainous habitat (Ludwig 1984). It is a habitat specialist typically restricted to linear stretches of habitat alongside alpine and subalpine streams, which are characterized as having narrow stream channels, a well-developed soil substratum, 8% (~5°) slope, and gravel bottoms (Pattie 1967, Hooven 1973, Anderson et al. 1976, Ludwig 1981, Getz 1985, Reichel 1986, Clark and Stromberg 1987, Ludwig 1988, Blankenship 1995).

Due to the water vole's narrowly defined habitat preferences and the patchy distribution of suitable habitat, movement between populations and habitat patches is limited (Klaus et al. 2001, Klaus and Beauvais 2004). Habitat and geomorphic features including large expanses of coniferous forests, valleys, and high-sloped mountainsides present physical barriers to dispersal for the water vole (Brown 1971, Ludwig 1988). Where water voles do occur, they live in groups of 8-40 individuals, with population densities remaining low (Hooven 1973, Anderson et al. 1976, Clark and Stromberg 1987, Ludwig 1988). Despite possessing the characteristics associated with high reproductive capabilities that other microtine rodents share (Hasler 1975, Brown 1977, Jannett et al. 1979), water vole populations remain small and do not exhibit the characteristic population cycles associated with other microtines (Pattie 1967, Anderson et al. 1976, Klaus 2003).

The combination of the water vole's habitat specificity, small population sizes, limited dispersal abilities, low colonization rates, and high extinction rates results in low population densities that are subject to habitat degradation and local extinction within the state (Brown 1971, Ludwig 1988, Friedlander 1995, Klaus et al. 1999, Keinath et al. 2003, Klaus 2003). Particularly, the species is much less common on the Bighorn National Forest (Forest) compared to the Shoshone National Forest in western Wyoming (Klaus and Beauvais 2004). As a result, the water vole has been listed as a Sensitive Species in the US Forest Service's (USFS) Region 2 and a Species of Greatest Conservation Need (SGCN) in the state of Wyoming by the Wyoming Game and Fish Department (Department; Friedlander 1995, WGFD 2017).

To address the lack of information about water voles in the Big Horn Mountains, the Department conducted surveys in 2014 and 2016, in collaboration with the Wyoming Natural Diversity Database (WYNDD) in 2016. Herein we report the methods and results from the 2016 survey efforts and discuss the combined results of both years' data. The objectives of these 2 combined surveys were to: 1) increase the records of known occurrences of water voles in the Big Horn Mountains; 2) estimate occupancy of water voles throughout the Big Horn Mountains to provide a baseline with which to monitor trends; 3) determine habitat components necessary for water vole presence; 4) evaluate the effects of livestock grazing management on water voles; 5) collect genetic samples to be stored for future analysis; 6) collect opportunistic records of other SGCN; and 7) analyze and update species distributions in the Wildlife Observation System,

State Wildlife Action Plan, and the Department's Atlas of Birds, Mammals, Amphibians, and Reptiles in Wyoming.

METHODS

The Big Horn Mountains are an island mountain range located in north-central Wyoming. The Forest covers 451,254 ha of the Big Horn Mountains, which includes the areas of highest elevation (USFS 2017). Because the water vole requires these high elevations, all our sites were located on Forest lands. Additionally, in 2016 we expanded our efforts and surveyed 2 sites in the Stough Creek Basin of the Wind River Range in the Shoshone National Forest in order to compare our results from the Forest.

In 2014, we defined suitable habitat for water voles as a 1st or 2nd order stream, ≥2400 m in elevation, and with a slope ≤8%. We laid a 1.6 × 1.6 km grid system over the Big Horn Mountains, and any cells with <50% suitable habitat were excluded. We then sorted grid cells by slope and excluded cells with <8% of the area having the target slope. Of the remaining 93 cells, we randomly selected cells to survey.

After the first year of surveys we realized that water vole numbers were lower than we had anticipated. With than in mind, we redesigned the survey efforts in 2016 to be better suited for occupancy analysis. Instead of using a grid overlay we switched to a hydrologic unit code (HUC) -based approach because it was a more biologically sensible approach, using watersheds as the basic sampling unit for a riparian-obligate species. By using the randomly selected HUCs as our basic sampling unit, we were then able to select preferred habitat within that unit in which to sample, increasing our odds of detecting water voles. Thus, by randomly selecting HUCs we were still able to perform statistical analyses without violating that assumption.

We divided the Big Horn Mountains into 3 geographic areas (north, central, and south) to stratify our sampling, focusing more effort in the north where water voles are more likely to occur based on historic records. Within each geographic area, we randomly selected 12-digit HUCs in which to survey. Within each HUC, we determined survey sites based on suitable habitat for water voles. The only different criteria we used to define suitable habitat from 2014 was that we prioritized sites in subalpine meadow, mixed grass prairie, or mountain big sagebrush (*Artemisia tridentata*) habitat types (Figure 1, Appendix 1). We focused survey efforts on these habitat types because they are the habitats in which water voles had been documented during our 2014 survey and in historic records. Additionally, we received permission from the Forest to survey 4 sites within the Cloud Peak Wilderness Area (Wilderness), an area we excluded in 2014. We also excluded HUCs lacking suitable water vole habitat, which resulted in several HUCs being surveyed multiple times.

We trapped each site for 4 consecutive nights, with 2 sites being trapped simultaneously. We placed a trapping transect, consisting of approximately 200 Sherman live-traps (Model #339A; H.B. Sherman Traps, Inc., Tallahassee, FL), parallel to 1 edge of the stream. We positioned the traps within 3 m of the stream and 3 m apart. Each transect was approximately 600 m long. We baited traps with 3-way grain mix with molasses (Ranch-Way Feeds, Inc., Fort

Collins, CO), and supplied traps with Poly-fil bedding to reduce temperature-related fatalities. We left traps open all day checking them twice, once starting within 30 minutes of sunrise and once at approximately 1700 hours. Trapping intervals were calculated following the method outlined by Klaus (2003).

When an individual was captured, we removed it from the trap by using a gallon-sized Ziploc bag. For all captured individuals, we recorded time of day, trap number, species, weight, sex, age, reproductive condition, and whether it was dead or alive. For voles (*Microtus* spp.), we measured hind foot length and tail length as needed. We identified water voles based on a hind foot length of ≥25 mm (including claws) or ≥23 mm (without claws; Ludwig 1984, Clark and Stromberg 1987). If the captured individual was a water vole, we scanned it to determine if it had been previously captured, and tagged new captures with a passive integrated transponder (PIT tag; AVID Microchip I.D. Systems, Folsom, LA). If tagged previously, we recorded the unique identifying number. If no tag was detected, we sedated the individual in the Ziploc bag by using isoflurane. Once the animal was sedated, we injected a PIT tag and recorded the unique identifying number. We also collected a genetic sample from water voles by using a 2-mm ear punch (World Precision Instruments, Sarasota, FL), which we stored in a 1.2-ml vial containing 85% ethanol. Additionally, the number of tubercles (foot pads) on the hind feet of water voles were counted and recorded. We followed the guidelines on capture and handling techniques outlined by Cudworth et al. (2013).

We recorded stream slope (%) by using a Suunto PM-5/360 PC clinometer (Suunto, Vantaa, Finland), taking readings at traps 1, 100, and 200. Traps were numbered starting upstream with trap 1 and ending downstream at trap 200. Looking upstream, 2 observers took a reading at each location, which were averaged to reduce observer bias. We then averaged the readings from all 3 locations to obtain the average slope of the stream segment.

We recorded stubble height measurements by using a modified version of the method used by the Forest. Starting at trap 1 and walking within the riparian zone along the edge of the stream, we took 10 paces moving downstream. We placed the 10th pace blindly to reduce bias. Upon placement of the 10th pace, we located the nearest sedge (*Carex* spp.) ≤6 inches (15.24 cm) in front of the toe of the boot. If no sedges were found in front of the boot, we searched the area within 15.24 cm of the outside of the boot. Again, if no sedges were found, we searched the area within 15.24 cm of the inside of the boot. If still no sedges were found, we skipped the sample and performed another 10 paces. When a sedge was present, we measured the height of the longest leaf to the nearest half inch. However, if the sedge was in a place inaccessible to grazers (e.g., under a willow, trampled) we skipped the sample. The process was repeated for the length of the trapline. Our goal was to obtain ≥50 stubble height measurements, but that was not always possible based on the abundance of sedges in an area. Additionally, we noted any signs that grazing had occurred or if domestic livestock were present in the area.

We measured willow (*Salix* spp.) cover by using a modified Daubenmire frame method (Daubenmire 1959). Starting at trap station 1, we dropped the 50 x 50-cm frame approximately 1 m from the stream edge. We estimated aerial cover of willows within the frame to the nearest percent. We also recorded the height of the tallest living willow branch within the frame to the

nearest half cm. Working downstream, we performed 20 paces between each sample for a total of 30 samples per site.

RESULTS

In 2016, we recorded 16,748.5 trap intervals in the Big Horn Mountains, averaging 598.2 intervals across 28 sites. We captured 2,028 small mammals, 11 carnivores, and 1 bird (Table 1). Of the 2,028 small mammal captures, 4 were water voles. We surveyed sites in 6 different habitat types, capturing water voles in 3 (Table 2). In the Wind River Range, we recorded 445.0 trap intervals, averaging 222.5 intervals across 2 sites. We captured 22 small mammals, 12 of which were water voles. Both sites surveyed were in the lodgepole pine (*Pinus contorta*) habitat type. In 2016, we surveyed sites in 20 HUCs, detecting water voles in 4 (Figure 3). Comparatively, we surveyed 9 HUCs in 2014, detecting water voles in 3 (Figure 4). These new records expand our knowledge of known water vole locations (Figure 5).

Water voles were more successfully captured during overnight trapping efforts than daytime trapping in both years as well as both mountain ranges (Table 3). Additionally, water voles were not captured before 15 July in either year (Table 4). In 2014, water vole relative abundance decreased as overall small mammal relative abundance increased (Figure 2). In 2016, that relationship seemed to stabilize, although the data are not strongly supported.

Slope was not significantly different between sites of detection and non-detection in 2016 (Table 5). Willow height and willow cover also were not significantly different between sites of detection and non-detection (Table 6). Sites where water voles were detected tended to have greater stubble heights than sites where they were not detected, although this difference was not significant. However, we cannot reject the null hypothesis because the confidence interval crosses zero (Table 6).

Finally, we collected genetic samples from water voles in both 2014 and 2016. In 2014, we obtained 5 samples from the Big Horn Mountains. In 2016, we collected 3 samples from the Big Horn Mountains and 10 samples from the Shoshone National Forest. We have stored these samples in alcohol to be preserved for any future genetic studies on water voles in Wyoming.

DISCUSSION

Water voles are known to be rare in the Big Horn Mountains and, after 2 extensive field seasons, our data support this notion. Of the 47 unique sites we surveyed (3 were surveyed twice), water voles were only detected at 8 sites. Out of the 2,796 small mammals captured, only 20 were water voles (0.7%). Despite these low numbers, we did document water voles in 7 HUCs, 3 of which previously had no records. These new HUCs include the first known records from within the Wilderness (Figures 3-5).

When Klaus (2003) conducted surveys in 1999 and 2000, she found that water vole relative abundance increased as overall small mammal relative abundance increased (Figure 2).

However, in 2014 we found the opposite trend, and in 2016 water vole relative abundance was consistent regardless of small mammal abundance. It is interesting to note that 2014 was a relatively wet year while 2016 was fairly dry. This is important because it indicates that these stable or decreasing trends are not an artifact of good or bad years; rather they show both ends of the spectrum, neither of which resulted in increasing numbers of water voles when compared to all small mammals. These trends could be the result of competition with other small mammal species, natural cycles in water vole abundance, or changes in habitat, and require further evaluation. Additionally, we captured no juveniles this year (compared to 6 juveniles in 2014), yet we had nearly 1,300 more small mammal captures overall. While we documented reproduction in most small mammals, we were unable to do so for water voles. Of the 4 water voles captured this year only 1 of the males was showing signs of being reproductively active, while the only female captured did not show signs of reproductive capabilities at that time.

In the Big Horn Mountains, water voles were restricted to subalpine meadow, mountain big sagebrush, mixed grass prairie, and clearcut conifer habitat types, based on GIS layers. However, available GIS layers are crude on such a large scale and likely outdated. For instance, the clearcut conifer habitat did not appear to be recently clearcut during our surveys. Additionally, in the Shoshone National Forest we captured water voles in lodgepole pine habitats, based on GIS layers, which is not a habitat type in which we would expect to find them. We primarily used the GIS layers to identify potential survey locations, then ground-truthed them to determine if they were suitable water vole habitat. Although this process is not ideal, until more precise and updated GIS layers are available, our precision in perfectly locating water vole habitat from computer-based programs will remain limited.

Water voles are known to use streams with slopes of ≤8%, and our results support this, but to an even more restricted degree. We only captured water voles at sites with a slope of ≤3% in the Big Horn Mountains. This could be the result of an under-saturated population. For instance, because water voles are rare in the Big Horn Mountains, they might only be occupying the most ideal habitats (e.g., streams with lower slopes). Further evidence that this scenario might be occurring is that we captured 10 water voles at a site in the Shoshone National Forest with a slope of 6.8%. In the Shoshone National Forest, water voles are much more abundant, thus they might be forced to use less than ideal stretches of streams.

Willow cover has also been suggested as a vital habitat component for water voles, especially where domestic livestock are present (Klaus 2003). Willows potentially provide protection to stream banks from trampling, which would compact the soils in which water voles construct their burrows (Klaus 2003). Because domestic sheep and cattle are abundant in the Big Horn Mountains, the Department and the Forest, who manages the grazing allotments for mixed-use, are interested in any effects that livestock may have on water voles. We captured water voles at sites with varying degrees of willow cover, with 1 having no willows at all. However, this particular site was one where livestock grazing is no longer permitted in the Wilderness (Paint Rock Creek). Further, we captured a water vole on North Clear Creek in the Wilderness, also an area with no livestock grazing but with moderate willow cover (Figure 6). Although we could not conclude that willows provide areas of refuge from livestock along stream banks, our dataset is too small to adequately evaluate this question. A larger dataset would allow us to determine if willows do shelter water vole habitat from livestock, and specifically address any

livestock/willow interaction effects. Additionally, a greater sample size would also help our stubble height data, which showed taller stubble heights where water voles were captured but could not be supported statistically. The Forest already has several areas with altered grazing restrictions where water voles were historically known to persist, but little has been done to evaluate the effects of the altered guidelines on water voles. As mentioned above, it is interesting to note that of the 4 sites where we captured water voles in 2016, 2 of them were in areas without livestock grazing.

One of the main goals of this project was to obtain occupancy and detection rates of water voles in the Big Horn Mountains. However, because we captured so few water voles we were unable to achieve this objective. Despite this setback, we have created a solid foundation for future monitoring of water voles in the Big Horn Mountains. We designed a survey method that can be used to obtain occupancy and detection rates, given sufficient detections, and have provided a baseline of data that can be used to monitor trends in water vole presence and abundance over time. We can, however, make some anecdotal observations. In 2016, we resurveyed 3 of the 4 sites that detected water voles in 2014, but failed to have any repeat detections at these sites. We also surveyed 6 historic water vole sites, detecting water voles at only 1 site. These observations suggest that the presence of water voles at a site is highly variable from year to year and over time.

To better understand the distribution and trends of water voles in the Big Horn Mountains, we need more survey efforts. The lack of data is the major hindrance in developing management goals and actions. Once a sufficient baseline is obtained, it would be ideal to set up a continued monitoring effort. In order to conduct monitoring as efficiently and effectively as possible, we provide the following suggestions:

1) *Delay surveys until later in the summer*. Klaus (2003) only captured water voles at 1 site during the May – early June trapping session, compared to all 6 sites during the late trapping season of late July – early August. We also never captured a water vole before 15 July in either year, yet we started surveys in early to mid-June. By delaying survey efforts 1 month, we could reduce the resources needed or reallocate those resources to assist with other SGCN surveys for the first month.

2) *Limit trapping efforts to overnight only*. Over both years combined on the Forest, we captured 70% (14) of water voles in the morning checks despite only 55.8% of our trapping effort taking place overnight. In the Shoshone National Forest, we captured 75% (9) of water voles in the morning checks with only 57.9% of our effort occurring overnight. Further, 75% (2,113) of all small mammal captures across both National Forests occurred in the morning checks while only accounting for 55.7% of our survey effort. By closing traps during the day, it would be possible to reduce the amount of time needed in the evenings to check/reopen traps without losing a substantial amount of data.

When designing future surveys, we suggest taking the following into consideration:

1) In the Big Horn Mountains specifically, surveys targeting streams with lower slopes (≤3%) would likely have higher success rates than the 8% slope that the literature suggests range-

wide. Because water voles are rare in the Big Horn Mountains, they are likely using the most ideal habitat available and may not be on the fringes of those habitat guidelines. Targeting these refined habitat conditions first will likely be the most cost effective method to maximize detections.

2) A flaw in our study design was taking stubble height measurements throughout the summer as we were at each site. As a result of this, our stubble height measurements towards the end of summer were taller because of the extended growth time and not comparable to measurements taken earlier in the summer. In the future, coming back to each site at the end of the field season and recording stubble height would ensure fewer temporal effects and allow for stronger statistical analyses.

3) Designing a project to specifically address how the presence of livestock, type of livestock, interaction of livestock and willows, and varying stubble heights affect water vole presence would be highly desirable. Our 2016 survey touched on these topics, but a more comprehensive approach to these topics is necessary to elucidate any effects.

Decreasing relative abundance, lack of detections at historic sites, and indications of an under-saturated population are causes for concern. For a species with limited mobility, it is less likely that individuals are moving to different areas over long distances; rather, it is more likely that populations are disappearing. Whether this represents a long-term decline or natural fluctuations in a metapopulation requires further study. We have surveyed 21 of 33 HUCs (63.6%) that contain a sufficient amount of suitable water vole habitat to survey, giving us a high level of confidence in this assessment. As such, it is our recommendation that the water vole remain a high priority species on the Forest.

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Table 1. All captures by species in the Big Horn Mountains of Wyoming in 2014 and 2016. The data from 2014 are from Zinke (2014).

Year	Common name	Scientific name	Total captures
2014	Vole species, unidentified	*Microtus* spp.	230
	Southern red-backed vole	*Myodes gapperi*	158
	Deermouse species, unidentified	*Peromyscus* spp.	114
	Water shrew	*Sorex navigator*	73
	Least chipmunk	*Tamias minimus*	53
	Western jumping mouse	*Zapus princeps*	23
	Montane vole	*Microtus montanus*	19
	Red squirrel	*Tamiasciurus hudsonicus*	18
	Water vole	*Microtus richardsoni*	16
	Shrew species, unidentified	*Sorex* spp.	15
	Masked shrew	*Sorex cinereus*	12
	Dusky shrew	*Sorex monticolus*	9
	Ermine (short-tailed weasel)	*Mustela erminea*	1
	Long-tailed vole	*Microtus longicaudus*	1
	Dark-eyed Junco	*Junco hyemalis*	1
	Total		743
2016	Vole species, unidentified	*Microtus* spp.	1220
	Western jumping mouse	*Zapus princeps*	504
	Montane vole	*Microtus montanus*	103
	American deermouse	*Peromyscus maniculatus*	91
	Water shrew	*Sorex navigator*	33
	Shrew species, unidentified	*Sorex* spp.	23
	Least chipmunk	*Tamias minimus*	22
	Southern red-backed vole	*Myodes gapperi*	19
	Ermine (short-tailed weasel)	*Mustela erminea*	10
	Long-tailed vole	*Microtus longicaudus*	5
	Water vole	*Microtus richardsoni*	4
	Meadow vole	*Microtus pennsylvanicus*	2
	Dusky shrew	*Sorex monticolus*	1
	Long-tailed weasel	*Mustela frenata*	1
	Northern pocket gopher	*Thomomys talpoides*	1
	White-crowned Sparrow	*Zonotrichia leucophrys*	1
	Total		2,040

Table 2. Number of sites we surveyed by habitat type in 2014 and 2016, and number of sites in each habitat type in which water voles (*Microtus richardsoni*) were detected in the Big Horn Mountains of Wyoming. The data from 2014 are from Zinke (2014).

Habitat type	# Sites surveyed		# Sites with water voles	
	2014	2016	2014	2016
Subalpine meadow	7	19	2	2
Lodgepole pine	5	1	0	0
Clearcut conifer	5	1	0	1
Mountain big sagebrush	3	2	2	0
Mixed grass prairie	2	4	0	1
Shrub-dominated riparian		1		0
Totals	22	28	4	4

Table 3. Water vole (*Microtus richardsoni*) capture success and trapping effort by mountain range and time of day in 2014 (BMZ, unpublished data) and 2016 in Wyoming.

Location	Year	Time of day	Trap intervals[a]	Water vole captures	Water voles/100 trap intervals
Big Horn Mountains	2014	Morning	8169.5	11	0.13
		Evening	6480.0	5	0.08
	2016	Morning	9340.0	3	0.03
		Evening	7408.5	1	0.01
Wind River Range	2016	Morning	257.5	9	3.50
		Evening	187.5	3	1.60

[a] Trap intervals were calculated using a modified version of Klaus' (2003) method. Morning/evening (half) trap interval = (0.5 × number of traps) – [(number of false closures + number of captures) × 0.5], where 1 interval = 24 hours

Table 4. Date and location of each water vole (*Microtus richardsoni*) captured in the Big Horn Mountains of Wyoming in 2014 and 2016. For each water vole, we recorded age, weight, sex, reproductive condition, and hindfoot length. The data from 2014 are from Zinke (2014).

Year	Stream	Age[a]	Weight (g)	Sex	Reproductive condition	Hind foot length (mm)[b,c]
2014	Unnamed Tributary to Granite Creek					
	15 July	Class I	25	F	No	25
	16 July	Class II	56	M	No	29
	16 July	Class I	29	F	No	29
	17 July	Adult	149	M	Yes	29
	17 July	Class I	29	F	No	28
	West Fork South Tongue River					
	17 July	Adult	111	M		27
	17 July	Class II	73	F	Yes	26
	18 July	Adult	105	F	Yes	26
	19 July	Class I	46	F	No	27
	East Fork South Tongue River					
	29 July	Adult	120	M	No	28
	30 July	Class II	50	F	No	26
	30 July	Adult	109	F	Yes	26
	1 August	Class II	50	F	No	26
	1 August	Class I	48	F	No	26
	1 August	Class I	44	F		27
	Big Willow Creek					
	14 August	Class II	58	M	Yes	27
2016	Duncum Creek					
	2 August	Class II	52	M	Yes	25 [24]
	Bald Mountain Creek					
	5 August	Adult	114	M	No	[24]
	Paint Rock Creek					
	17 August	Class II	56	M	No	26 [25]
	North Clear Creek					
	19 August	Class II	64	F	No	25 [23]

[a] Age classes follow those outlined by Klaus et al. (1999).
[b] Water vole hindfoot measurements are ≥25 mm (with claws) or ≥23 mm (without claws). In 2014 we measured with claws, and in 2016 we measured with and without.
[c] Measurements = without claws [with claws]

Table 5. Slopes of the stream segments we surveyed for water voles (*Microtus richardsoni*) in 2014 and 2016 in the Big Horn Mountains of Wyoming. The 2014 slopes are for the subalpine meadow and mountain big sagebrush (*Artemisia tridentata*) habitat types only, as water voles were not captured in any of the others. In 2016, we focused survey efforts on subalpine meadow, mountain big sagebrush, and mixed grass prairie habitat types, thus the slopes are for all habitat types surveyed that year. The data from 2014 are from Zinke (2014).

Year	Slope (%) Capture sites (n = 4, 4)	Non-capture sites (n = 6, 24)	t	df	P-value
2014	1.50	2.86	2.24	6.32	0.06
2016	2.45	3.44	1.76	5.42	0.13

Table 6. Willow (*Salix* spp.) cover, willow height, and stubble height averages for sites at which water voles (*Microtus richardsoni*) were captured and not captured in the Big Horn Mountains of Wyoming in 2016.

Characteristic	Capture sites (n = 4)	Non-capture sites (n = 24)	t	df	P-value
Willow cover (%)	15.94	15.06	-0.10	3.96	0.92
Willow height (cm)	34.82	56.93	1.23	13.45	0.24
Stubble height (in)	10.08	7.41	-2.44	5.27	0.056

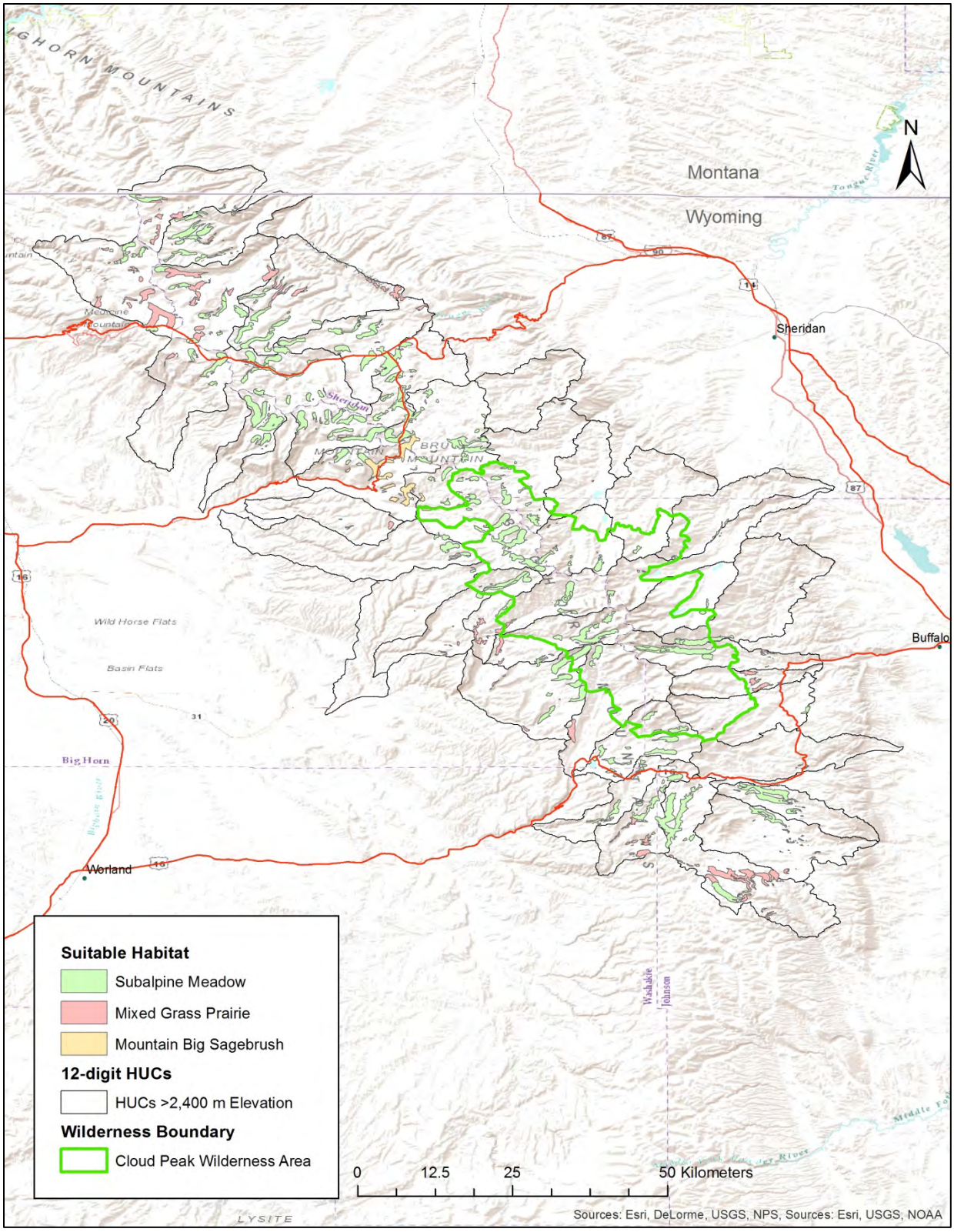

Figure 1. Overlay of 12-digit hydrologic unit codes (HUCs) on the Big Horn Mountains of Wyoming. Suitable habitat for water voles (*Microtus richardsoni*) was based on historic records.

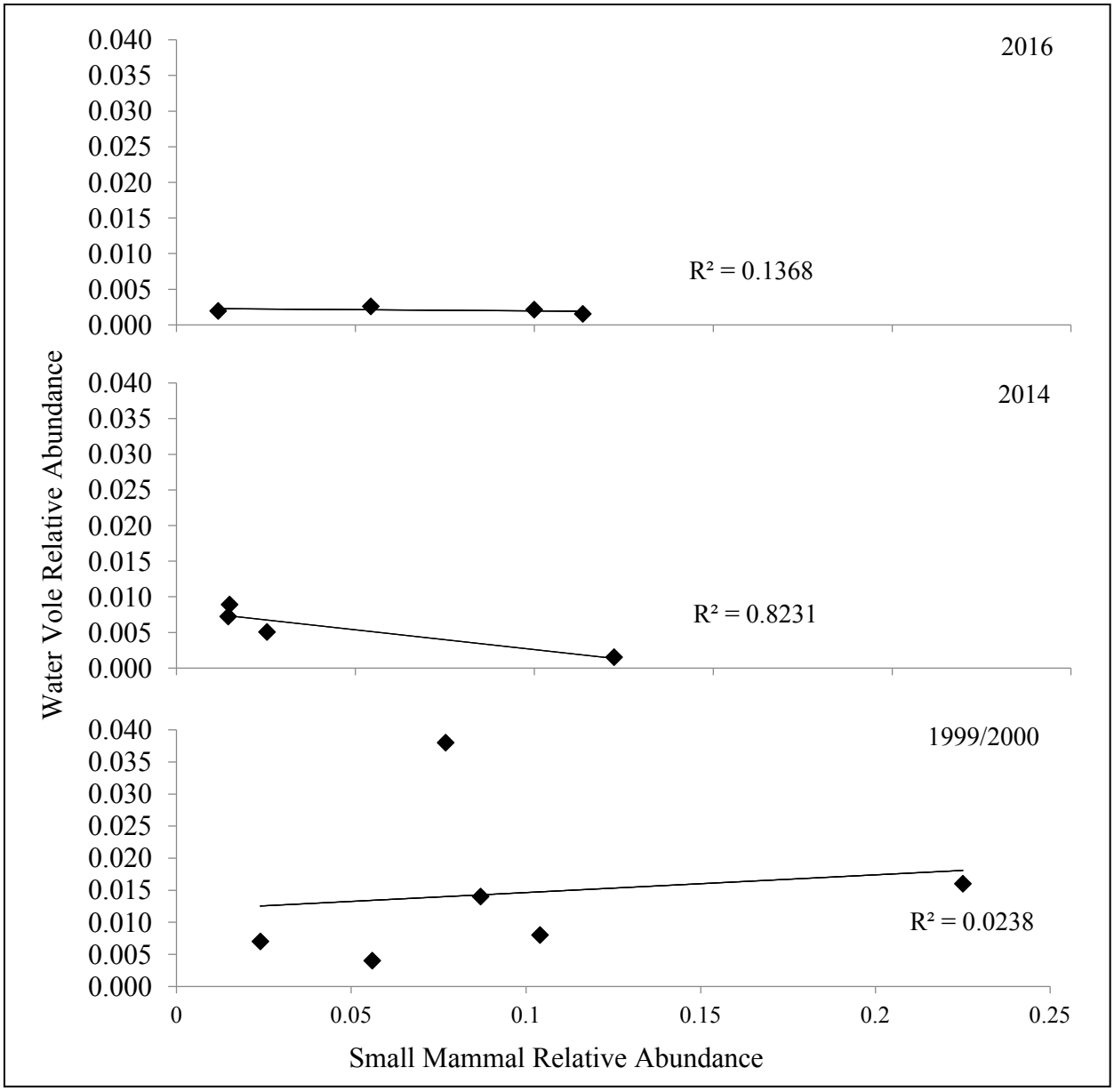

Figure 2. Relative abundance of the water vole (*Microtus richardsoni*) compared to the relative abundance of the overall small mammal community in the Big Horn Mountains in 2016 (this study), 2014 (BMZ, unpublished data), and 1999/2000 (Klaus 2003). Relative abundance = number captured/trap interval.

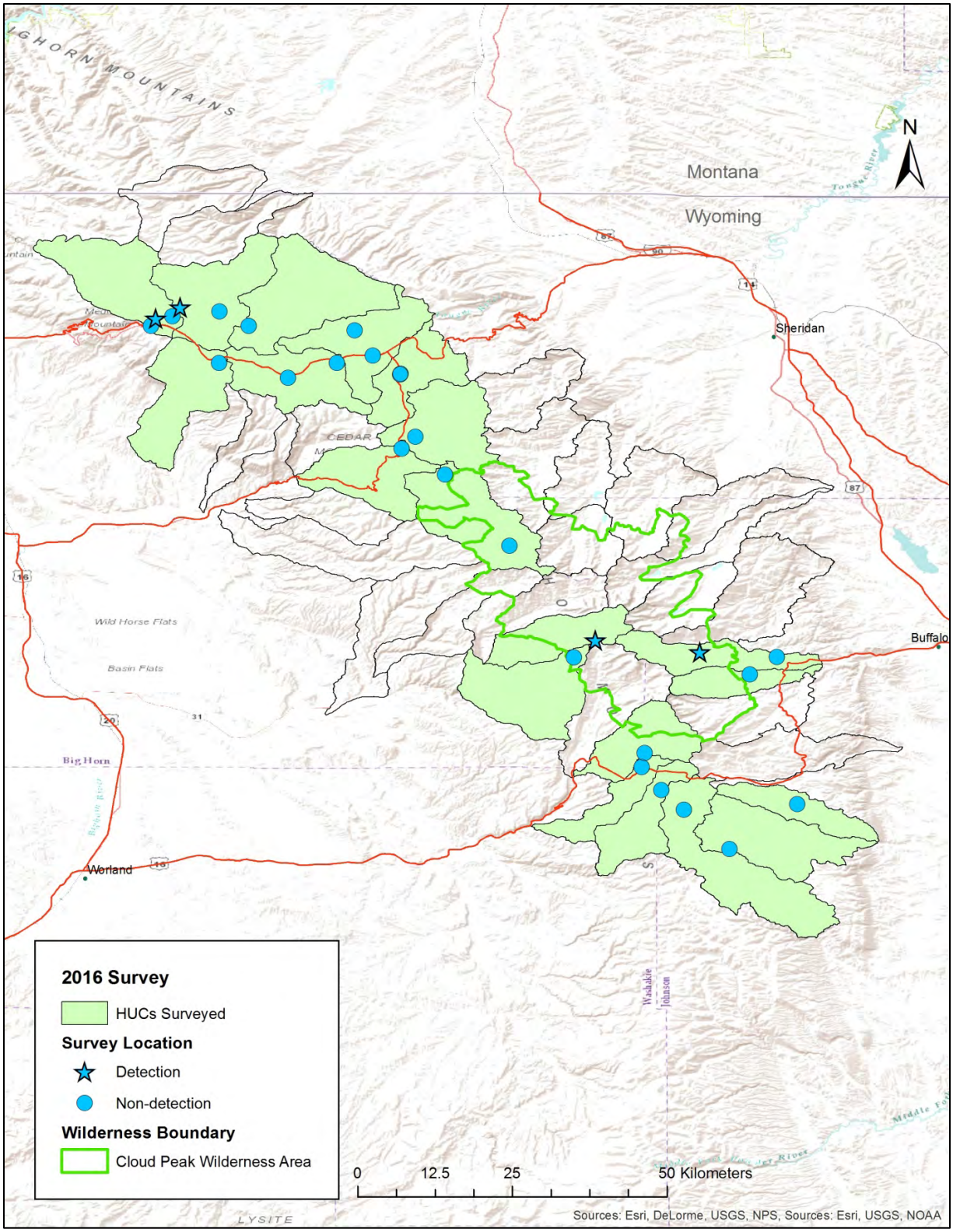

Figure 3. Hydrological unit codes (HUCs) and specific locations where surveys were conducted for water voles (*Microtus richardsoni*) in the Big Horn Mountains of Wyoming in 2016. Sites where voles were detected are designated by a blue star.

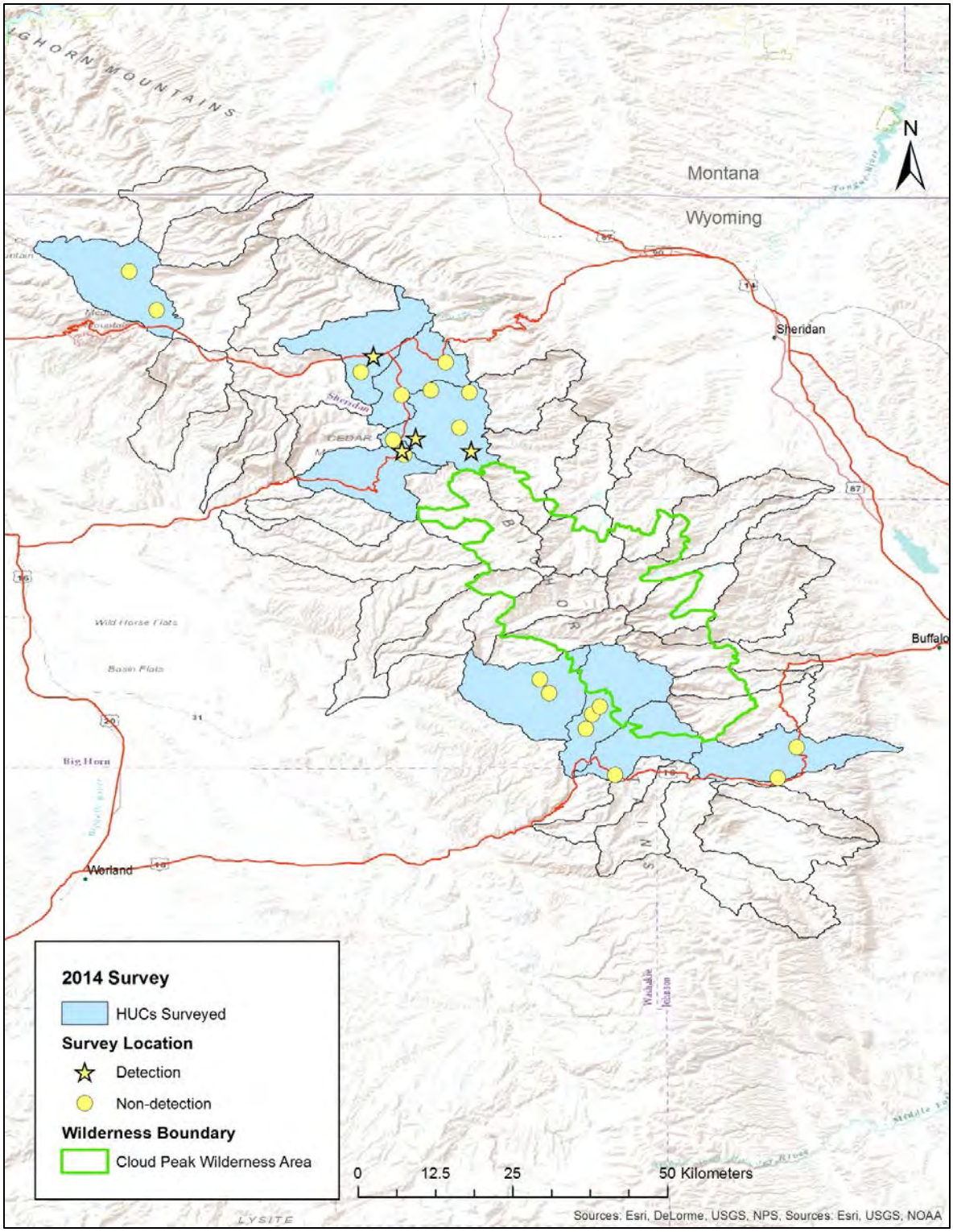

Figure 4. Hydrological unit codes (HUCs) and specific locations where surveys were conducted for water voles (*Microtus richardsoni*) in the Big Horn Mountains of Wyoming in 2014. Sites where voles were detected are designated with a yellow star. The data from 2014 are from Zinke (2014).

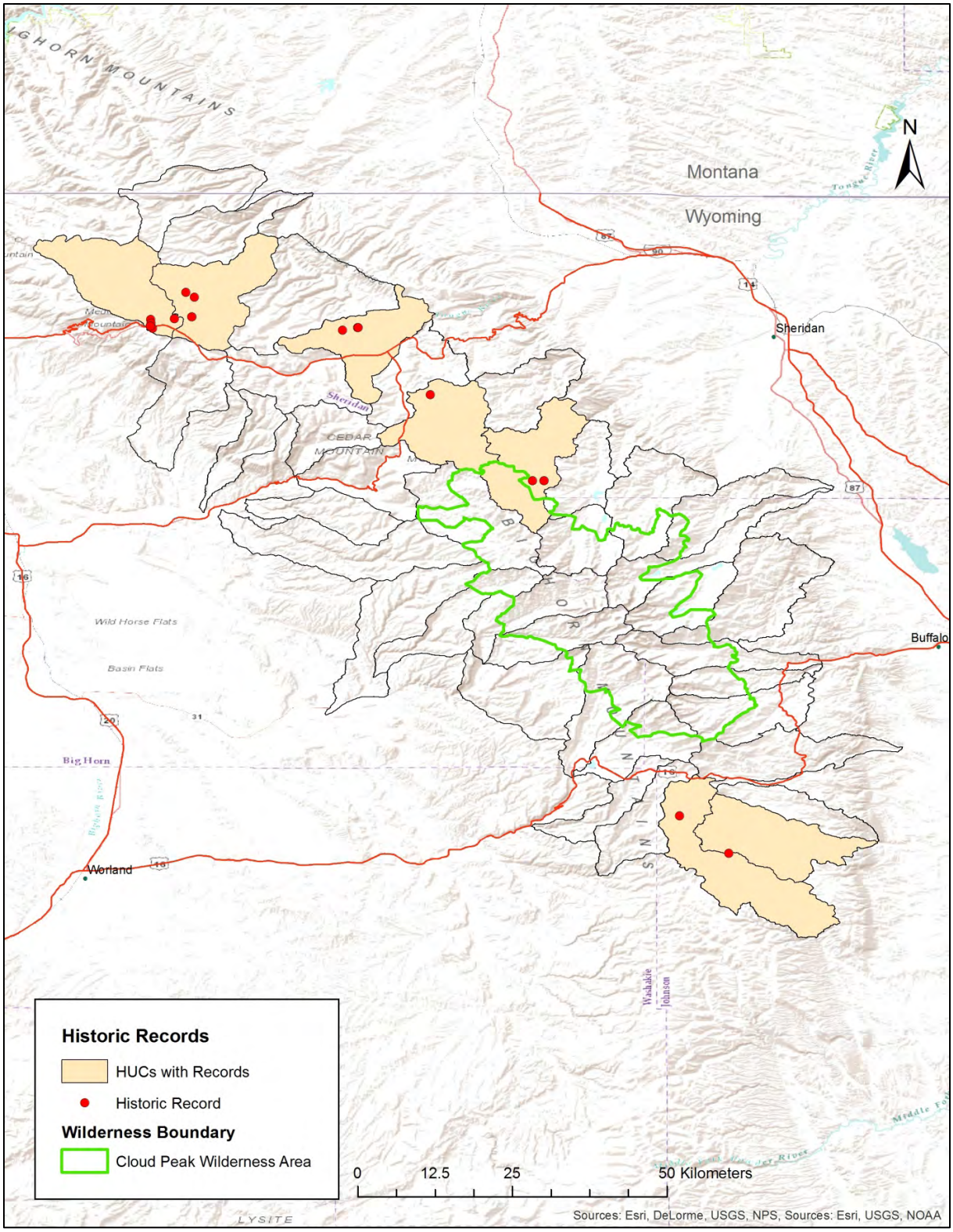

Figure 5. Hydrological unit codes (HUCs) and specific locations where historic records for water voles (*Microtus richardsoni*) are known in the Big Horn Mountains of Wyoming prior to 2014.

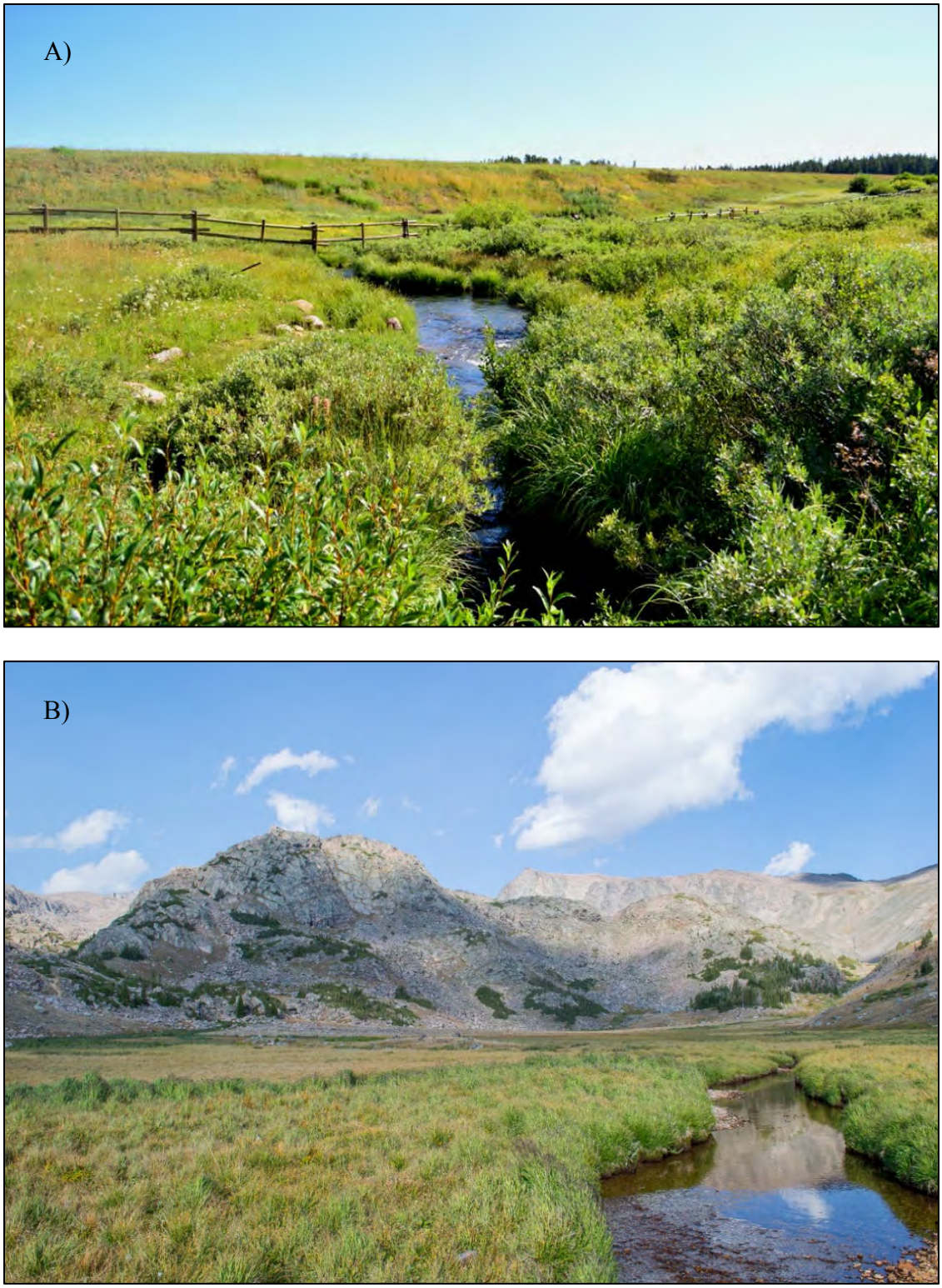

Figure 6. Photographs of 2 sites in the Big Horn Mountains of Wyoming where a water vole (*Microtus richardsoni*) was captured. A) Big Willow Creek near Burgess Junction in 2014, a site with moderate willow cover and cattle grazing (Zinke 2014). B) Paint Rock Creek within the Cloud Peak Wilderness Area in 2016, a site with neither willow cover nor livestock grazing.

Appendix 1. List of all sites surveyed for water voles (*Microtus richardsoni*) in the Big Horn Mountains in 2014 and 2016, including dates, GPS location, elevation, Rosgen class, dominant substrate, and predominant habitat type. The data from 2014 are from Zinke (2014).

Year	Stream name	Dates trapped	GPS (Zone 13T, NAD83)		Elevation (m)	Rosgen class	Dominant substrate	Habitat type
2014	North Fork Crazy Woman Creek	6/24-6/28	343814	4890689	2456	B4a	Pebble gravel	Clearcut conifer
	Willow Creek	6/25-6/28	346134	4895561	2481	G4	Pebble gravel	Clearcut conifer
	Bull Creek (South)	8/25-8/29	324919	4891642	2705	G4	Pebble gravel	Subalpine meadow
	West Tensleep Creek	6/30-7/4	321719	4899164	2634	B3a	Cobble	Lodgepole pine
	West Tensleep Creek	8/25-8/29	322514	4901535	2742	B4	Pebble gravel	Lodgepole pine
	Middle Tensleep Creek	6/30-7/4	323468	4902760	2747	B2a	Boulder/ cobble	Lodgepole pine
	Buckskin Ed Creek	7/7-7/11	317615	4905062	2734	A4	Pebble gravel	Clearcut conifer
	Middle Paint Rock Creek	7/7-7/11	316619	4907267	2727	A3	Cobble	Clearcut conifer
	Unnamed Tributary to Granite Creek	7/14-7/18	302002	4944031	2703	G4	Pebble gravel/ silt/clay	Mountain big sagebrush
	Unnamed Tributary to Granite Creek	7/14-7/18	301763	4944789	2715	G4	Pebble gravel	Mountain big sagebrush
	East Fork South Tongue River	7/28-8/1	309758	4944470	2804	E4	Pebble gravel	Subalpine meadow
	Prospect Creek	7/14-7/18	300808	4946474	2755	A4	Pebble gravel	Subalpine meadow
	West Fork South Tongue River	7/17-7/21	303404	4946788	2704	E4	Pebble gravel	Mountain big sagebrush
	Graves Creek	7/28-8/1	308525	4948225	2722	E4	Pebble gravel	Lodgepole pine

Appendix 1. Continued.

Year	Stream name	Dates trapped	GPS (Zone 13T, NAD83)		Elevation (m)	Rosgen class	Dominant substrate	Habitat type
2014	Owen Creek	7/21-7/25	302017	4953715	2567	G2	Boulder/ cobble	Subalpine meadow
	Tributary to Sucker Creek	8/18-8/22	309810	4953870	2635	G4	Pebble gravel	Clearcut conifer
	Copper Creek	7/21-7/25	305388	4954345	2543	E4	Pebble gravel	Subalpine meadow
	Big Willow Creek	8/11-8/14	297439	4957577	2505	G4	Pebble gravel	Subalpine meadow
	Prune Creek	8/18-8/22	307228	4958804	2437	G4	Pebble gravel	Lodgepole pine
	Big Willow Creek	8/11-8/15	298943	4960118	2440	E3	Cobble	Subalpine meadow
	Porcupine Creek	8/4-8/8	274289	4968305	2669	G3	Cobble	Mixed grass prairie
	Big Tepee Creek	8/4-8/8	271389	4974712	2727	A4	Pebble gravel/cobble	Mixed grass prairie
2016	Bald Mountain Creek	6/20-6/24	273540	4965626	2760			Subalpine meadow
	Sheeley Creek	6/14-6/17	301995	4956868	2515			Subalpine meadow
	Bald Mountain Creek	8/3-8/5	274185	4966901	2715			Mixed grass prairie
	Big Willow Creek	8/1-8/5	298937	4960040	2442			Subalpine meadow
	Bull Creek (North)	8/9-8/12	294764	4958941	2474			Shrub-dominated riparian
	Canyon Creek	7/12-7/15	330309	4888969	2736			Subalpine meadow

Appendix 1. Continued.

Year	Stream name	Dates trapped	GPS (Zone 13T, NAD83)		Elevation (m)	Rosgen class	Dominant substrate	Habitat type
2016	Doyle Creek	7/18-7/22	337969	4879276	2542			Lodgepole pine
	Duncum Creek	8/2-8/5	277022	4968599	2731			Clearcut conifer
	Fool Creek	6/27-7/1	296943	4964154	2403			Subalpine meadow
	Hidden Tepee Creek	6/20-6//24	289044	4956763	2550			Subalpine meadow
	Hunter Creek	7/25-7/29	344226	4910109	2302			Mixed grass prairie
	Leigh Creek	7/5-7/9	328110	4892725	2811			Subalpine meadow
	Lick Creek	6/27-7/1	284824	4965283	2697			Subalpine meadow
	Little Bighorn River	7/11-7/15	281537	4967740	2535			Subalpine meadow
	Middle Clear Creek	7/25-7/29	341030	4907384	2422			Mixed grass prairie
	Middle Paint Rock Creek	8/15-8/19	320718	4910643	2993			Subalpine meadow
	North Clear Creek	8/15-8/19	335343	4911165	2793			Subalpine meadow
	North Fork Powder River	7/12-7/15	332858	4885725	2703			Subalpine meadow
	Paint Rock Creek	8/15-8/19	323264	4913418	3085			Subalpine meadow
	Poison Creek	7/18-7/22	346067	4886305	2332			Subalpine meadow
	Porcupine Creek	8/8-8/12	313771	4928886	2933			Subalpine meadow

Appendix 1. Continued.

Year	Stream name	Dates trapped	GPS (Zone 13T, NAD83)		Elevation (m)	Rosgen class	Dominant substrate	Habitat type
2016	South Beaver Creek	7/11-7/15	281197	4959417	2714			Subalpine meadow
	Unnamed Tributary to Granite Creek	6/14-6/17	301776	4944912	2739			Mountain big sagebrush
	Unnamed Tributary to Willet Creek	7/19-7/22	306653	4940563	2861			Subalpine meadow
	West Fork South Tongue River	7/19-7/22	303419	4946770	2705			Mountain big sagebrush
	Wyoming Gulch	8/1-8/5	276088	4967114	2742			Mixed grass prairie

WOLVERINE (*GULO GULO*) DISTRIBUTION AND OCCUPANCY IN WESTERN WYOMING

STATE OF WYOMING

NONGAME MAMMALS: Species of Greatest Conservation Need – Wolverine

FUNDING SOURCE: Great Northern Landscape Conservation Cooperative
Idaho Fish and Game Department
Montana Fish, Wildlife, and Parks
National Fish and Wildlife Foundation
US Fish and Wildlife Service Competitive State Wildlife Grant
US Forest Service
Washington Department of Fish and Wildlife
Wyoming Game and Fish Department Commission Funds
Wyoming State Legislature General Fund Appropriations

PROJECTION DURATION: 1 July 2015 – 30 June 2017

PERIOD COVERED: 1 November 2015 – 31 May 2016

PREPARED BY: Nichole Bjornlie, Nongame Mammal Biologist
Lee Tafelmeyer, Nongame Biologist
Zack Walker, Nongame Bird and Mammal Program Supervisor

ABSTRACT

Wolverines (*Gulo gulo*) have a circumpolar distribution that historically extended to California and New Mexico in the western United States, but were possibly extirpated from the contiguous US in the early 1900s. Since 1930, wolverines have recolonized portions of their former range, although the extent of recolonization is unknown. Concerns about vulnerability to climate change led to a petition to list the species as Federally Threatened in 2000, and a federal court ruling recently remanded the 2014 not warranted finding, returning wolverines to 'Proposed Threatened' status. In response to the petition, the Multi-state Wolverine Working Group, comprised of state, federal, tribal, and university partners from Idaho, Montana, Washington, and Wyoming, initiated the Western States Wolverine Conservation Project to assess current distribution and identify conservation actions. A key conservation action identified in the Western States Wolverine Conservation Project was the need to develop a coordinated, multi-state monitoring strategy throughout the wolverine's range in the contiguous US. To that end, in 2015 the Wyoming Game and Fish Department initiated the first of a 2-year effort to use remote cameras coupled with bait and lure stations to detect wolverines and estimate occupancy throughout the western mountains and Big Horn Mountains. During the winter of

2015-2016, we documented ≥2 unique wolverines at 3 of 25 stations located throughout the southern half of the western mountains. Individuals were documented in the Wind River and Absaroka Mountain Ranges, areas where wolverines have been documented both historically and as part of a recent pilot effort to evaluate techniques to detect wolverines in the state. Interestingly, however, we did not detect wolverines in the Wyoming, Salt, or Teton Mountain Ranges, all of which have documented historical presence. Additional surveys are planned for the winter of 2016-2017 to survey throughout the northern half of the western mountains and the Big Horn Mountains. The other western states will also be conducting surveys at this time in an effort to evaluate current distribution throughout the 4-state region and provide a baseline occupancy rate with which population trends can be monitored over time.

INTRODUCTION

Wolverines (*Gulo gulo*) are the largest member of the weasel family and are found throughout the northern latitudes of North America, Europe, and Asia. Historically, wolverines were found throughout the western US as far south as California and New Mexico. Despite this widespread distribution, wolverines were nearly eliminated from the contiguous US by the mid-1920s, primarily due to overharvesting and habitat loss (Aubrey et al. 2007). However, wolverines began recolonizing their former range in the 1930s as a result of natural dispersal from larger populations in Canada and Glacier National Park (Newby and Wright 1955, Newby and McDougal 1964, Pasitschniak-Arts and Larivière 1995). Recently, wolverines have been documented as far south as Utah and Colorado; however, wolverines remain rare in the continental US. As a result of these small population sizes and concerns regarding potential impacts of climate change, the species was petitioned for listing under the Federal Endangered Species Act (ESA) in 2000. In 2014, the US Fish and Wildlife Service withdrew its proposed rule to list the species as threatened (USFWS 2014), although a federal court ruling recently remanded the 2014 not warranted finding, returning wolverines to 'Proposed Threatened' status throughout the continental US (USFWS 2016).

In Wyoming, wolverines are considered rare and 1 of 6 species protected by Wyoming Statute §23-1-101. Wolverines are found in high-elevation coniferous forests (Pasitschniak-Arts and Larivière 1995), which, in Wyoming, are potentially exposed to threats such as fire suppression, disease and insects, and drought and climate change (WGFD 2017). Because population sizes and distribution are limited and the species is potentially limited by restricted habitat and anthropogenic and climate-induced habitat loss, the species is classified as a Species of Greatest Conservation Need in the state. Little is known about wolverine populations in Wyoming, including species status, distribution, densities, and trends (WGFD 2017). Additionally, although wolverines have been observed in Colorado and Utah, individuals are unlikely reproducing there. It is unclear where the transition line is between breeding populations and dispersing individuals, but it is likely that the southern boundary of breeding wolverines lies somewhere in Wyoming (Inman et al. 2013, 2015).

In response to the petition to list the wolverine under the ESA, 4 northwestern states (Washington, Idaho, Montana, and Wyoming) developed a multi-state monitoring strategy to document presence of wolverines throughout their range in the contiguous United States, a need

which had previously been identified as a key conservation priority by an inter-agency panel of wildlife biologists and managers (Inman et al. 2013). In 2015, the Department contracted with the Wolverine Initiative to develop detection protocols and conduct a pilot project to evaluate the efficacy of these protocols. Using remote cameras combined with bait and scent lure during the winter of 2014-2015, the project documented ≥3 unique wolverines at 5 of 18 survey stations throughout western Wyoming, including the first confirmed documentation of wolverines in the Gros Ventre Range (Inman et al. 2015). Building from the success of this project, the Department, in collaboration with the Multi-state Wolverine Working Group (Working Group), initiated the first of a 2-year project in the fall of 2015 to systematically survey for wolverines throughout predicted habitat in western Wyoming and the Big Horn Mountains. Herein, we provide results from the 1st year of this effort.

METHODS

We followed the protocol developed by the Working Group in 2015 (Multi-state Wolverine Working Group 2015; Appendix A) to survey for wolverine presence by using noninvasive, baited camera and hair-snare stations. The Working Group used Generalized Random Tessellation Stratified methods to select a subset of grid cells across Wyoming, Montana, Idaho, and Washington consisting of ≥50% primary wolverine habitat (Inman et al. 2013). This resulted in fifty-one 15 km x 15 km grid cells selected for survey within Wyoming. We surveyed the southernmost 25 grid cells during the winter of 2015-2016, and will survey the northernmost 26 grid cells during the winter of 2016-2017. The 25 grid cells surveyed in 2015-2016 were located within the southern portion of the Greater Yellowstone Ecosystem (Figure 1) and included grid cells within the Absaroka, Gros Ventre, Mount Leidy Highlands, Salt River, Snake River, Teton, Wind River, and Wyoming Mountain Ranges.

We deployed 1 camera station in each cell during November or early December 2015, and removed them in April and early May 2016. We used 2 types of camera stations: accessible stations (n=23) and inaccessible stations (n=2). General camera station locations were selected prior to going into the field based on criteria identified in the Working Group protocol; specifically, we focused on locations >2,438 m in elevation within natural movement corridors (e.g., high elevations near tree line, mountain saddles, drainage bottoms). Additional consideration was given to avalanche terrain risk and snowmobile and ski access. We selected specific station locations from within these preselected general locations while in the field.

All camera stations consisted of 3 separate elements: camera, hair snare, and attractants. We placed Reconyx Hyperfire infrared cameras (models PC 800, PC 850, or PC 900; Reconyx, Holmen, WI) within a metal security box (Hyperfire Camera Series Security Enclosure; Reconyx, Holmen, WI) and attached the camera approximately 1.5 m above the ground to the northern aspect of a tree. We then attached the hair snare and attractants about 1.5 m above the ground to a bait tree 4-6 m away from the camera and within view of the camera. We followed the Working Group protocol to construct the hair snares by using a plastic belt, tee nuts, and .30 caliber gun brushes; however, we adapted the protocol to use wire to attach the snare to the trees instead of staples because this made it easier to install and change the height of the hair snare as snow depths increased in order to keep the snare approximately 45 cm below the bait. We used

baling wire to attach 1 skinned mule deer (*Odocoileus hemionus*) quarter or 1/2 beaver (*Castor canadensis*) carcass to the bait tree approximately 30-60 cm above the hair snare. This amounted to approximately 7-16 kg of bait per station. We also attached a sponge soaked in a long-call scent lure mix next to the bait. We revisited each accessible station once per month as conditions allowed to exchange memory cards and batteries in the cameras, replenish bait and scent lures, and collect and replace gun brushes containing hair. We also opportunistically recorded any tracks observed at the site or during the trip to the site.

We placed inaccessible stations in grid cells where winter access was not safe or reliable for crew members. In general, protocols for inaccessible stations followed that of accessible stations listed above with a few exceptions. In addition to the attractants used at accessible stations, we also attached a cow (*Bos taurus*) femur to the bait tree with a cable and poured a food scent lure onto the femur bone. We placed all the site elements approximately 3.5 m above the ground on their respective trees and did not revisit inaccessible stations after they were set until we took them down in April.

After retrieving memory cards, we uploaded and organized photos using a Microsoft Access database and sent hair samples to the National Genomics Laboratory for Wildlife and Fish Conservation located in Missoula, MT for genetic analysis to species. Because this is the 1st year of a 2-year study, we report summary statistics (± SE) from the 1st season. Additional analyses will be completed following the final field season.

RESULTS

We deployed 25 camera stations between 2 November and 4 December 2015. We set 2 of the stations following the inaccessible protocol and did not revisit these sites until we collected all equipment at the end of the season. We visited the remaining 23 stations an average of 3.5 times (± 0.14, range: 2-4 times), for a total of 80 site visits. We removed all cameras between 3 April and 13 May. The average elevation of camera stations was 2,902 m (± 40 m, range: 2,436-3,234 m; Table 1).

We documented 3,652 camera days throughout the winter. All cameras remained operational throughout the duration of the project; however, 9 cameras experienced ≥1 day during which snow blocked the lens (average 12.4 ± 6.0 days per camera, range: 1-57 days), for a total of 3,520 snow-free camera days. Stations were operational an average of 141days per station (± 4.3 days, range: 68-174 days) from the date they were set until they were collected (Table 1). On average, we recorded 3,108 photos (± 897 photos, range: 455-23,891 photos) per camera station, with inaccessible stations recording the fewest number of photos overall (Table 2). Of the 77,712 total photos, we recorded 70,915 photos of 23 different species; the remainder of the photos were of humans, individuals that could not be identified to species, or did not contain any wildlife (e.g., moving trees or snowfall; Table 2).

We recorded 1,414 photos of wolverines at 3 of the 25 stations (Table 2, Figure 2); all stations that detected wolverines followed accessible station protocols. The average elevation of these 3 sites was 3,024 m (± 148 m, range: 2,737-3,232 m). We documented 26 independent

wolverine visits (i.e., photographs of wolverines ≥60 minutes apart). Wolverines were detected at least once throughout the study area during each of the 4 sampling periods (December, January, February, March), as well as during the month of April. In all, we detected wolverines during 6 sampling occasions out of a possible 100 (i.e., 25 camera stations with 4 sampling periods each).

Based on pelage patterns, we detected ≥2 individual wolverines, although the 2nd individual was detected in April and outside of the sampling period (Figure 3). Out of 60 hair samples collected, we collected a total of 11 hair samples that were identified as wolverines. We collected ≥1 wolverine sample from every sampling period where we also detected a wolverine on camera, except the April detection at camera #085 (Table 2). Genetic results for sex and individual identity of each sample are pending.

We detected 22 non-target species on camera, including 12 mammal and 10 bird species. The most commonly detected non-target mammals included red fox (*Vulpes vulpes*) and pacific marten (*Martes caurina*). The most commonly detected avian species included Black-billed Magpie (*Pica hudsonia*), Common Raven (*Corvus corax*), and Clark's Nutcracker (*Nucifraga columbiana*; Table 3).

DISCUSSION

Wyoming represents the southernmost extent of current wolverine distribution in the contiguous United States (Inman et al. 2012). In 2015-2016, we detected ≥2 unique individuals at 3 different locations in the southern half of the Greater Yellowstone Ecosystem in Wyoming, including 2 locations in the Wind River Mountain Range and 1 location in the Absaroka Mountain Range. The pilot study conducted in 2015 had similar results, with ≥3 unique wolverines detected at 5 locations within the same general area (Inman et al. 2015; Figure 2). These observations tended to be clumped in the northern portion of the Wind River Range, an area where we did not detect wolverines during this survey. Conversely, wolverines were not detected in the southern part of the Wind River Range during previous work, but were documented in the area during this survey (Inman et al. 2015; Figure 2). However, given the ability for wolverines to travel large distances, especially during dispersal events (Inman et al. 2012), it is possible that these could represent the same individuals, despite differences in presence between years. Additionally, we detected a wolverine during each month of the survey period in the west-central Wind River Mountains, an area known to support wolverines historically (e.g., Inman et al. 2012), suggesting this individual is likely a territorial resident in the area. Interestingly, we detected ≥2 unique wolverines in both years at nearby camera sites in the Absaroka and Gros Ventre Mountain Ranges, approximately 20 km straight line distance and within the normal home range size of adult wolverines in the Greater Yellowstone Ecosystem (Inman et al. 2012). One of these individuals displayed distinctive white forelimbs and is most likely the same individual; the identity of the other individual is unknown. As with the individual in the Wind River Mountain Range, the detection of these individuals in subsequent years may suggest territorial residents, and, depending on sex, potentially a breeding pair. Pending genetic analysis will likely help address these questions.

Although we recorded numerous photos of wolverines, there were still large areas of modeled habitat where wolverines were not detected in either this or the pilot project. For example, despite the presence of multiple camera stations throughout the Wyoming and Salt River Mountain Ranges and previous work documenting wolverines using the area (Inman et al. 2012), we did not detect any wolverines in either mountain range. Both mountain ranges contain predicted wolverine habitat and predicted maternal habitat in particular, so their apparent absence likely warrants further investigation. Additionally, despite the first confirmed wolverine detection in the Gros Ventre Range during the pilot project in 2015 (Inman et al. 2015), neither of the 2 stations in the Gros Ventre Range detected a wolverine during this project. However, camera stations in the Gros Ventre Mountain Range were located in the western end of the Range in 2015-2016, nearer the Wyoming Range, and the detection during the pilot study was located at the far eastern end of the Range, nearer the Wind River Mountain Range. The single station in the Teton Range also did not detect a wolverine, despite the Range containing a reproducing population of wolverines as recently as 2004 (Inman et al. 2012). More recent capture efforts resulted in a single capture of an old male whose capture location was near the camera station for this project (Heinemeyer and Squires 2015). Although we cannot infer much from a single survey site within this range, a better understanding of the current status of wolverines and causes for potential population declines is needed.

Despite the potential for Wyoming to support approximately 20% of the population of wolverines in the western United States (Inman et al. 2013), little work had been done previously to systematically determine presence and occupancy of wolverines in the state. However, the pilot work conducted in 2015 (Inman et al. 2015) and the development of the multi-state protocol by the Working Group have resulted in a technique to allow for range-wide evaluation of the current distribution of wolverines in the contiguous US. During the winter of 2016-2017, the Department will be completing surveys in the state by setting an additional 26 remote camera stations throughout the northern half of the western mountains and the Big Horn Mountains. The other western states (Idaho, Montana, and Washington) will also be conducting surveys at this time for a total of 180 remote stations throughout the 4-state region. Not only will this effort provide a large-scale understanding of current distribution throughout potential habitat, it will also provide the baseline occupancy rate with which population trends can be monitored over time. Although contingent on funding, additional questions may also be addressed through genetic analyses, including determining sex and individual identification, thereby providing a more comprehensive picture of population structure, as well as potentially addressing questions pertaining to relatedness, residency, and movement among sites. Each of these strategies will further our understanding of the current status of wolverines throughout the contiguous US, thus contributing to management and conservation recommendations and goals into the future.

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Reservation. Department Nongame Biologists C. Atkinson and S. Halman provided invaluable assistance with all aspects of field surveys. Lander Wyoming Department of Transportation personnel helped immensely with the collection of deer bait. Thank you to A. Sinner and J. Pearce for supplying beaver for use as bait. B. Inman provided valuable insight and assistance regarding wolverine natural history. We also thank the numerous volunteers, both within and external to the Department, who assisted with this effort. Finally, we thank the Multi-state Wolverine Working Group for their work developing protocols and assisting with all technical aspects of this project.

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Table 1. Location, station type, geographical information, and operational dates of cameras set throughout western Wyoming from November 2015 through May 2016 to detect wolverines (*Gulo gulo*). Refer to Figure 1 for more detailed location information. Total camera days does not include days when cameras were covered with snow and unable to take photos.

Cell #	Site name	Station type	Elevation (m)	Date set	Date removed	Total camera days
2	Hamm's Fork	Accessible	2,712	1-Dec-15	6-Apr-16	105
12	Lander Peak	Accessible	2,901	19-Nov-15	5-Apr-16	136
13	Pocket Creek	Accessible	2,971	21-Nov-15	3-Apr-16	134
16	Cony Mountain	Accessible	3,232	10-Nov-15	11-Apr-16	151
18	North Fork Sheep Creek	Accessible	2,436	18-Nov-15	6-Apr-16	140
22	Gaylord Lake	Inaccessible	3,123	4-Dec-15	21-Apr-16	139
25	Deadman's Mountain	Accessible	2,747	17-Nov-15	6-Apr-16	135
27	Miller Park	Accessible	3,102	19-Nov-15	8-Apr-16	141
30	Mount Shoshone	Accessible	3,189	24-Nov-15	20-Apr-16	148
31	Grayback Ridge	Accessible	2,882	16-Nov-15	5-Apr-16	116
32	Upper Kilgore	Accessible	2,902	5-Nov-15	13-Apr-16	158
33	Boulder Creek	Accessible	2,730	17-Nov-15	7-Apr-16	142
39	Indian Peak	Accessible	2,834	2-Dec-15	5-Apr-16	68
43	Slide Creek	Accessible	2,746	18-Nov-15	4-Apr-16	138
45	Indian Ridge	Accessible	3,234	20-Nov-15	27-Apr-16	159
49	Swift Creek	Inaccessible	3,014	17-Nov-15	13-Apr-16	148
51	Pinion Ridge	Accessible	3,001	18-Nov-15	7-Apr-16	141
58	Upper Slide	Accessible	2,812	4-Nov-15	12-Apr-16	159
68	Alaska Basin	Accessible	2,769	1-Dec-15	12-Apr-16	127
70	Kettle Creek	Accessible	2,994	6-Nov-15	3-Apr-16	149
73	Trail Ridge	Accessible	3,097	23-Nov-15	13-May-16	171
82	North Fork Spread Creek	Accessible	2,918	2-Nov-15	4-Apr-16	154
85	Five Pockets	Accessible	2,737	12-Nov-15	7-Apr-16	147
86	Wiggin's Creek	Accessible	2,615	13-Nov-15	5-May-16	174
87	East Fork	Accessible	2,848	9-Nov-15	5-Apr-16	148

Table 2. Results from camera surveys in western Wyoming from November 2015 through May 2016 for wolverines (*Gulo gulo*). See Table 1 and Figures 1 and 2 for more information. Camera number 85 resulted in 2 unique wolverines (Figure 3).

Cell #	Total # of photos	# of wolverine photos	# of wolverine visits	Months wolverines detected	Total # of genetic samples	# of wolverine samples
2	1,245	0	0		3	0
12	3,105	0	0		0	0
13	1,473	0	0		0	0
16	3,118	139	1	Jan	4	4
18	1,056	0	0		12	0
22	598	0	0		0	0
25	1,766	0	0		2	0
27	2,196	1002	23	Dec, Jan, Feb, Mar, Apr	13	6
30	3,162	0	0		0	0
31	1,260	0	0		0	0
32	5,247	0	0		0	0
33	1,487	0	0		4	0
39	2,371	0	0		9	0
43	645	0	0		5	0
45	2,544	0	0		0	0
49	455	0	0		0	0
51	4,478	0	0		0	0
58	3,799	0	0		4	0
68	2,922	0	0		1	0
70	1,869	0	0		0	0
73	23,891	0	0		0	0
82	1,593	0	0		0	0
85	2,489	273	2	Feb, Apr	3	1
86	2,800	0	0		0	0
87	2,143	0	0		0	0

Table 3. Avian and mammalian non-target detections (excluding humans, unknown detections, and photographs without an individual) during camera surveys from November 2015 through May 2016 in western Wyoming.

Common name	Scientific name	# of photos	# of stations
Dusky Grouse	*Dendragapus obscurus*	13	2
Northern Goshawk	*Accipiter gentilis*	10	1
Golden Eagle	*Aquila chrysaetos*	559	4
Great Horned Owl	*Bubo virginianus*	10	2
Gray Jay	*Perisoreus canadensis*	518	10
Steller's Jay	*Cyanocitta stelleri*	801	7
Clark's Nutcracker	*Nucifraga columbiana*	1,252	13
Black-billed Magpie	*Pica hudsonia*	25,444	12
Common Raven	*Corvus corax*	1,997	10
Mountain Chickadee	*Poecile gambeli*	65	6
Snowshoe hare	*Lepus americanus*	239	9
Red squirrel	*Tamiasciurus hudsonicus*	982	6
Coyote	*Canis latrans*	1,267	12
Gray wolf	*Canis lupus*	64	1
Red fox	*Vulpes vulpes*	13,321	22
Pacific marten	*Martes caurina*	12,005	24
Short-tailed weasel	*Mustela erminea*	5	1
American badger	*Taxidea taxus*	91	1
Mountain lion	*Puma concolor*	5	1
Elk	*Cervus canadensis*	458	4
Mule deer	*Odocoileus hemionus*	15	1
Moose	*Alces americanus*	124	2

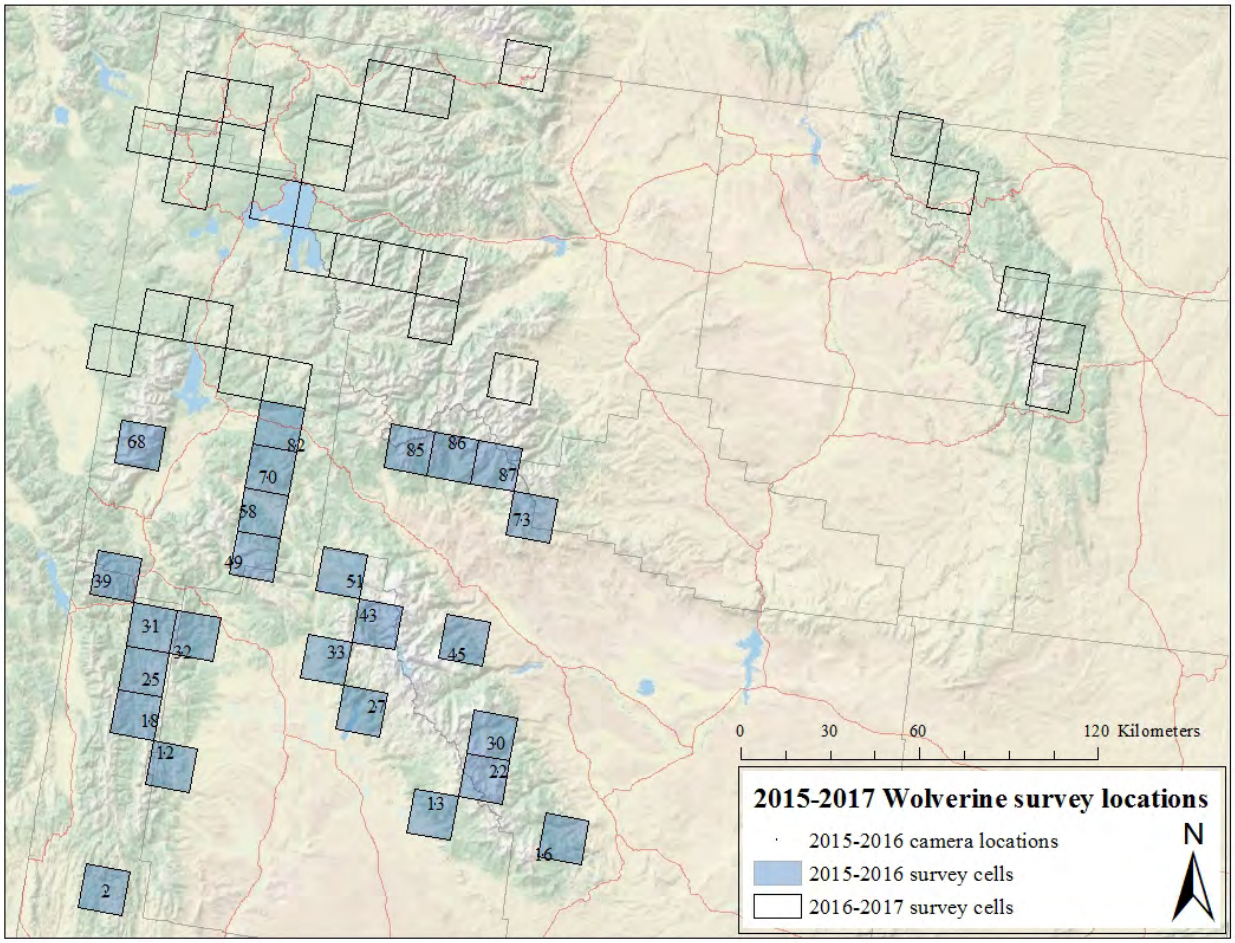


Figure 1. All grid cells selected to survey in Wyoming for wolverines (*Gulo gulo*) from 2015-2017. Blue cells are those surveyed from November 2015 through May 2016. Specific camera locations are designated by camera numbers within the cells.

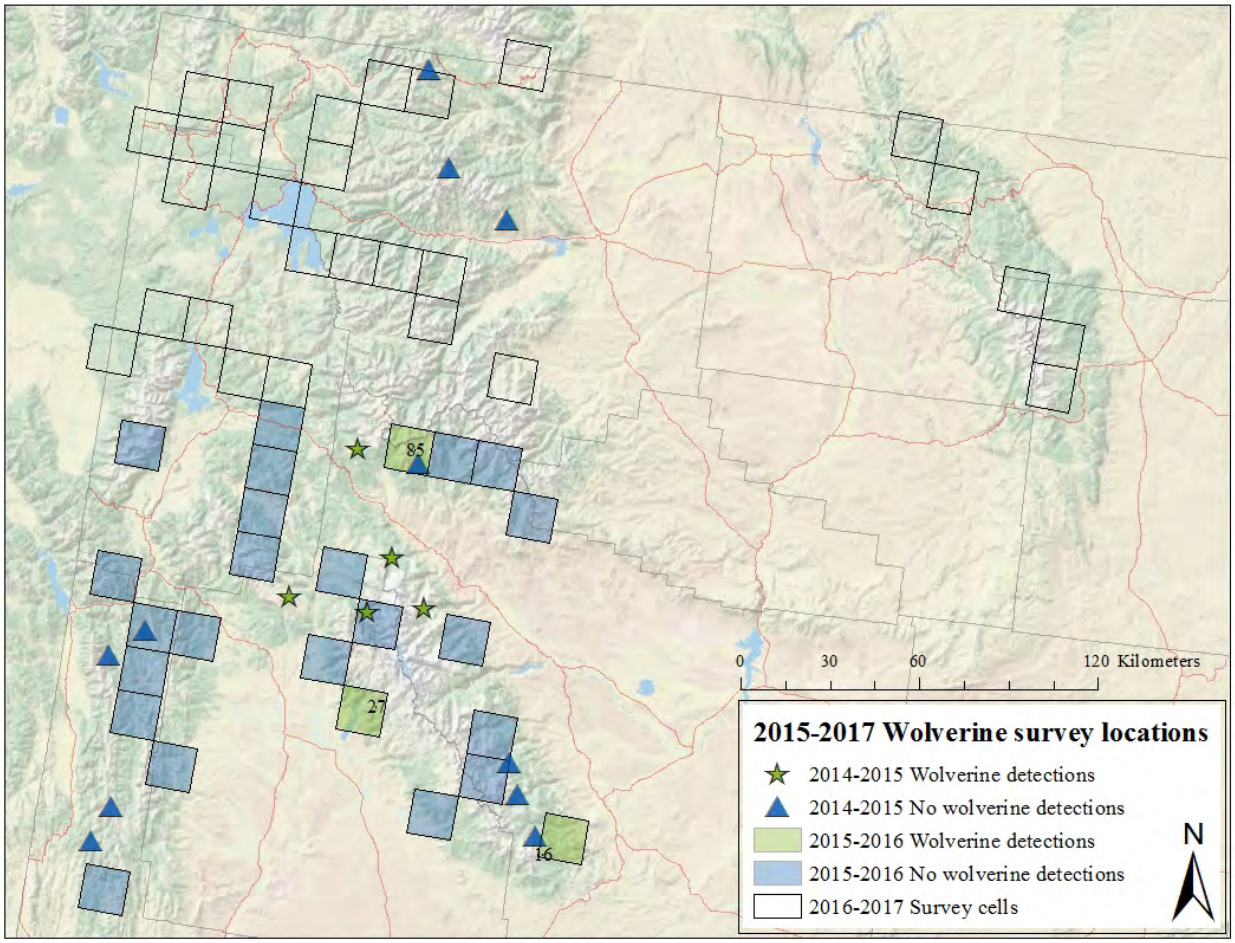


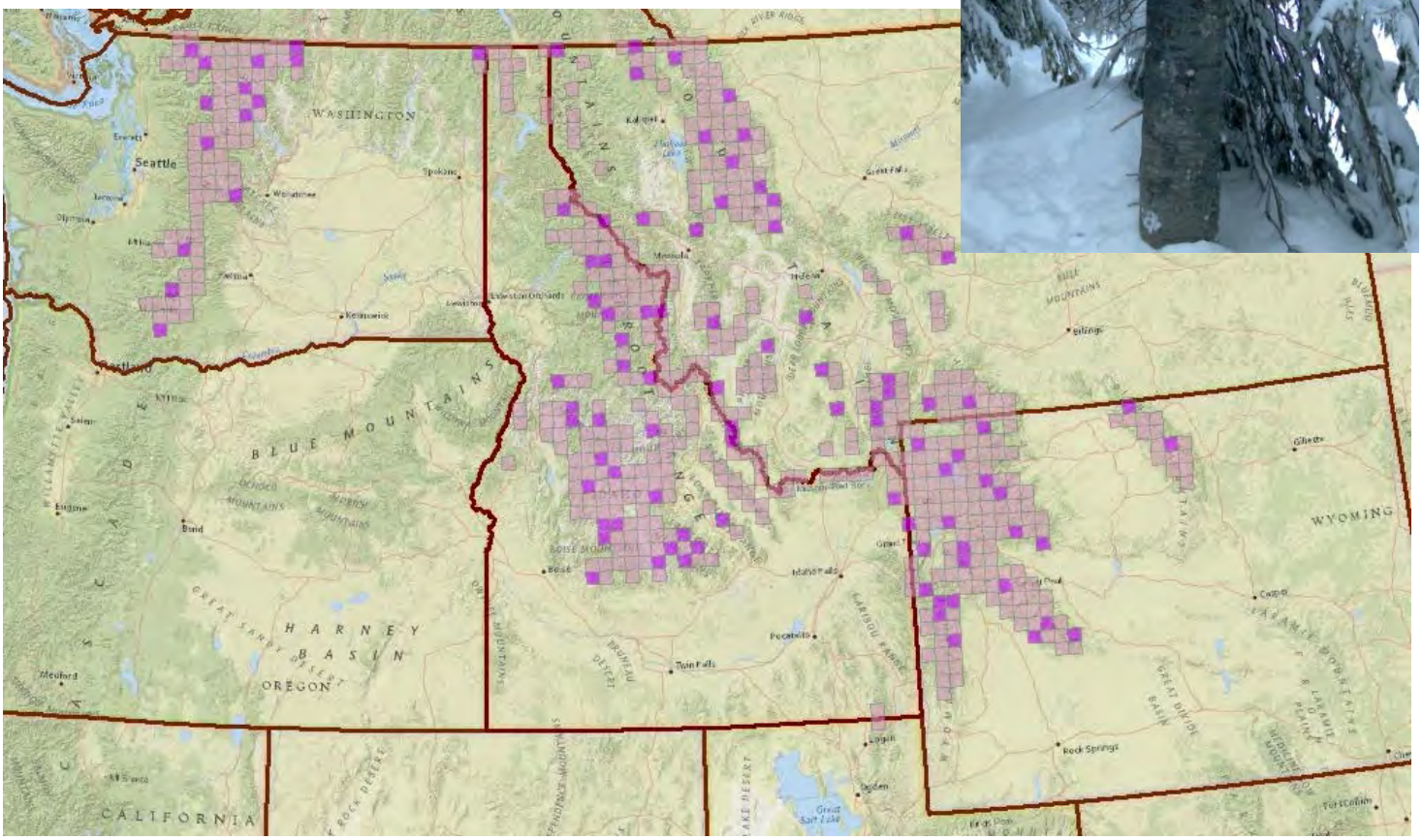
Figure 2. All grid cells selected to survey in Wyoming for wolverines (*Gulo gulo*) from 2015-2017. Blue cells are those where wolverines were not detected, and green cells are where wolverines were detected from November 2015 through May 2016. Specific camera locations where wolverines were detected are designated by camera numbers within the cells. For comparison, green stars represent wolverine detections and blue triangles represent non-detections from spring and summer of 2015 (Inman et al. 2015).

Figure 3. Photographs showing different pelage in wolverine (*Gulo gulo*) visiting camera number 85. The upper photograph depicts a wolverine with solid dark forelegs and chest. The lower photograph depicts a wolverine with white forefeet and mottled chest.

Appendix A.

Coordinated Multi-state Wolverine Baseline Sampling in Montana, Idaho, Wyoming and Washington:

Standard Operating Procedures for Camera DNA Stations



Multi-state Wolverine Working Group

October 31, 2015

Diane Evans Mack and Robert Long compiled this protocol for the Multi-state Wolverine Working Group based on decisions made by the group at a workshop in Salmon, ID, July 2015 and subsequent discussion.

The Multi-state Wolverine Working Group consists of:

Jeff Copeland – The Wolverine Foundation
Stacy Courville – Confederated Salish & Kootenai Tribes
Diane Evans Mack – Idaho Department of Fish & Game
Justin Gude – Montana Fish, Wildlife & Parks
Kim Heinemeyer – Round River Conservation Studies
Bob Inman – Montana Fish, Wildlife & Parks
Jake Ivan – Colorado Parks & Wildlife
Scott Jackson – USFS Region 1
Bob Lanka – Wyoming Game & Fish Department
Jeff Lewis – Washington Department of Fish & Wildlife
Robert Long – Woodland Park Zoo
Paul Lukacs – University of Montana
Kevin McKelvey – USFS Rocky Mountain Research Station
Rex Sallabanks – Idaho Department of Fish & Game
Michael Schwartz – USFS Rocky Mountain Research Station
Steve Torbit – USFWS Region 6
John Vore – Montana Fish, Wildlife & Parks
Zack Walker – Wyoming Game & Fish Department
Beth Waterbury – Idaho Department of Fish & Game
Gary White – Emeritus, Colorado State University

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Several individuals shared techniques and ideas incorporated into this protocol. We thank Joel Sauder, Idaho Department of Fish and Game, for his thoughts on camera and hair snare placement. Michael Lucid, Idaho Department of Fish and Game, shared techniques for hanging and securing bait. Eric Lofroth, British Columbia, developed the long call scent lure that formed the basis for our current recipe. Meghan Riley, The Wolverine Initiative, led the field work for a pilot effort in Wyoming in early 2015.

INTRODUCTION

This document provides the standard operating procedures (SOPs) for deploying and maintaining baited camera stations for coordinated multi-state wolverine sampling within suitable habitat across Washington, Idaho, Montana, and Wyoming. The objective of this project is to establish a baseline of wolverine occurrence (probability of occupancy) across the four-state area from which to assess the influences of future conservation actions, environmental change, and anthropogenic disturbance.

Sampling will occur within a spatially balanced random selection of 15 km x 15 km grid cells resulting from a Generalized Random Tessellation Stratified (GRTS) sampling procedure which ranked each cell (Stevens and Olsen 2004). At a minimum, 100 cells (ranks 1–100) will be sampled for this project, with approximately 15 grid cells in WA, 31 in Idaho, 30 in Mt, and 24 in WY. Sample size will increase up to 200 cells as additional funding allows.

By providing detailed protocols we aim to ensure that field methods and results are consistent in all 4 states and across 2 consecutive winters and that we will generate a statistically reliable dataset with minimum 'noise'. The main elements of these SOPs were developed at a workshop for Wolverine Coordinated Multi-state Monitoring held July 8 & 9, 2015, in Salmon, ID.

STANDARD OPERATING PROCEDURES

Project Period and Timing of Deployment

Sampling will begin in Wyoming during winter 2015/16. Sampling will continue in winter 2016/17 in WA, ID, MT, and remaining locations in WY.

Sampling will occur during 1 December through 31 March both years. The timing of deployment will differ among stations (see below under Station Type). As part of the occupancy modeling design, each 1-month interval will represent an independent visit to the station (December, January, February, March).

Station Density

We will deploy 1 camera/hair snag station per 15 km x 15 km sampling unit (grid cell).

Station Location within a Grid Cell

The field crew will select the location at which to deploy the camera based on these considerations:

- as centrally as possible within the cell within mapped wolverine habitat, given the remaining considerations
- at the best-quality site that can be reached (e.g., high elevations near tree line, a saddle between peaks, or drainage bottoms)
- >2 km from any adjacent station; the farther apart the better
- >200 m from a human-use road or trail
- >500 m from a campground

Maps and Waypoint Lists
Field crews will be provided 2 paper maps of each grid cell selected for sampling. One will have aerial imagery as the base layer, the other will have topography as the base layer. Other spatial data included on the maps will be:

- wolverine habitat
- roads/trails
- rivers/streams
- groomed snow machine trails (if available)

Coordinates of the 4 corners of each grid cell and the center of the cell will be calculated in ArcMap and uploaded to GPS units for field navigation. A hard copy list of these coordinates will be carried in the field.

Coordinates uploaded to, and collected by, GPS units will be standardized as:

geographic coordinate system:	lat/long
locations expressed as:	decimal degrees (dd.dddd on the GPS)
datum:	WGS84

Equipment
Camera All stations will deploy the same type of camera, the Reconyx PC800 HyperFire semi-covert infrared model. Cameras will operate with Energizer Ultimate Lithium batteries (no alkaline batteries). Camera settings are detailed in Appendix A.

Hair snagging collar All stations will use .30 caliber gun brushes to collect DNA samples (via snagged hair). Brushes will be arrayed on a corrugated polypropylene plastic 'collar' that wraps on the bole of a tree per the Figura and Knox (2008) design, except with a 5" spacing. Construction and attachment are detailed in Appendix B. DNA collection is detailed in Appendix C.

Bait and Lure All stations will be baited initially with game meat and a long call scent lure. Additional scents and baits will be incorporated at remote sites where monthly rebaiting is not possible. Appendix D provides details on bait and lures.

A complete equipment check list is itemized in Appendix E.

Station Type and Deployment–Revisit Schedule
There are 2 types of stations based on accessibility during December through March. "Accessible" stations will be revisited monthly to replenish bait and scent, collect DNA samples, exchange the SD card, and adjust the camera. Inaccessible stations will be deployed in late fall and not revisited until the following spring (6-9 months later) with no rebaiting, camera adjustments, or periodic DNA collection.

I. <u>Accessible location</u> (assumes reliable access by ski and/or snow machine December–March)

Deployment Date---Accessible stations should be deployed in the tightest window possible **before 1 December**. Bait and scent lure will degrade over time, and our goal is to start the project with stations as near as possible to fresh conditions.

1. Select a suitable site (see Site Location section above).
2. Bait the station with a 15–20 lb chunk of game (e.g., elk or deer hind quarter, beaver). Firmly secure bait to the tree bole with smooth wire as high overhead as can be reached from the ground or snow surface on which you're standing. Secure with multiple wraps around the tree. Tighten wire with twists of a screw driver. See Appendix C for bait prep and attachment.
3. Attach a gun brush collar 12–18" below the bait (see Appendix B, p. 2).
4. Review the camera settings and make sure they match Appendix A. Make sure the LABEL has been assigned as the station ID (grid cell #). Make sure date and time are correct for the current time.
5. Secure the camera to the bole of a tree ~4–6 meters from the bait tree. Use a knotted cord marked at 1-meter intervals to measure this distance.
6. Focus the camera midway between the ground and bait (i.e., with sufficient view to catch an animal on the ground or snow surface if it doesn't climb the tree).
7. Wire a sponge saturated with long call scent lure to a high branch near the bait tree, making sure the ground or snow surface below the sponge (where it will drip) is in view of the camera.
8. Conduct a 'walk test' to test sensor and photo positioning.
9. Carefully examine the walk-test images[1] to confirm that the camera is positioned properly (not too high or too low, too far right or left, etc.). The image should capture an animal on the ground below the bait and on the bait itself.
10. Review tips from Appendix A regarding false triggers.
11. Lock the camera with the cable lock.
12. Mark the location with a GPS and label the GPS point with the station ID.
13. Arm the camera.
14. Write the **station ID** and **date** on a sheet of white paper with a marker and stand in front of the deployed camera to store a reference image that includes yourself in the image.

Revisit the station at 1-month intervals---Revisits should be as close to the **1st of the month** as possible.

1. Walk in front of the camera to photograph your presence.
2. Disarm the camera.

[1] Examine walk-test images on site with a laptop or tablet with appropriate card reader that has been tested to handle the images without damage.

3. Remove the SD card and place in a secure holder for transport. Do not look at the images. Some digital cameras and cell phones damage the images or metadata on the card.
4. Insert a fresh SD card pre-labeled for the camera. Enter the CodeLoc to reactivate the camera. Ensure LABEL is set for the correct grid cell # on the new card.
5. Check battery capacity and replace if needed.
6. Examine gun brushes and remove any brushes with hair from the gun brush collar.
7. Collect gun brush samples per DNA protocol (see Appendix C).
8. Replenish bait; adjust height to account for snow accumulation.
9. Replenish gun brushes.
10. For brushes that had no hair, run lighter flame over brush to re-sterilize.
11. Re-focus the camera per #6 above.
12. Conduct a walk test per #8 above.
13. Carefully examine a walk-test image to confirm that the camera is positioned properly.
14. Review tips from Appendix A regarding false triggers.
15. Arm the camera.
16. Write the **station ID** and **date** on a sheet of white paper with a marker and stand in front of the deployed camera to store a reference image that includes yourself in the image.

Dismantling the station (after March 31):

1. Walk in front of the camera to photograph your presence.
2. Disarm and remove the camera.
3. Remove gun brushes from the collar.
4. Collect hair samples per the DNA protocol (see Appendix C).
5. Collect and remove all materials associated with deployment.

II. <u>Inaccessible location</u> (assumes station will be deployed in fall and not revisited until spring)

Deployment date---as late as possible in the fall when sites are still accessible by driving and/or hiking. This could be as early as the last week of September at some locations.

Follow **all** the same steps as for an Accessible location, with the following exceptions:

1. Use climbing steps and a climbing harness to get bait ~12 ft above bare ground to account for snow accumulation.
2. In addition to, and separate from, the chunk of game meat, **cable** (not wire) 1-2 domestic cow femur bones to the bole of the tree above the meat using 5/8” coated cable and cable locks. Douse these bone(s) liberally with a food scent lure. The bones provide a food lure after the meat has been consumed.

Dismantling the station:

1. Walk in front of the camera to photograph your presence.
2. Disarm and remove the camera.
3. Remove gun brushes from the collar.
4. Collect hair samples per the DNA protocol (see Appendix C).
5. Collect and remove **all** materials associated with deployment to comply with 'leave no trace' principles.

Warning Signs
All stations in grizzly bear areas must have at least 4 warning signs placed at the most likely approach points to minimize the chance that the public inadvertently stumbles onto a bear at our baited sites. Flag each warning sign with high visibility flagging tape. A sample sign is provided at the end of this protocol.

Pre-field Work
For either station type, as much pre-work as possible should be completed before venturing into the field. This includes:

- Construct gun brush collars.
- Label each camera with a unique ID.
- Label 2 SD cards for each camera (same ID as the camera).
- Program SD cards with the Reconyx Professional Settings software.
- Insert programmed SD cards into cameras and manually set the current, correct date and time.
- Print sheets of labels for DNA samples.
- Fill sample vials with desiccant (if using vials instead of envelopes).
- Pre-drill and pre-wire bait.

Field Data & Data Management
Each field crew will be responsible for accurate records of every visit to a grid cell, sorting and managing camera images, logging and storing DNA samples, and entering data into a shared-access, project-wide database. Data management should occur as frequently as possible to avoid a backlog of data entry or lost data and to keep SD cards in rotation.

<u>Field Data</u>
Each visit to a grid cell should be documented on a data form. A project data form is attached at the end of this document. In addition to details about the station itself and the status of cameras, bait, and DNA samples, also record information observed on approach to and in the vicinity of the station, including evidence of disturbance (human or animal) and tracks of species of interest (e.g., fisher, lynx, wolverine).

Camera Images

As a first step, SD cards should be backed up (copied to) to a stable computer. With the volume of photo data this project will be collecting, organization and subfolder structure is critical. Each download from a camera will reside in its own subfolder. Use the following subfolder structure:

\project folder\station folder\visit folder\images

Once copied into the visit subfolder from the SD card, rename all the images in the visit subfolder using a naming convention that combines grid cell ID, date, and revisit #. See Appendix A – Photo Management for details. This will avoid confusion down the road if images are misfiled or moved.

Once a back-up copy of all the images has been downloaded to a hard drive, we will use Colorado Parks and Wildlife CPW Photo Warehouse software (http://cpw.state.co.us/learn/Pages/ResearchMammalsSoftware.aspx) to upload images directly from the SD card to the project database. The software will sort, catalogue, rename, and facilitate identifying images. SD cards should not be cleared until the crew has triple checked that all images have been uploaded to the database and backed up on at least one additional hard drive. At least one of these hard drives should be stored at a different location.

Data Entry

State leads will develop and activate a web-based, secure, shared-access database for data entry. This database will capture field data from visits to sampling stations, photo image results, quantity of DNA samples submitted, and ultimately the presence/absence of wolverine at each station. Each field crew will be instructed how to access the database and enter results frequently as they become available.

Training

A training session will be held for all new and returning crew members. The training program will be developed by the project Coordinator. At a minimum the training will encompass overall project objectives; expectations; work schedules; participating states and contact info of key contacts; examination of field equipment and supplies; and hands-on demonstrations of camera operation, SD card readers, data entry, and photo software. The training also will include review and field practice of snow machine operation, safety, and basic repair; trailering; winter defensive driving; and operation of avalanche beacons and SPOTs or other personal emergency locator devices. An avalanche safety course is strongly recommended.

Literature Cited

Figura, P. and L. Knox. 2008. A lightweight, portable tree-mounted hair snare for mesocarnivores. Unpublished document, California Department of Fish and Game, Redding, CA.

Stevens, D. L., Jr., and A. R. Olsen. 2004. Spatially balanced sampling of natural resources. Journal of the American Statistical Association 99: 262–278.

APPENDIX A

Reconyx PC800 HyperFire IR Camera Settings and Image Files

Every camera used for this project should be programmed by inserting a **32 gb class 10** SD memory card pre-programmed to the settings listed below using the Reconyx Professional Settings software. When the SD card is inserted into the camera, the settings will be transferred. Do not use anything larger than a 32-gb card.

Date/Time: Once the card is inserted, you will be prompted to enter the current date and time. Follow this step interactively on the camera and set the current date and time even if you already set a date/time on the SD card with the programming software. **Make sure the date and time are correct**. Do not change date/time for daylight savings time on any subsequent visits.

The software interface will show settings organized by 5 tabs.

Triggers Tab
- Quickset = Advanced
- Near Video = **5** pictures, waiting **1** second between pictures
- Quiet Period = **15** seconds
- Options = Use the internal motion trigger
  - Advanced: sensitivity = High; require **1** pulses within **1** second
- Schedule = View Schedule
  - Set Daily Schedule = All On (lower right)

Time Lapse Tab (to take a single reference photo per day to show camera is working)
- Time Lapse Interval = Hours; enter **24**
- At the Specified Interval = Take one picture
- Schedule = View Schedule
  - Set Daily Schedule = 1st select 'All Off' (lower right), then scroll to 11 am and toggle to 'Camera On' for the hour of 11 am to 12 noon.

Images Tab
- **Label = Cell <ID> (enter the grid cell #)**
- Brightness = 5th or mid
- Contrast = 5th or mid
- Sharpness = 5th or mid
- Saturation = 5th or mid
- Temperature = Fahrenheit
- Time = 24 hr
- Night Shutter Speed = Fast

Night ISO Sensitivity = Low
Resolution = High
Silent Image VGA Models = leave blank (no border)

Cellular Tab
N/A

Other Tab
HyperFire Models Only = leave blank
CodeLoc = check 'Use CodeLoc' ; select digits **3 3 3 4** (see Note below)

Click 'OK to save all settings.

Note: the CodeLoc must be entered every time the camera is powered up or a SD card is added. The camera won't operate without entering the code. For this reason, it can be a theft deterrent. Place a small sticker on the outside of the camera housing stating "This camera protected by CodeLoc" to deter theft.

Camera Set-up Tips

Avoid false triggers. False triggers most often occur on sunny, breezy days (Reconyx Instruction Manual). Vegetation will soak up the sun's energy and it will become warmer than the ambient air temperature. When the wind moves the vegetation, the camera sees this and cannot distinguish it from a warm-blooded animal moving in the scene. Examine your set-up carefully and anticipate problems. Clear away hanging branches and lichen.

Use only wire to tightly secure hanging bait (no rope or cord that will fray or stretch over time or swing in the wind when the bait is gone).

Use the walk test and examine the photos! Move through the trigger space as if you were the size of a wolverine. Keep in mind that movement directly toward and away from the camera is less likely to trigger the camera than movement across the camera's field of view.

High contrast images—those with large amounts of shade and sun in the same image—often create deep shadows and result in underexposed areas of the frame. These can make it difficult to make out the details of animals that trigger the unit from the shade. Ideally, cameras should face evenly lit or shady areas, such as a backdrop of trees or an open gap with relatively no shade.

Attempt to aim the camera towards the north, away from the east and west where low sun angles during sunrise and sunset can cause flare and distortion in any images taken during those times. Aiming the camera north also could reduce backlighting issues if not facing a highly reflective surface (e.g., snow field).

Photo Management

Images stored on SD memory cards will be downloaded at least twice directly from the card.

The first process creates a back-up copy of the card. Images should be copied to a subfolder specific to that station and visit using the structure:

\project folder\station folder\visit folder\images

Images are assigned a sequential number by the camera, but a card from a different camera will have the same file names.

Name	Date modified	Type	Size
IMG_0001.JPG	2/13/2014 12:53 PM	JPEG Ima...	465 KB
IMG_0002.JPG	2/13/2014 12:53 PM	JPEG Ima...	465 KB
IMG_0003.JPG	2/13/2014 12:53 PM	JPEG Ima...	468 KB
IMG_0004.JPG	2/19/2014 11:29 AM	JPEG Ima...	501 KB
IMG_0005.JPG	2/19/2014 11:29 AM	JPEG Ima...	501 KB

Thus, once the files are copied to their unique visit subfolder, rename the images to assign grid cell ID, year, date, and revisit #. Select all the files in the folder (Control A), right-click the first file name, select 'Rename', and type in the new name.

Name	Date modified	Type	Size
313.2016.02.17.v1.JPG	2/13/2014 12:53 PM	JPEG Ima...	465 KB
IMG_0002.JPG	2/13/2014 12:53 PM	JPEG Ima...	465 KB
IMG_0003.JPG	2/13/2014 12:53 PM	JPEG Ima...	468 KB
IMG_0004.JPG	2/19/2014 11:29 AM	JPEG Ima...	501 KB
IMG_0005.JPG	2/19/2014 11:29 AM	JPEG Ima...	501 KB
IMG_0006.JPG	2/19/2014 11:29 AM	JPEG Ima...	500 KB
IMG_0007.JPG	2/19/2014 11:33 AM	JPEG Ima...	497 KB
IMG_0008.JPG	2/19/2014 11:34 AM	JPEG Ima...	498 KB
IMG_0009.JPG	2/19/2014 11:34 AM	JPEG Ima...	498 KB
IMG_0010.JPG	2/19/2014 12:09 PM	JPEG Ima...	520 KB
IMG_0011.JPG	2/19/2014 12:09 PM	JPEG Ima...	520 KB

313 = cell number
2016 = year
02 = month
17 = day
v1 = revisit #1

Hit enter or move the mouse outside of the file name box; all the files will be renamed with their original sequential number in ( ).

Name	Date modified	Type	Size
313.2016.02.17.v1 (1).JPG	2/13/2014 12:53 PM	JPEG Ima...	465 KB
313.2016.02.17.v1 (2).JPG	2/13/2014 12:53 PM	JPEG Ima...	465 KB
313.2016.02.17.v1 (3).JPG	2/13/2014 12:53 PM	JPEG Ima...	468 KB
313.2016.02.17.v1 (4).JPG	2/19/2014 11:29 AM	JPEG Ima...	501 KB
313.2016.02.17.v1 (5).JPG	2/19/2014 11:29 AM	JPEG Ima...	501 KB
313.2016.02.17.v1 (6).JPG	2/19/2014 11:29 AM	JPEG Ima...	500 KB
313.2016.02.17.v1 (7).JPG	2/19/2014 11:33 AM	JPEG Ima...	497 KB
313.2016.02.17.v1 (8).JPG	2/19/2014 11:34 AM	JPEG Ima...	498 KB
313.2016.02.17.v1 (9).JPG	2/19/2014 11:34 AM	JPEG Ima...	498 KB
313.2016.02.17.v1 (10).JPG	2/19/2014 12:09 PM	JPEG Ima...	520 KB
313.2016.02.17.v1 (11).JPG	2/19/2014 12:09 PM	JPEG Ima...	520 KB
313.2016.02.17.v1 (12).JPG	2/19/2014 12:09 PM	JPEG Ima...	521 KB
313.2016.02.17.v1 (13).JPG	2/19/2014 12:10 PM	JPEG Ima...	514 KB

The second download from the SD card will use the CPW Photo Warehouse software to catalogue files. Refer to the software User Guide http://cpw.state.co.us/learn/Pages/ResearchMammalsSoftware.aspx) for instructions on how to set up a new project in the database prior to downloading photos. You will define a study area, station locations, visits, and, optionally, a species list and detection details. When ready to 'Import Photos' from the SD card, opt to also copy the photos to a new location. Select a destination folder located on a different hard drive than the initial backup and rename files using the same naming convention described above (cell ID.year.month.day.revisit).

SD cards should not be cleared until the crew has triple checked that all images have been uploaded to the database and backed up on at least one additional hard drive.

APPENDIX B

Gun Brush Collar

A lightweight, portable tree-mounted hair snare for mesocarnivores

Pete Figura and Luke Knox
California Department of Fish and Game
Redding, CA
Contact: pfigura@dfg.ca.gov, (530) 225-3224

March 2008

Description

This tree-mounted hare snare design utilizes corrugated plastic, tee nuts, and gun cleaning brushes as its main components. It is light, portable, relatively inexpensive, and is easy to build and install. Samples can be collected by removing the brushes that contain hair, and replacement brushes can be threaded into place. The design has been very effective for detecting marten in northern California, and it has also detected long-tailed weasel, spotted skunk, red fox, and gray fox[1].

<u>Parts list for each device (see Figure 1)</u>

- 1 - 3" x 22" piece of Coroplast™ corrugated polypropylene plastic (or equivalent), cut with long axis perpendicular to the plastic flutes
- 4 – tee nuts (8-32 thread)
- Duct tape (approximately 30" length)

<u>Parts list for installation (see Figure 1)</u>

- 4 - .30 caliber gun cleaning bristle brushes (8-32 thread)
- 3 – 1" fence staples ("u nails") or 1" roofing nails

Figure 1

<u>Helpful tools for assembly</u>

- Dark-colored Sharpie™ or equivalent marker
- Utility knife
- Hammer
- Electric drill w/ 3/16" bit
- Scrap piece of lumber

[1] Dimensions and quantities specified in the following sections have been modified from the original design to accommodate larger carnivores anticipated in this wolverine project.

Assembly

1. Mark the plastic at the following distances from one end: 1”, 6”, 11”, 16”, 21”.

2. At each mark location, cut through the top layer of plastic parallel to and between the flutes nearest each mark. After making these cuts, the top layer of the plastic (which will become the front of the device) will now be cut into four 3”x5” rectangles, bounded by a 1”x3” rectangle on each end (Figure 2). These cuts permit the device to readily flex around the bole of a tree.

3. Mark the center point of each of the 3”x5” rectangles. Drill through the plastic sheet at these locations with a 3/16” bit.

4. Insert a tee nut into each of the holes. Insert the nut from the back side of the snare device, with the prongs facing forward. The fit should be snug. It is usually helpful to tap each tee nut in with a hammer. Use a piece of scrap lumber on the front side of the device to absorb the blows and protect the front end and threads of the tee nut (Figure 3).

5. Place a piece of duct tape over the back of each tee nut, and then place a long piece of duct tape across all of the tee nuts (Figures 4 and 5).

Figure 2

Figure 3

Figure 4

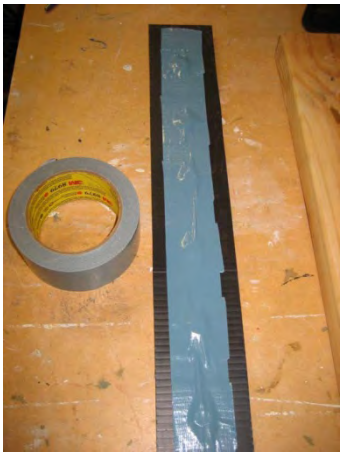

Figure 5

General installation/use guidelines

1. The gun brush collar can be attached to trees of various sizes, although it is probably best to utilize trees that allow the brushes to be centered under the bait.

2. Attach snare device 12-18” below bait. Aim for ~12‘’ (no closer) but adjust as needed to avoid branches and stobs. Attach by doubling back the one inch flaps at each end and driving a fence staple or nail through the two layers of Coroplast and into the tree. A third staple can also be driven through the center of the snare device for added stability.

3. Thread a gun brush into each of the tee nuts (Figure 6).

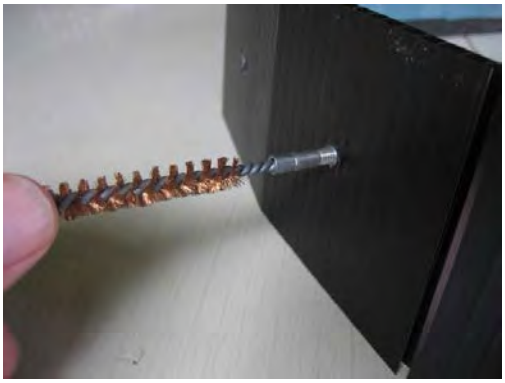

Figure 6

APPENDIX C

Handling DNA Samples

This project uses the USFS Rocky Mountain Research Station National Genomics Center for Wildlife and Fish Conservation's *Protocols for Collecting and Storing DNA Samples* (rev December 2006), with modifications approved by authors Michael Schwartz and Kristy Pilgrim.

Field Collection

In most cases the entire gun brush with ensnared hair will be collected.

1. Unscrew the gun brush from the collar on the tree and place the brush in a 2 ½ x 4 ¼ coin envelope (no desiccant) *or* a 30- ml polyethylene plastic vial filled ~ ½ full with silica desiccant beads.
2. Attach a pre-printed label and fill out the label with cell ID, date, observer, type of DNA, and sample number.
   (Note: A bar code system is planned for winter 2016/2017.)
3. Repeat steps #1 and #2 for each brush, attaching a new label to each envelope or vial.
4. If using coin envelopes, place sealed envelopes into a zip lock bag holding silica desiccant beads.
5. Protect envelopes and vials from sun, moisture, and other damage during transport from the field.

Sorting

In an office setting, examine all photos from the camera corresponding to the sample to determine which samples should be retained for DNA analysis.

1. If there is clear evidence of only nontarget species (e.g., a hundred photos of a marten or fox) and no gaps in the photo sequence, exclude the sample.
   a) Remove hair from the brush.
   b) Record the status of that grid cell and time period in the database.
   c) Burn the gun brush to sterilize and reuse.

2. If wolverine images occur on the camera or it is unclear if wolverines could have been present, retain the sample.
   a) Wearing sterile gloves, remove the gun brush from coin envelope or vial and place on a sterile surface.
   b) Pour a small amount of ethanol on tweezers or forceps and wipe tweezers thoroughly with Kim-Wipes or similar clean tissue.
   c) Remove hair from the gun brush and put it back into the original labeled envelope or vial from which it came.
   d) Record the status of that grid cell and time period in the database.
   e) Burn the gun brush to sterilize and reuse.

Storage/Shipping

DNA samples will be shipped periodically (see below) to the RMRS genetics lab for analysis. Prior to shipment, store samples at room temperature out of direct sunlight. Occasionally check the color of the desiccant, if relevant, and add fresh desiccant as needed. Do not replace desiccant in vials as you might inadvertently dispose of hair.

DNA samples should be shipped every 2 or 3 weeks, depending on the project's collection schedule. Ship to:

Kristy Pilgrim
National Genomics Center for Wildlife and Fish Conservation
Rocky Mountain Research Station
800 E. Beckwith Ave.
Missoula, MT 59801

1. Ship samples on a Monday, Tuesday, or Wednesday. Avoid Thursday and Friday so they don't sit at a post-office in unknown conditions.

2. Send via overnight mail.

3. Send an e-mail to Kristy Pilgrim and cc Mike Schwartz letting them know the samples are coming.
   kpilgrim@fs.fed.us
   mkschwartz@fs.fed.us

4. Attach to the email a list of the samples being shipped.

5. Include in the package a hard copy of the list of samples so they can cross check the samples.

6. Include a hard copy of the chain of custody form in the shipment. The form is for each batch (not each sample). Fill out the top gray boxes and the first "From" line (name, release signature, release date). The form can be obtained from the RMRS website at: http://www.fs.fed.us/rm/wildlife-terrestrial/docs/genetics/reports-protocols/CHAIN_OF_CUSTODY_RECORD.pdf

7. Expect an email confirmation from the lab when samples arrive. The lab will begin extractions immediately to preserve DNA.

APPENDIX D

Bait and Scent Lures

The presence or absence of bait and lure at camera stations influences detection of wolverines. Because station type (accessible, inaccessible) is one variable to be accounted for in analyses, it's important to reduce other potential sources of variation. Bait size relates to persistence of bait over 1-month intervals and therefore should be standardized. Scent lures and amounts also should remain consistent across stations.

Long call scent lure

This project uses a recipe originally developed by Eric Lofroth for wolverine surveys in British Columbia and modified by Robert Long and Joel Sauder to perform in a prototype pump dispenser they are testing during winter 2015/16 on independent projects in WA and ID. If the dispenser performs well, it potentially could be a tool available across all 4 states during winter 2016/17 to maintain scent at remote sites that can't be visited to manually replenish scent. For consistency, we will use this same long call scent lure without the dispenser during year 1 of the project in WY.

For a 2-liter (67-oz) batch of lure:

Propylene glycol	38.0 oz
Water	25.0 oz
Hawbaker's Marten lure	1.0 oz
Beaver castor oil (liquid)	2.0 oz
Skunk Quill	0.3 oz
Anise oil	0.5 oz

Saturate a ~3x3x3 piece of sponge thoroughly with the long call lure and wire the sponge to a high branch adjacent to the bait tree in view of the camera.

Suggested Sources for Lure Ingredients

Item	**Part #/Details**	**Unit**	**Source**
Skunk Essence (100% Pure Quill)		1 oz bottle	Northland Animal Lures
Propylene glycol; food grade	SKU: 82020	1 (40 lbs)	The Chemistry Store
Beaver castor (liquid)	NWS011L	16 oz bottle	Wildlife Control Supplies
Hawbaker's Marten Lure	HBMARTEN	1 oz bottle[a]	Minnesota Trapline Products
Anise oil			most trapping supply sources

[a] Note that it is very difficult to get the paste out of these tiny bottles, so an alternate source may be preferred. Avoid marten lures that look like chapstick; these don't dissolve well in propylene glycol.

Bait

Aim for a 15-20 lb chunk of wild game meat, typically from a road-killed deer or elk. Beaver carcasses also work well. Use hind quarters of deer (front quarters are not big enough), front or hind quarters of elk, or an entire beaver. Skin the meat to avoid bait hair falling onto gun brushes and contaminating DNA samples.

Drill holes through the frozen meat for wiring. Make 2 holes on either side of the spinal column or leg bones about 3-4”apart. Wrap wire through these 4 holes and around the spinal column several times. Use a sturdy screw driver to twist-tighten the wire around the carcass (the wiring will loosen as meat thaws). Leave wire tails 3-4 feet long on both ends.

Place a large nail on the backside of the tree at the same height as the bait, and a nail above, below, and on either side of the bait ~4 inches away. Take the tails of wire extending from the bait and wrap them around the tree and the nails. Wrap 2-3 more long pieces of wire from different angles around the whole carcass, using the nails as anchor points. Twist-tighten the wire with a screwdriver so it is securely attached to the tree.

Cow bones and food scent lure

Inaccessible stations will eventually run out of bait. Bones will continue to attract animals after the flesh is gone. As a substitute for fresh bait we will use 2 domestic cow femur bones and a food scent lure <u>in addition to</u> the bait described above at inaccessible stations. Drill a ¾” hole through the bones and thread 5/8” cable through the hole, leaving a 3-4 ft tail. Secure the bones to the tree <u>above</u> the meat bait with cable locks above 1-2 of the anchor nails to keep the cable from slipping. Make sure the bones are within view of the camera. Liberally douse the bone with the food scent lure (see below).

Food scent lure

Different from the long call scent lure, a food scent lure on bones is a substitute for fresh bait once the bait is gone. Preferred is a mixture of aged fish and blood, commonly used in bear research and monitoring projects. Check with your local large carnivore biologist for a source.

APPENDIX E

Equipment and Materials Checklist

- gun brushes (4 plus 4 replacement)
- plastic gun brush collar
- Reconyx PC800 semi-covert camera
- desiccant pak for camera
- camera cable lock & key
- AA lithium batteries (12 per camera plus 12 replacement)
- 32 gb class 10 SD card (1 plus 1 replacement)
- 2 ½ x 4 ¼ coin envelopes or 30 ml vials
- labels
- desiccant
- ziplock bags
- long call scent lure
- 3”x3’x3” sponge
- bait
- smooth wire
- lighter

Additional items for “inaccessible sites”

- screw-in climbing steps (3)
- climbing harness
- climbing safety straps
- cow leg bones (2)
- food scent lure
- cable
- cable locks
- small wrench for cable locks

- map w/ habitat and grid cells
- GPS (set to dd.dddd, WGS84)
- list of grid cell coordinates
- 6-meter cord knotted at 1-m intervals
- large nails (5-6 per station)
- hammer
- screw driver
- folding saw
- rite-in-rain paper
- Sharpy wide-tip magic maker
- rubber gloves
- SD card reader
- laptop or tablet
- SPOT or other emergency safety device

ATTENTION

Wildlife Monitoring Station
Beyond This Sign

Carnivore attractant in use

Please use caution in the area

Camera/DNA Station Data Form

Station Information **Type (circle one):** **Accessible** **Inaccessible**

Cell/Site Number _____ Cell/Site Name _____ State _____

Drainage _____ Mtn. Range _____

Elevation _____ Lat _ _ . _ _ _ _ _ Long _ _ _ . _ _ _ _ _ (decimal degrees, WGS84)

Site Description (why site chosen) _____

_____

Access and Specific Location Notes _____

_____

Visit Type (circle one): Initial Deployment Revisit 1 Revisit 2 Revisit 3 Pull Camera

Date _____ Observers _____

Initial Deployment

Camera Model _____ Camera ID# _____ CodeLoc _ _ _ _

Batteries: Brand _____ Size _____ Type (Lithium NIMH) Expire Date_____

Correct Date & Time set? Y N Image Label set to cell ID? Y N Desiccant Pak? Y N

Bear Box deployed? Y N

Gun Brush Collar? Y N Number Gun Brushes Deployed_____

Bait Type _____ Bait Size_____ Distance Camera to Bait (m)_____

Scent Lure Type _____ Lure Placement _____

Warning Signs_____

Walk-test: Gun brushes visible in camera? Y N Bait visible? Y N

Revisit *(do not adjust camera date/time for daylight savings)*

# of Photos _____ % Memory Used _____ Memory Card Exchanged? Y N

New Card: Model _____ Size _____GB Read/Write Speed_____MB/s Class_____ ID#_____

Battery Status _____% Batteries Replaced? Y N

Batteries: Brand _____ Size _____ Type (Lithium NIMH) Expire Date_____

Desiccant Pak Changed? Y N

Camera Issues? Describe _____

Number of Gun Brushes Collected _____ DNA Sample ID #s:_____

Bait Status (circle one): Intact Partially Gone Gone

New Bait Type _____ Bait Size _____

Scent Lure Type _____ Lure Placement _____

All Visits

Evidence of Disturbance _____

_____

Tracks Observed (fisher, lynx, wolverine). Document with good quality photos showing key measurements. Mark tracks with GPS and record coordinates below in decimal degrees, WGS84.

Species _____ Lat _ _ . _ _ _ _ _ Long _ _ _ . _ _ _ _ _ Dist from Station (m)_____
Photos Taken? Y N Photo Numbers _____

Species _____ Lat _ _ . _ _ _ _ _ Long _ _ _ . _ _ _ _ _ Dist from Station (m)_____
Photos Taken? Y N Photo Numbers _____

Species _____ Lat _ _ . _ _ _ _ _ Long _ _ _ . _ _ _ _ _ Dist from Station (m)_____
Photos Taken? Y N Photo Numbers _____

Additional Notes

(over)

DISTRIBUTION OF SPOTTED SKUNKS (*SPILOGALE* SPP.) IN WYOMING

STATE OF WYOMING

NONGAME MAMMALS: Species of Greatest Conservation Need – Eastern Spotted Skunk and Western Spotted Skunk

FUNDING SOURCE: Wyoming Governor's Big Game License Coalition
Wyoming Governor's Endangered Species Account Fund

PROJECT DURATION: 1 July 2015 – 30 June 2016

PERIOD COVERED: 1 March 2016 – 30 April 2016

PREPARED BY: Brian M. Zinke, Nongame Biologist

SUMMARY

In 2011, the plains spotted skunk (*Spilogale putorius interruptus*), a subspecies of the eastern spotted skunk (*S. putorius*), was petitioned to be listed under the Federal Endangered Species Act. Both the plains spotted skunk and western spotted skunk *(S. gracilis*) occur in Wyoming, but their distributions are poorly understood due to their nocturnal habits. In addition, both species are similar in morphometric and pelage characteristics, which further complicates our understanding of distribution. Prior to 2016, the Wyoming Game and Fish Department's (Department) database contained 55 historic records of spotted skunks. These records are the result of the Department's 2014-2015 spotted skunk survey, roadkills, legal harvest/non-target captures by trappers, other management/research trapping, casual observations, and unknown circumstances (Table 1).

To better understand the distribution of both spotted skunk species in Wyoming, we conducted a database search for historic sightings (before 1 March 2016), implemented a public outreach campaign, and set trail cameras in suspected spotted skunk habitat. The public outreach campaign consisted of asking the public for information on spotted skunk sightings via press release, Wyoming Wildlife magazine, the Department's Facebook page, and e-mail newsletters. An online form was also created through which the public could report sightings. Two trail cameras were opportunistically set in March while assisting with bat hibernacula surveys. Finally, we contacted the Nebraska Game and Parks Commission and the South Dakota Game, Fish, and Parks to determine if they had any records of spotted skunks along the eastern border of Wyoming (Figure 1).

The public outreach campaign successfully solicited 16 new spotted skunk sightings from multiple sources (Table 1). Additionally, both trail cameras detected spotted skunks in the

Birdseye Mountain region of the Owl Creek Mountains. As a result, we now have 73 records in the Wildlife Observation System database, an increase of 33%. The majority of all records have come in recent years (67% since 2000) due to increased survey effort and increased public outreach (Figure 2).

Due to the similar appearance of both spotted skunk species, we did not attempt to distinguish each species. Rather, the goal was simply to determine where spotted skunks, in general, occur throughout the state. The addition of these new records helps the Department better understand the overall distribution of spotted skunks across the state as well as their habitat use, which could help guide future, more targeted surveys, if needed. Additionally, these new data allow the Department to be better prepared for a potential listing in the future if spotted skunk populations continue to decline. Soliciting information from the public about species sightings, particularly when the species are easily identifiable, proved to be a successful technique and should be considered when seeking information about cryptic species in the future.

ACKNOWLEDGEMENTS

Funding for this project was provided by Wyoming Governor's Big Game License Coalition, for which the Department is extremely grateful. We thank Public Outreach Specialist S. DiRienzo, Communications and Outreach Supervisor R. Fitzgerald, and *Wyoming Wildlife* Magazine Interim Editor J. Obrecht for their assistance in creating press releases, newsletters, social media outreach, and a magazine article asking for information from the public. We also extend a special thanks to K. Stoner, R. Simpson, and S. Wilson of the Nebraska Game and Parks Commission and E. Dowd Stukel and C. Heimerl of the South Dakota Game, Fish and Parks for their cooperation and sharing of records. Finally, we are extremely grateful to those members of the public who contacted us and reported their sightings, without whom this project would not have been as successful.

Table 1. Number of records of spotted skunks (*Spilogale* spp.) by information source in Wyoming. Historic records are those previously recorded in the Wildlife Observation System (WOS) database before 1 March 2016. New records are from recent sightings, or older sightings that were previously unknown to the Wyoming Game and Fish Department (WGFD), thus not recorded in the WOS database prior to 1 March 2016.

Information source	Historic records	New records	Total
WGFD 2014-2015 survey	16	0	16
Unknown circumstances	13	0	13
Legal harvest/non-target captures by trappers	9	4	13
Casual observations	2	9	11
Roadkills	10	0	10
Other management/research trapping	5	5	10
Totals	55	18	73

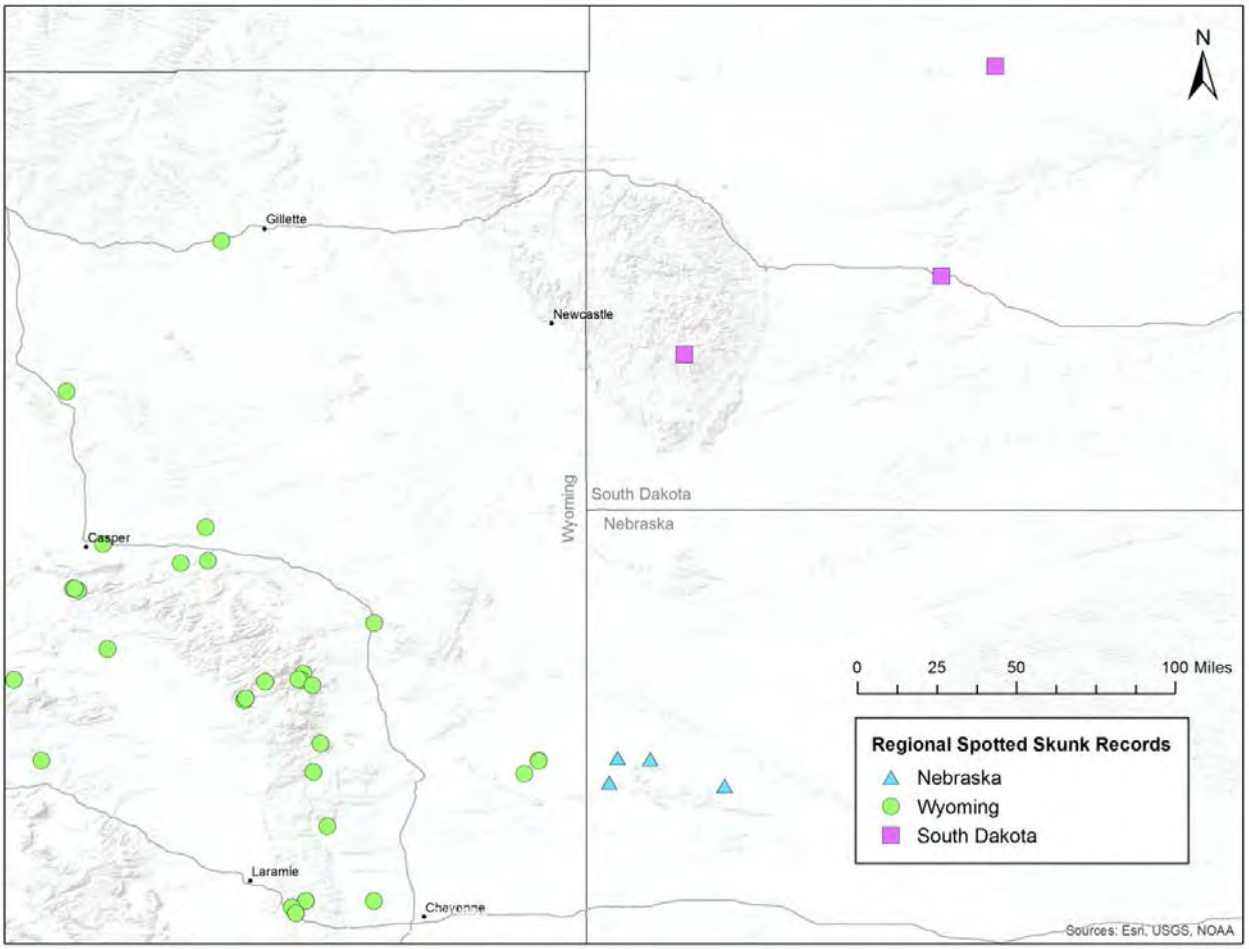

Figure 1. Records of spotted skunks (*Spilogale* spp.) along the Wyoming, Nebraska, and South Dakota borders as of September 2016.

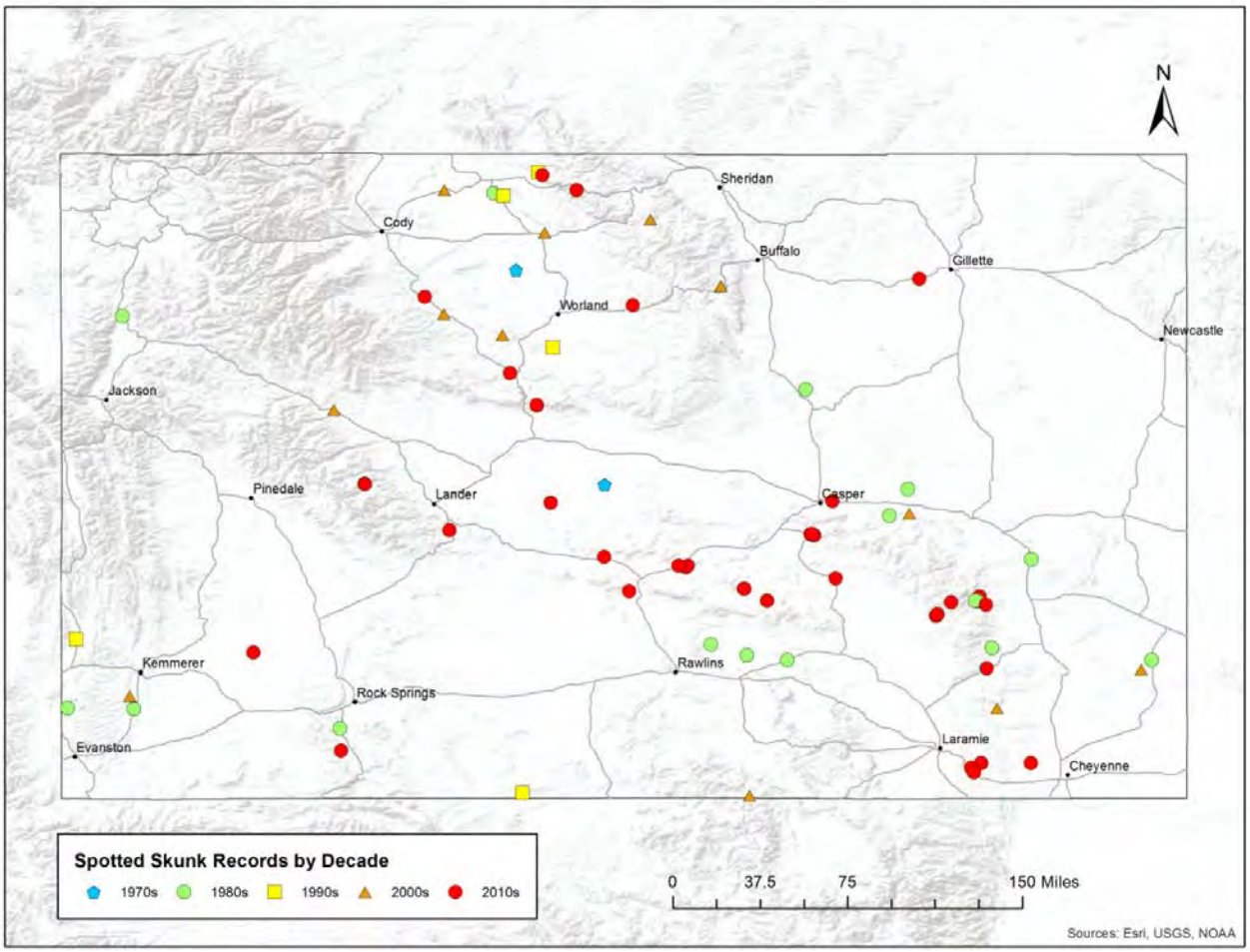

Figure 2. Distribution of spotted skunk (*Spilogale* spp.) records across Wyoming as of September 2016, displayed by the decade in which the observation occurred.

HARVEST REPORTS

HARVEST OF RAPTORS FOR FALCONRY

STATE OF WYOMING

NONGAME BIRDS: Raptors

FUNDING SOURCE: Wyoming Game and Fish Department
Bureau of Land Management Cooperative Agreement

PROJECT DURATION: Annual

PERIOD COVERED: 1 January 2016 – 31 December 2016

PREPARED BY: Courtney Rudd, Nongame Biologist
Kristen DaVanon, Game Warden Trainee

SUMMARY

In 2016, the Wyoming Game and Fish Department issued 41 falconry capture licenses. The number of licenses issued represented no change from 2015 (n = 41 licenses). Licenses were issued for 30 residents and 11 nonresidents. Residents filled 10 of 30 licenses; nonresidents filled 6 of 11 licenses. Like 2015, Red-tailed Hawk (*Buteo jamaicensis*) was the most commonly captured species during 2016, with 4 captures (all females) by residents and the remaining capture (1 female) by a nonresident. Of the 4 Prairie Falcons (*Falco mexicanus*) captured, 3 were captured by residents (2 males, 1 unknown) and 1 (female) by a nonresident. Three Peregrine Falcons (*Falco peregrines*) were captured, 2 by residents (1 female, 1 male) and 1 female by a nonresident. A resident and nonresident each captured female Northern Goshawks (*Accipiter gentilis*). Two Ferruginous Hawks (*Buteo regalis*) were captured by nonresidents in 2016 (1 female, 1 male); this species was last captured in 2014 (Table 1). The total number of birds captured in 2016 (n = 16) was less than the mean (±SE) number of captures from 1981-2015 (21.83 ± 1.48 birds). Additionally, capture success for 2016 (39%) was slightly less than the mean (±SE) capture success from 1981-2015 (45.8% ± 2.17%, Table 2).

Table 1. Species and number of raptors captured by residents and nonresidents for falconry in Wyoming, 2016.

Species captured	Number of resident captures	Number of nonresident captures	Total captures
Ferruginous Hawk	0	2	2
Northern Goshawk	1	1	2
Red-tailed Hawk	4	1	5
Peregrine Falcon	2	1	3
Prairie Falcon	3	1	4
Total	10	6	16

Table 2. Number of individuals captured and yearly capture success rate (%) for raptors taken for falconry in Wyoming, 1981-2016.

Year	Number of raptors captured	Capture success rate (%)
1981	27	37
1982	40	52
1983	18	18
1984	25	33
1985	39	53
1986	33	35
1987	19	36
1988	28	51
1989	26	55
1990	32	68
1991	29	66
1992	22	53
1993	13	37
1994	21	33
1995	12	30
1996	25	47
1997	19	61
1998	31	63
1999	27	55
2000	24	57
2001	21	45
2002	29	58
2003	21	49
2004	33	48
2005	13	31
2006	14	40
2007	15	45
2008	27	69
2009	8	53
2010	5	26
2011	15	50
2012	20	49
2013	10	30
2014	11	41
2015	12	29
2016	16	39

OTHER NONGAME – BIRDS

USING THE BREEDING BIRD SURVEY TO MONITOR POPULATION TRENDS OF AVIAN SPECIES IN WYOMING

STATE OF WYOMING

NONGAME BIRDS: Other Nongame

FUNDING SOURCE: Wyoming State Legislature General Fund Appropriations
Bureau of Land Management Cooperative Agreement
Bureau of Reclamation Cooperative Agreement
National Park Service Cooperative Agreement
United States Fish and Wildlife Service Cooperative Agreement
United States Forest Service Cooperative Agreement

PROJECT DURATION: Annual

PERIOD COVERED: 14 April 2015 – 14 April 2016

PREPARED BY: Courtney Rudd, Nongame Biologist
Andrea Orabona, Nongame Bird Biologist
Unites States Geological Survey – Biological Resources Division

ABSTRACT

The Breeding Bird Survey has provided long-term monitoring of a variety of avian species in Wyoming since 1968. In 2015, volunteers surveyed 72 Breeding Bird Survey routes across the state. Overall, survey effort and number of species detected per route have increased, while the number of detections per survey has decreased. Recruiting knowledgeable volunteers to conduct Breeding Bird Survey routes is critical to ensuring the success of the Breeding Bird Survey and our ability to continue to monitor populations of breeding birds along roadside surveys.

INTRODUCTION

Fifty-six avian species are classified as Species of Greatest Conservation Need (SGCN) by the Wyoming Game and Fish Department (Department; WGFD 2017). The Department utilizes data from various large-scale, multi-species survey efforts to monitor trends in avian populations, while implementing species-specific surveys for those species that are not adequately monitoring using the multi-species survey methods.

The Breeding Bird Survey (BBS) is used to monitor trends of breeding birds across North America. The BBS is sponsored jointly by the United States Geological Survey – Biological Resources Division (USGS-BRD; formerly the US Fish and Wildlife Service [USFWS]) and the Canadian Wildlife Service. This roadside survey methodology was field tested in 1965 and formally launched in 1966, with 600 routes established in the US east of the Mississippi River and in Canada (Sauer et al. 1997). In 1967, the BBS spread to the Great Plains states and prairie provinces. By 1968, approximately 2,000 BBS routes were set up across southern Canada and the contiguous 48 states, and more than 1,000 routes were surveyed annually. During the 1980s, the BBS expanded further into Alaska and Canada's Yukon and Northwest Territories, and additional routes were added in many states. Today, over 4,600 BBS routes are located across the continental US and Canada, including 108 active routes in Wyoming (Figure 1).

The BBS was designed to provide a continent-wide perspective of population change. All routes have been randomly located in order to sample habitats that are representative of the entire region. Other requirements, such as consistent methodology, observer expertise, visiting the same stops each year, and conducting surveys under suitable weather conditions, are necessary to produce comparable data over time (Sauer et al. 1997). A large sample size (i.e., number of routes conducted) is needed to average local variations and reduce the effects of sampling error (i.e., variation in counts attributable to both sampling technique and real variation in trends).

The BBS provides an index of relative abundance rather than a complete count of breeding bird populations. Data can be used to estimate population trends and relative abundance of individual species at the continental, regional, statewide, and physiographic region scale. Relative abundance maps should be viewed with some caution, however, as species tend to be rare, locally distributed, and likely to be poorly represented along BBS routes at the edges of their ranges (Sauer et al. 1997). The most effective use of BBS data is to analyze population change on survey routes; however, these data do not provide an explanation for the causes of population trends. To evaluate population changes over time, BBS indices from individual routes are combined to acquire regional and continental estimates of trends (Sauer et al. 1997). Some species have consistent trends throughout the history of the BBS, although most do not due to stochastic effects that can affect populations.

Our objectives in 2015 were to add additional data to the BBS and interpret current large-scale trends of nongame breeding birds in Wyoming. Population trend estimates were completed through 2015 for over 420 species of birds and, for the purposes of this report, were reviewed for SGCN only (Sauer et al. 2017). All raw data can be accessed on the BBS web site http://www.pwrc.usgs.gov/bbs/ (Pardieck et al. 2016).

METHODS

Volunteers are instructed to conduct BBS routes during the height of the avian breeding season when birds are most vocal. This is typically during the month of June, although routes in higher elevations can be conducted through the first week of July. Each route is 39.4 km

long and consists of 50 stops spaced at 0.8 km intervals along the route. Beginning 0.5 hour before sunrise, observers record birds seen within a 0.4 km radius and all birds heard at each stop during a 3-minute count period. Each route is surveyed once annually, and data are submitted to the USGS-BRD for analysis. For all summary statistics on survey effort, we report averages ±SE. All analyses on abundance of breeding birds in Wyoming were conducted by USGS-BRD.

RESULTS

In 2015, observers surveyed approximately 2,516 of 3,578 (70%) active routes in the US. In Wyoming, observers surveyed 72 of the 108 (67%) active routes. Results are reported in Table 1. Since 1990, the number of routes surveyed in Wyoming has decreased by 0.59 routes per year ($P<0.001$; $R^2=0.3519$; Figure 2). Contrary to this trend, the number of routes surveyed in 2015 (i.e., 72 routes) was greater than the mean number of routes completed from 1990-2014 (65.0 ±1.52 routes).

Observers detected a total of 37,318 individual birds representing 186 species in Wyoming (Table 2). Since 1990, the number of individuals detected has decreased by 4.5 individuals per route per year ($P<0.001$; $R^2=0.557$; Figure 3), but the number of species detected has increased by 0.14 species per route per year ($P<0.001$; $R^2=0.424$; Figure 4). Consistent with these trends, the number of individuals detected per route in 2015 (i.e., 517.5 ±32.6 individuals) was slightly less than the mean number of individuals detected per route between 1990–2014 (i.e., 528.4 ±9.4 individuals); however, the number of species detected per route in 2015 (i.e., 40.2 ±1.3 species) was slightly greater than the mean number of species detected per route between 1990-2014 (i.e., 38.0 ±0.3 species).

Of the 186 species detected in 2015, 30 are SGCN. Of this latter total, 5 have sufficient data for trend analysis from 1968-2015 (Tables 3-4) and includes Brewer's Sparrow (*Spizella breweri*), Grasshopper Sparrow (*Ammodramus savannarum*), Lark Bunting (*Calamospiza melanocorys*), and Sage Thrasher (*Oreoscoptes montanus*), which display stable populations; and Sagebrush Sparrow (*Artemisiospiza nevadensis*), which displays an increasing population. Of the SGCN for which the USGS-BRD can determine a directional trend (Tables 3-4), 5 species differ from nationwide trends. BBS data suggest that Brewer's Sparrow, Grasshopper Sparrow, Lark Bunting, and Sage Thrasher populations are decreasing nationwide, but are stable in Wyoming. BBS data also suggest that Sagebrush Sparrow is increasing in Wyoming, while the population is stable nationwide.

DISCUSSION

A complete history of BBS observers and routes surveyed in Wyoming from 1968-2015 is available from the Department's Nongame Bird Biologist in the Lander Regional Office. Because the primary purpose of the BBS is to monitor population trends of avian species nationwide, it is important that each route is conducted annually, preferably by the same observer. However, in Wyoming fewer than 20 of the 108 total routes have been surveyed

annually or with minimal interruptions in the annual survey cycle for >10 years. Most routes contain gaps in surveys of ≥2 years or have had ≥2 observers. There are several causes of BBS observer disruption: change in location or job duties during the course of an observer's career, loss of observers as they age and have increasing difficulty detecting vocalizations, and a limited pool of new and skillful observers in Wyoming from which to draw. In addition, as the degree of urbanization steadily increases, associated problems with safety and noise are an issue on some BBS routes. To address these problems, dangerous routes have been altered or are no longer conducted, although data gathered from progressively urbanized routes are important for the BBS's ability to measure changes on the landscape that birds are experiencing.

Overall, survey effort has decreased in the last 26 years. 2015 recorded the 5th highest number of routes completed since 1990; at 72 routes, this was an increase of 7 routes from 2014, keeping Wyoming in the 51-75% completion bracket. While the number of individual birds detected per route has decreased steadily, the number of species detected per route has slightly increased over time. This increase in number of species per route is interesting, and may represent changes in species distributions or increases in identification skills of observers over time.

The UGSG-BRD has sufficient data to develop population trends for 5 avian SGCN in Wyoming; 4 of these species demonstrate stable trends, including Brewer's Sparrow, Grasshopper Sparrow, Lark Bunting, and Sage Thrasher; while 1 species, Sagebrush Sparrow, demonstrates an increasing population. The stable population trend associated with Lark Bunting is a positive shift from recent declines in the statewide population. Lark Bunting is highly dependent on grasslands, a habitat at high risk for degradation, alteration, or loss, and listed among the most imperiled habitats in the US (WYPIF 2002, WGFD 2017). Sagebrush habitats are increasingly threatened by habitat modification, and are often recognized as the limiting factor for sagebrush-obligate species (WGFD 2017). Consequently, the stable populations of Brewer's Sparrow, Grasshopper Sparrow, and Sage Thrasher, in addition to the increasing population of Sagebrush Sparrow, is promising.

The uses of BBS data are manifold. Trend data are used by the USFWS, Canadian Wildlife Service, and Partners in Flight to assess bird conservation priorities. Data were instrumental in focusing research and management actions on Neotropical migratory birds in the late 1980s, and on grassland birds in the mid-1990s. BBS data are used to help determine the need for SGCN status in State Wildlife Action Plans. State Natural Heritage programs and Breeding Bird Atlas projects use BBS data to enrich their databases. Data are used by educators as a tool to teach biological, statistical, and Geographic Information System concepts. Finally, BBS data have been used in over 450 scientific publications. Thus, the importance of recruiting and retaining qualified observers and ensuring that routes are conducted annually cannot be overstated.

ACKNOWLEDGEMENTS

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many volunteers and biologists from this and other natural resources management agencies for their valuable contributions to the 2015 Breeding Bird Survey (see names in Table 1). The continued dedication of these individuals and agencies to this monitoring effort makes it possible to collect long-term population trend data on numerous avian species in Wyoming.

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Table 1. Latitudinal/longitudinal (latilong) degree block, observer, number of avian species detected, and number of individuals recorded for each Breeding Bird Survey route in Wyoming, 2015. Data are presented in numerical order by survey route. An asterisk indicates a deficiency is associated with a route (e.g., inclement weather, route conducted before or after the recommended survey window, private land access issues, lost data sheet, late start time).

Route number and name	Latilong	Observer	Species	Individuals
1 – NE Entrance, YNP	1	John Parker	55	561
2 – Cody	2	Grace Nutting	51	466
3 – Otto	3	Rex Myers	34	529
4 – Basin	4	N/A – discontinued		
5 – Wyarno	5	John Berry	40	1190
6 – Clarkelen	6	N/A – discontinued		
7 – Sundance	7	Jennifer Adams	47	410
8 – Colter Bay	8	N/A – discontinued		
9 – Dubois	9	Jazmyn McDonald	53	384
10 – Midvale	10	Observer needed	Not conducted	Not conducted
11 – Nowood	11	Donna Walgren	Not conducted	Not conducted
12 – Natrona	12	N/A – discontinued		
13 – Bill	13	Observer needed	Not conducted	Not conducted
14 – Redbird	14	N/A – discontinued		
15 – Fontenelle	15	Observer needed	Not conducted	Not conducted
16 – Elk Horn	16	Zack Walker	30	349
17 – Bear Creek	17	Andrea Orabona	19	316
18 – Ervay	18	Jazmyn McDonald	36	273
19 – Brookhurst	19	Bruce Walgren	48	367
20 – Glenrock	20	N/A – discontinued		
21 – Dwyer	21	Martin Hicks	Not conducted	Not conducted
22 – Cumberland	22	Observer needed	Not conducted	Not conducted
23 – McKinnon	23	N/A – discontinued		
24 – Patrick Draw	--	N/A – discontinued		
25 – Savery	25	Marie Adams	41	296
26 – Riverside	26	Steve Loose	43	666
27 – Buford	27	Suzanne Fellows	Not conducted	Not conducted
28 – Yoder	28	Gloria Lawrence	52	1294
29 – Canyon	--	N/A – discontinued		
30 – Mammoth, YNP	1	Lisa Strait	44	469
31 – West Thumb	--	N/A – discontinued		
32 – Hunter Peak	2	Observer needed	Not conducted	Not conducted
33 – Clark	2	Suzy Grimes	Not conducted	Not conducted
34 – no route		N/A – no route		
35 – Frannie	3	Suzy Grimes	36	502
36 – Moose	8	Susan Patla	64	504
37 – Lovell	3	Paul DuBowy	38	259
38 – Meeteetse	3	Jazmyn McDonald	54	384
39 – Ten Sleep	4	C.J. Grimes	62	672

Table 1. Continued.

Route number and name	Latilong	Observer	Species	Individuals
40 – Dayton	4	Tracey Ostheimer	59	644
41 – Bald Mountain*	4	Jackie Canterbury	18	82
42 – Crazy Woman	5	Grace Nutting	46	199
43 – Schoonover	5	Donald Brewer	29	511
44 – Arvada	5	Donald Brewer	33	1029
45 – Recluse*	6	Donald Brewer	30	799
46 – Soda Well	6	Sandra Johnson	47	557
47 – Piney	--	N/A – discontinued		
48 – Seely	--	N/A – discontinued		
49 – Upton	7	Observer needed	Not conducted	Not conducted
50 – Moskee	--	N/A – discontinued		
51 – Alpine	8	Susan Patla	56	432
52 – Wilson	8	Observer needed	Not conducted	Not conducted
53 – Horse Creek	9	Eva Crane	43	353
54 – no route		N/A – no route		
55 – Crowheart	9	Observer needed	Not conducted	Not conducted
56 – Ethete	10	Joe Austin	41	674
57 – Anchor	10	Observer needed	Not conducted	Not conducted
58 – Gebo	10	Jazmyn McDonald	45	356
59 – Arminto	11	Heather O'Brien	26	523
60 – Lysite	11	Observer needed	Not conducted	Not conducted
61 – Worland	11	C.J. Grimes	Not conducted	Not conducted
62 – Teapot Dome	--	N/A – discontinued		
63 – Mayoworth	12	Observer needed	Not conducted	Not conducted
64 – Sussex	12	Bill Ostheimer	41	884
65 – Harland Flats	13	Observer needed	Not conducted	Not conducted
66 – Pine Tree	13	Observer needed	Not conducted	Not conducted
67 – Highlight	--	N/A – discontinued		
68 – Riverview	14	Nathan Darnall	33	439
69 – Newcastle	14	Observer needed	Not conducted	Not conducted
70 – Raven	14	Nichole Cudworth	32	459
71 – Soda Lake	15	Observer needed	Not conducted	Not conducted
72 – Buckskin Mountain	15	Don Delong	43	424
73 – Daniel	--	N/A – discontinued		
74 – Boulder	16	Susan Patla	56	522
75 – Big Sandy	16	Susan Patla	49	433
76 – Farson	16	Observer needed	Not conducted	Not conducted
77 – Fiddler Lake	17	Eva Crane	49	336
78 – Sand Draw*	17	Jazmyn McDonald	31	359
79 – Sweetwater	17	Stan Harter	Not conducted	Not conducted
80 – Gas Hills	18	N/A – discontinued		
81 – Bairoil	18	Greg Hiatt	25	364
82 – Lamont	18	Greg Hiatt	37	350

Table 1. Continued.

Route number and name	Latilong	Observer	Species	Individuals
83 – Pathfinder	19	Laurie Schwieger	32	353
84 – Leo	19	Donna Walgren	38	264
85 – Shirley	19	Linda Drury	23	326
86 – Warbonnet	20	Nathan Darnall	48	301
87 – Fletcher Peak	20	Gloria Lawrence	49	535
88 – Shawnee	20	Irene Fortune	37	506
89 – Meadowdale	21	Martin Hicks	Not conducted	Not conducted
90 – Lusk	21	Grant Frost	30	463
91 – Lingle	21	Nathan Darnall	35	649
92 – Diamondville	--	N/A – discontinued		
93 – Mountain View	22	Observer needed	Not conducted	Not conducted
94 – no route	--	N/A – discontinued		
95 – Green River	--	N/A – discontinued		
96 – Reliance	23	Observer needed	Not conducted	Not conducted
97 – Rock Springs	23	Fern Linton	30	271
98 – Black Rock	--	N/A – discontinued		
99 – Kaycee	12	Charlotte Snoberger	Not conducted	Not conducted
100 – no route	--	N/A – no route		
101 – Wamsutter	25	Tony Mong	Not conducted	Not conducted
102 – Rawlins	25	N/A – discontinued		
103 – Baggs	25	Tony Mong	Not conducted	Not conducted
104 – Walcott	26	Frank Blomquist	51	449
105 – Fox Park	26	Wendy Estes-Zumpf	36	432
106 – Ryan Park	26	Debbie Wagner	36	260
107 – Sybille Canyon	27	Ian Abernethy	54	972
108 – Rock River	27	Sandra Taylor	39	964
109 – Harmony	27	Doug Keinath	48	567
110 – Cheyenne	28	Chuck Seniawski	25	443
111 – Chugwater	28	Chuck Seniawski	31	414
112 – Pine Bluff	28	Chuck Seniawski	25	517
120 – Welch	20	Chris Michelson	36	481
123 – Flaming Gorge	23	Leah Yandow	Not conducted	Not conducted
147 – Rozet	6	Observer needed	Not conducted	Not conducted
148 – Seely 2	7	Mary Yemington	49	636
150 – Government Valley	7	Jennifer Adams	38	603
167 – Thunder Basin	13	Nichole Cudworth	29	458
173 – Rye Grass	15	Theresa Gulbrandson	20	386
180 – Gas Hills 2	18	Courtney Rudd	21	366
192 – Carter	23	Observer needed	Not conducted	Not conducted
195 – Seedskadee	23	Tom Koerner	55	1308
198 – Black Rock 2	24	Andrea Orabona	Not conducted	Not conducted
202 – Rawlins 2	25	Sandra Taylor	31	298
204 – Basin 2	4	Observer needed	Not conducted	Not conducted

Table 1. Continued.

Route number and name	Latilong	Observer	Species	Individuals
206 – Caballa Creek	6	Observer needed	Not conducted	Not conducted
208 – Moran	8	John Stephenson	57	528
212 – Bucknum	12	Observer needed	Not conducted	Not conducted
214 – Hampshire	14	Nathan Darnall	23	434
224 – Patrick Draw III		N/A – discontinued		
250 – Moskee 2	7	Jennifer Adams	58	580
524 – Patrick Draw VI	24	Observer needed	Not conducted	Not conducted
900 – Hayden Valley		N/A – discontinued		
901 – Yellowstone, YNP*	1	John Parker	55	1700
902 – Pryor Flats*	1	Sandra Taylor	34	238

Table 2. Number of individuals and relative abundance of each species detected on Breeding Bird Survey routes in Wyoming, 2015. Data are presented in alphabetical order. The 30 most abundant species detected on BBS routes in 2015 are denoted by an asterisk.

Species name	Number detected	Relative abundance (%)	Total routes
American Avocet	25	0.07	9
American Coot	49	0.13	10
American Crow	135	0.36	34
American Dipper	3	0.01	3
American Goldfinch	102	0.27	24
American Kestrel	107	0.29	40
American Pipit	1	0.00	1
American Redstart	35	0.09	2
American Robin*	1250	3.35	63
American Three-toed Woodpecker	3	0.01	3
American White Pelican	94	0.25	10
American Wigeon	54	0.14	9
Audubon's Warbler*	398	1.07	25
Bald Eagle	16	0.04	8
Bank Swallow	74	0.20	12
Barn Swallow*	357	0.96	52
Barrow's Goldeneye	26	0.07	2
Belted Kingfisher	3	0.01	2
Black-backed Woodpecker	1	0.00	1
Black-billed Cuckoo	1	0.00	1
Black-billed Magpie*	456	1.22	44
Black-capped Chickadee	37	0.10	16
Black-headed Grosbeak	38	0.10	17
Black-necked Stilt	2	0.01	1
Black-throated Gray Warbler	2	0.01	1
Blue Grosbeak	6	0.02	2
Blue Jay	8	0.02	4
Blue-winged Teal	31	0.08	9
Bobolink	11	0.03	3
Brewer's Blackbird*	1076	2.88	60
Brewer's Sparrow*	1324	3.55	50
Broad-tailed Hummingbird	44	0.12	12
Brown Creeper	2	0.01	2
Brown Thrasher	8	0.02	5
Brown-headed Cowbird*	298	0.80	44
Bufflehead	24	0.06	1
Bullock's Oriole	66	0.18	22

Table 2. Continued

Species name	Number detected	Relative abundance (%)	Total routes
Burrowing Owl	2	0.01	2
California Gull	157	0.42	9
Canada Goose*	1638	4.39	20
Canyon Wren	1	0.00	1
Cassin's Finch	49	0.13	15
Cedar Waxwing	21	0.06	7
Chestnut-collared Longspur	7	0.02	2
Chestnut-sided Warbler	1	0.00	1
Chipping Sparrow*	338	0.91	33
Chukar	10	0.03	2
Cinnamon Teal	48	0.13	7
Clark's Nutcracker	82	0.22	15
Clay-colored Sparrow	14	0.04	3
Cliff Swallow*	1528	4.09	42
Common Grackle*	411	1.10	28
Common Merganser	16	0.04	5
Common Nighthawk	222	0.59	44
Common Poorwill	8	0.02	7
Common Raven*	384	1.03	46
Common Yellowthroat	104	0.28	23
Cooper's Hawk	2	0.01	2
Cordilleran Flycatcher	21	0.06	5
Dark-eyed Junco	272	0.73	16
Dickcissel	8	0.02	2
Double-crested Cormorant	5	0.01	2
Downy Woodpecker	4	0.01	4
Dusky Flycatcher	99	0.27	19
Eared Grebe	11	0.03	1
Eastern Kingbird	81	0.22	23
Eurasian Collared-Dove	161	0.43	15
European Starling*	1093	2.93	32
Ferruginous Hawk	10	0.03	7
Field Sparrow	16	0.04	3
Fox Sparrow	18	0.05	4
Gadwall	62	0.17	10
Golden Eagle	29	0.08	20
Golden-crowned Kinglet	3	0.01	2
Grasshopper Sparrow	168	0.45	21
Gray Catbird	34	0.09	16

Table 2. Continued

Species name	Number detected	Relative abundance (%)	Total routes
Gray Flycatcher	2	0.01	1
Gray Jay	25	0.07	4
Great Blue Heron	47	0.13	13
Great Horned Owl	5	0.01	5
Greater Sage-Grouse	56	0.15	12
Green-tailed Towhee*	334	0.90	26
Green-winged Teal	8	0.02	4
Hairy Woodpecker	23	0.06	7
Hammond's Flycatcher	6	0.02	4
Hermit Thrush	186	0.50	15
Horned Lark*	2434	6.52	50
House Finch	29	0.08	12
House Sparrow*	318	0.85	22
House Wren	231	0.62	39
Killdeer	251	0.67	49
Lark Bunting*	2599	6.96	39
Lark Sparrow	280	0.75	34
Lazuli Bunting	101	0.27	18
Least Flycatcher	3	0.01	3
Lesser Scaup	51	0.14	4
Lincoln's Sparrow	132	0.35	14
Loggerhead Shrike	72	0.19	28
Long-billed Curlew	19	0.05	6
MacGillivray's Warbler	45	0.12	12
Mallard*	353	0.95	36
Marsh Wren	46	0.12	3
McCown's Longspur	74	0.20	6
Mountain Bluebird	249	0.67	37
Mountain Chickadee	79	0.21	14
Mountain Plover	2	0.01	2
Mourning Dove*	1163	3.12	60
Northern Goshawk	1	0.00	1
Northern Harrier	37	0.10	26
Northern Mockingbird	2	0.01	1
Northern Pintail	9	0.02	4
Northern Rough-winged Swallow	114	0.31	15
Northern Shoveler	31	0.08	5
Olive-sided Flycatcher	22	0.06	10
Orange-crowned Warbler	7	0.02	3

Table 2. Continued

Species name	Number detected	Relative abundance (%)	Total routes
Orchard Oriole	6	0.02	2
Osprey	11	0.03	6
Ovenbird	63	0.17	3
Peregrine Falcon	2	0.01	1
Pied-billed Grebe	14	0.04	4
Pine Grosbeak	10	0.03	2
Pine Siskin	237	0.64	18
Pinyon Jay	1	0.00	1
Plumbeous Vireo	13	0.03	5
Prairie Falcon	11	0.03	10
Red Crossbill	55	0.15	10
Red-breasted Nuthatch	43	0.12	15
Red-eyed Vireo	10	0.03	3
Redhead	28	0.08	3
Red-headed Woodpecker	6	0.02	4
Red-naped Sapsucker	23	0.06	8
Red-shafted Flicker*	297	0.80	50
Red-tailed Hawk	102	0.27	42
Red-winged Blackbird*	1523	4.08	55
Ring-billed Gull	135	0.36	3
Ring-necked Duck	22	0.06	3
Ring-necked Pheasant	154	0.41	13
Rock Pigeon	138	0.37	13
Rock Wren*	320	0.86	40
Ruby-crowned Kinglet*	399	1.07	22
Ruddy Duck	11	0.03	5
Ruffed Grouse	1	0.00	1
Sage Thrasher*	536	1.44	40
Sagebrush Sparrow*	286	0.77	16
Sandhill Crane	83	0.22	24
Savannah Sparrow	204	0.55	29
Say's Phoebe	67	0.18	32
Sharp-shinned Hawk	5	0.01	3
Sharp-tailed Grouse	6	0.02	1
Short-eared Owl	24	0.06	5
Song Sparrow	220	0.59	38
Sora	27	0.07	12
Spotted Sandpiper	67	0.18	17
Spotted Towhee	134	0.36	13

Table 2. Continued

Species name	Number detected	Relative abundance (%)	Total routes
Steller's Jay	3	0.01	3
Swainson's Hawk	23	0.06	13
Swainson's Thrush	96	0.26	11
Townsend's Solitaire	39	0.10	9
Tree Swallow*	319	0.85	30
Trumpeter Swan	6	0.02	1
Turkey Vulture	84	0.23	16
Unidentified Buteo hawk	1	0.00	1
Unidentified Dark-eyed Junco	65	0.17	9
Unidentified Empidonax flycatcher	9	0.02	4
Unidentified flicker	17	0.05	6
Unidentified hummingbird	1	0.00	1
Unidentified woodpecker	6	0.02	3
Upland Sandpiper	62	0.17	9
Veery	21	0.06	3
Vesper Sparrow*	1421	3.81	62
Violet-Green Swallow	151	0.40	18
Warbling Vireo*	332	0.89	30
Western Grebe	5	0.01	2
Western Kingbird	243	0.65	29
Western Meadowlark*	5051	13.54	62
Western Tanager	100	0.27	19
Western Wood-Pewee	167	0.45	35
White-breasted Nuthatch	5	0.01	5
White-crowned Sparrow	209	0.56	19
White-throated Swift	31	0.08	4
Wild Turkey	40	0.11	10
Willet	14	0.04	5
Willow Flycatcher	25	0.07	10
Wilson's Phalarope	52	0.14	11
Wilson's Snipe	184	0.49	34
Wilson's Warbler	10	0.03	7
Yellow Warbler*	371	0.99	45
Yellow-breasted Chat	36	0.10	10
Yellow-headed Blackbird	74	0.20	12
Total individuals	*37,318*		
Total species	*186*		

Table 3. Population trends (i.e., % change per year) and relative abundance (i.e., individuals per route) of avian Species of Greatest Conservation Need with stable populations in Wyoming that are adequately monitored (i.e., ≥14 survey routes with detections and relative abundance >1 bird per route) by the Breeding Bird Survey, 1966-2015 (analysis by Sauer et al. 2017). The 95% Lower Confidence Limit (LCL) and Upper Confidence Limit (UCL) are also presented for the reported trend. Total number of survey routes used in the analysis for each species is represented by *n*. Results are presented in alphabetical order.

Species	Trend	LCL	UCL	Relative abundance	*n*
Brewer's Sparrow	-0.01	-1.02	1.01	63.91	120
Grasshopper Sparrow	1.30	-1.04	3.69	2.37	66
Lark Bunting	-2.04	-4.16	0.18	414.98	110
Sage Thrasher	-0.38	-1.41	0.60	50.59	96

Table 4. Population trends (i.e., % change per year) and relative abundance (i.e., individuals per route) of avian Species of Greatest Conservation Need with increasing populations in Wyoming that are adequately monitored (i.e., ≥14 survey routes with detections and relative abundance >1 bird per route) by the Breeding Bird Survey, 1966-2015 (analysis by Sauer et al. 2017). The 95% Lower Confidence Limit (LCL) and Upper Confidence Limit (UCL) are also presented for the reported trend. Total number of survey routes used in the analysis for each species is represented by *n*. Results are presented in alphabetical order.

Species	Trend	LCL	UCL	Relative abundance	*n*
Sagebrush Sparrow	2.03	0.19	3.86	21.21	69

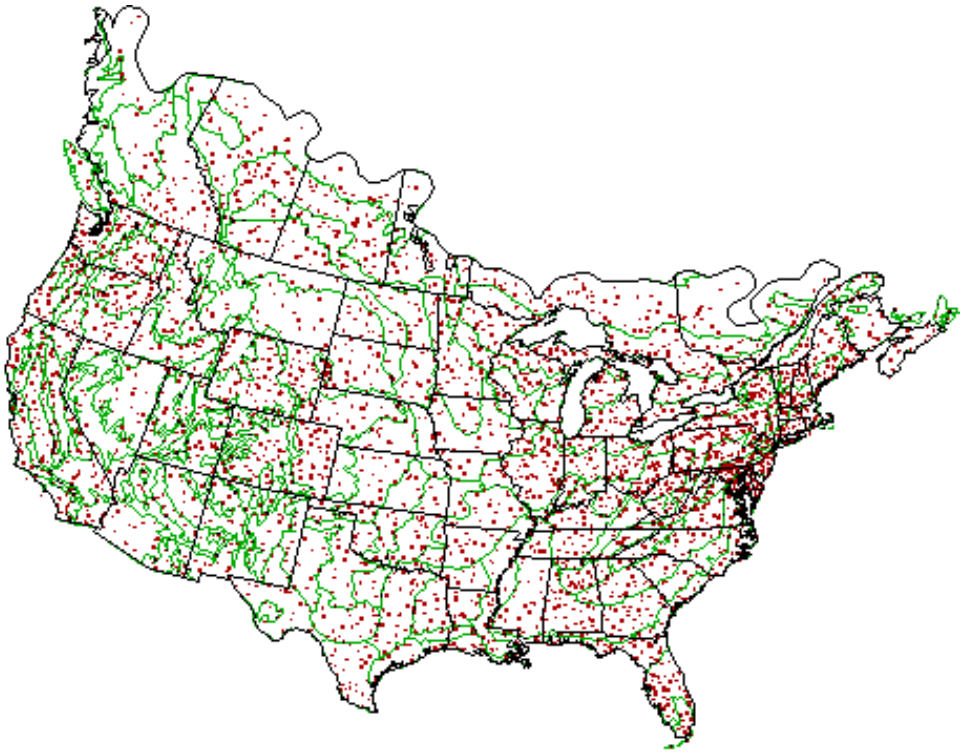

Figure 1. Location (red dots) of all Breeding Bird Survey routes in the United States and Canada (Sauer et al. 1997).

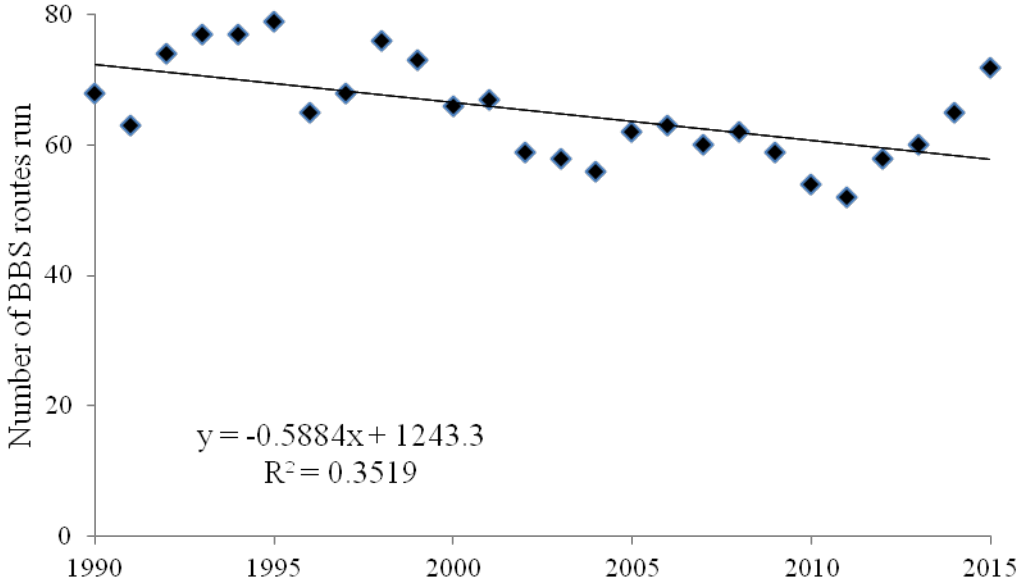

Figure 2. Number of Breeding Bird Survey routes completed in Wyoming, 1990-2015. Only currently active routes with data submitted to the Breeding Bird Survey are included in the analysis. The trend line is shown for reference.

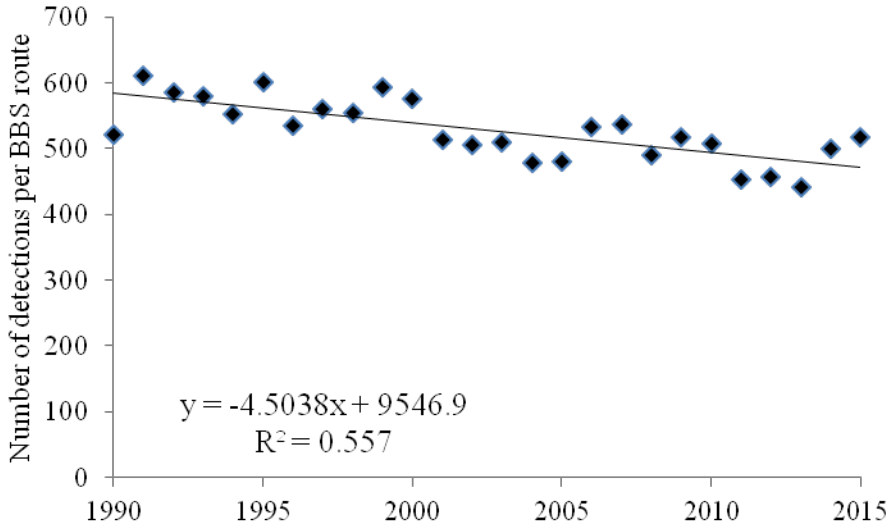

Figure 3. Average number of individual detections of birds per Breeding Bird Survey route in Wyoming, 1990-2015. Only currently active routes with data submitted to the Breeding Bird Survey are included in the analysis. The trend line is shown for reference.

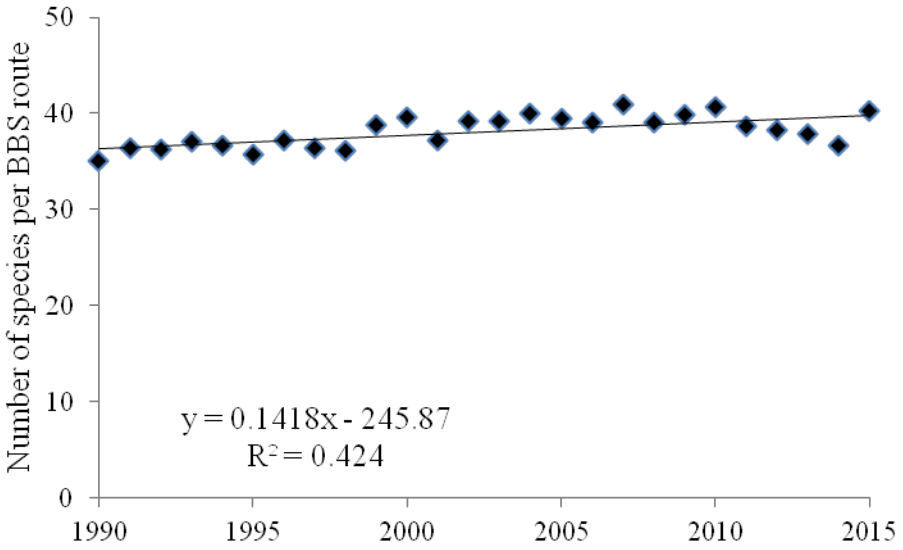

Figure 4. Average number of species detected per Breeding Bird Survey route in Wyoming, 1990-2015. Only currently active routes with data submitted to the Breeding Bird Survey are included in the analysis. The trend line is shown for reference.

OTHER NONGAME – MAMMALS

EVALUATION OF ORAL SYLVATIC PLAGUE VACCINE IN WHITE-TAILED PRAIRIE DOGS (*CYNOMYS LEUCURUS*): 2013-2016 COMPREHENSIVE REPORT

STATE OF WYOMING

NONGAME MAMMALS: White-tailed prairie dog

FUNDING SOURCE: Wyoming State Legislature General Fund Appropriations
United States Fish and Wildlife Service State Wildlife Grant
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PROJECT DURATION: 1 June 2013 – 30 June 2018

PERIOD COVERED: 1 June 2013 – 15 April 2017

PREPARED BY: Jesse Boulerice, Nongame Project Biologist

ABSTRACT

Since being unintentionally introduced to North America in the early 1900s, sylvatic plague has been a major contributor to the decline of populations of prairie dogs (*Cynomys* spp.). Several species of wildlife have either an obligate or facultative dependency on prairie dogs, which has prompted conservation efforts to focus on developing a deliverable and effective vaccine for sylvatic plague in these keystone species. Recently, the US Geological Survey developed an oral vaccine shown to increase titers to sylvatic plague in prairie dogs within a laboratory environment. In 2013, the US Geological Survey initiated a nationwide, multi-agency collaborative endeavor to conduct field trials of this vaccine on 4 species of prairie dogs in the wild. The Nongame Program of the Wyoming Game and Fish Department agreed to participate in this effort, and began fieldwork specific to white-tailed prairie dogs (*C. leucurus*) in Wyoming. This report comprehensively summarizes 4 years of efforts (2013-2016) conducted by the Wyoming Game and Fish Department to assess the effectiveness of the vaccine in combating the effects of plague in white-tailed prairie dogs. Our measures to assess the deliverability of the vaccine, namely persistence of the vaccine-baits on the landscape and bait consumption rate within white-tailed prairie dogs, both suggested that, in current form, the vaccine could be effectively transferred to white-tailed prairie dogs. In 2016, we found significant declines in survival and abundance of white-tailed prairie dogs as a result of epizootic plague outbreak. In one set of paired-plots, both survival and abundance were greater for white-tailed prairie dogs treated with the vaccine (0.327 [95% CI: 0.266-0.401] and 232.4 [95% CI: 210.1-287.4], respectively). However, a second set of paired-plots suggested that the vaccine did not significantly increase survival or abundance of white-tailed prairie dogs exposed to plague, possibly due to the timing of vaccine distribution or other factors. These results suggest that the sylvatic plague vaccine can be both effectively delivered to white-tailed prairie dogs and combat

the effect of plague in this species in Wyoming. However, additional research is required to elucidate other factors that may influence the level of immunization (i.e., timing of distribution) provided by the vaccine to maximize the effectiveness.

INTRODUCTION

Sylvatic plague is an exotic disease caused by the bacteria *Yersinia pestis* that has affected a multitude of wildlife species being introduced to North America in the early 1900s (Gage and Kosoy 2005). Transmitted between hosts primarily by infected fleas, *Y. pestis* is especially prevalent within mammalian species of social nature where frequent physical contact aids in the spread of fleas, such as prairie dogs (*Cynomys* spp.; Antolin et al. 2002). With mortality rates of >90% in infected individuals, epizootic outbreaks of sylvatic plague often result in localized or even regional extirpation of colonies of prairie dogs (Cully and Williams 2001). The combined impacts of decades of poisoning, shooting, habitat loss, and sylvatic plague have diminished populations of prairie dogs nationwide, leading to range reduction of >98% for black-tailed prairie dogs (*C. ludovicianus*), and reductions are likely to be similar for other Cynomys species (Van Putten and Miller 1999, Miller and Cully 2001). Several other species of wildlife exhibiting an obligate or facultative dependency on prairie dogs also suffer from declines of this keystone species as a result of plague (Kotliar et al. 1999). Most notably, this includes the Federally Endangered black-footed ferret (*Mustela nigripes*; ferret), a species that depends on prairie dogs as a primary source of food and shelter. Transmission of infected fleas from prairie dogs to ferrets is thought to be common, and ferrets are highly vulnerable to the direct effects of plague (Williams et al. 1994, Grenier et al. 2009, Jachowski and Lockhart 2009). Prompted by the severity of the threats posed by this disease to prairie dogs, ferrets, and affiliated communities, conservation efforts have focused on developing strategies and tools for combating sylvatic plague (Rocke et al. 2010, Abbott et al. 2012).

The US Geological Survey (USGS), University of Wisconsin, and Western Association of Fish and Wildlife Agencies (WAFWA) have recently begun evaluating a new vaccine for sylvatic plague (Rocke et al. 2010; sylvatic plague vaccine, SPV). SPV was designed to be delivered to prairie dogs via edible vaccine-laden baits, modeled after the oral vaccination program for rabies in carnivores (Abbott et al. 2012). As an alternative to dusting burrows with insecticide, vaccine-laden baits are purported to be cheaper to produce, easier to distribute, and less harmful to non-target species (Seery et al. 2003, Rocke et al. 2010, Abbott et al. 2012). This new management approach represents a proactive, rather than reactive, method to mitigate plague outbreaks in prairie dogs (Abbott et al. 2012). Laboratory tests have shown that baits are readily consumed by prairie dogs in a lab environment (Rocke et al. 2010). Once consumed, SPV has produced significant increases in antibody titers to sylvatic plague antigens that results in increased survival rates of prairie dogs when challenged with *Y. pestis* (Rocke et al. 2010). Encouraged by these results, the USGS, WAFWA, and the Black-footed Ferret Recovery and Implementation Team initiated a nationwide, multi-agency collaborative endeavor in 2013 to evaluate the effectiveness of these vaccine-laden baits in combating sylvatic plague in wild populations of 4 prairie dog species in North America—white-tailed prairie dog (*C. leucurus*), black-tailed prairie dog, Utah prairie dog (*C. parvidens*), and Gunnison's prairie dog (*C. gunnisoni*).

A crucial component of these efforts to evaluate SPV includes assessing how species-specific differences between species of prairie dogs influence the effectiveness of the vaccine. Each species of prairie dog afflicted by plague exhibits variation in social behaviors, density of individuals within a colony, proximity of burrows, and configuration of colonies across the landscape that must be accounted for in designing an effective tool for mitigation of plague among species (Cully and Williams 2001, Antolin et al. 2002). Specifically, these differences are likely to produce critical distinctions in the rate of transmission of infected fleas between individuals, persistence of plague during enzootic periods, and frequency and lethality of epizootic outbreaks (Cully and Williams 2001, Antolin et al. 2002, Hanson et al. 2007). Likewise, rate of consumption of SPV baits and degree of antibiotic response are expected to vary by species and may require distinct density, pattern, and frequency of distribution of SPV to account for these differences (T. Rocke, personal communication). Accordingly, the collaborative project by the USGS seeks to elucidate these relationships between the vaccine, plague, fleas, and each species of prairie dog through field trials of SPV nationwide in order to maximize the success of SPV at combating the virulence and spread of sylvatic plague.

In conjunction with species-specific differences among prairie dogs, the dynamics of plague and SPV are further complicated by small rodent communities that also may play a veiled but significant role. For example, rodent species occurring within colonies such as the northern grasshopper mouse (*Onychomys leucogaster*) and North American deermouse (*Peromyscus maniculatus*) are capable of harboring infected fleas or even sustaining direct infection with *Y. pestis* without suffering the lethal effects of plague. Due to this reduced virulence in small rodents, these species are thought to be largely responsible for the persistence of the plague bacterium within an ecological system, especially during enzootic periods (Biggins and Kosoy 2001, Salkeld et al. 2010). In addition, movement of these alternative host species throughout and between colonies of prairie dogs may increase the spread of infection more so than by prairie dogs alone, whose movements tend to be localized to a particular set of burrows and small home range (Stapp et al. 2004, Salkeld et al. 2010). As a result of this increased connectivity, high abundances of small rodents have been linked to greater likelihood of plague outbreak within prairie dog colonies (Salkeld et al. 2010). These attributes of alternative hosts dictate that efforts to combat sylvatic plague in prairie dogs must include consideration of the influence of small rodents on plague and the success of SPV.

Starting in 2012, the Wyoming Game and Fish Department (Department) agreed to participate with the USGS and other agencies in a multi-year collaborative project to test the effectiveness of SPV in populations of wild prairie dogs. We selected colonies of white-tailed prairie dogs (*C. leucurus*) near Meeteetse as the site of SPV trials in Wyoming due to a well-documented history with white-tailed prairie dogs, plague, and ferrets in the region (WGFD 1990; Menkens and Anderson 1989, 1991). White-tailed prairie dogs are the least-social of all prairie dog species in North America and, therefore, are likely to exhibit species-specific differences that could be crucial to successfully combating plague with SPV (Cully and Williams 2001, Antolin et al. 2002). As 1 of only 2 sites participating in SPV field trials nationwide to focus on white-tailed prairie dogs, our efforts are fundamental in assessing the use of SPV as a tool for mitigating the impacts of sylvatic plague specific to this species, which ranges throughout much of Wyoming. The overall goal of this project in Wyoming was to determine if the vaccine will result in significant increases in survival rates as compared to unvaccinated

individuals of white-tailed prairie dogs (T. Rocke, personal communication). Although the project was initially anticipated to be a 3-year study (2013-2015), a 4th year was added in 2016. Following a protocol standardized for use among all agencies participating in the project, a mark-recapture approach was employed to compare survival rates between white-tailed prairie dogs presented with vaccine-laden or placebo baits over a 4-year period. Our results from Meeteetse will be used by the USGS to inform a multi-species assessment.

This report is intended to be a comprehensive summary of the SPV trials conducted in Meeteetse over the 4-year period in which trials occurred (2013-2016). For annual reports specific to efforts conducted in 2013, 2014, and 2015, please see Boulerice and Grenier (2014), Boulerice (2015), and Boulerice (2016), respectively. The primary objective of this project was to evaluate the efficacy of the orally delivered vaccine on combating plague in white-tailed prairie dogs in Meeteetse. Broadly, 2 themes were considered in assessing efficacy; namely the deliverability of the vaccine to white-tailed prairie dogs and the ability of the vaccine to combat the effects of plague in white-tailed prairie dogs. Deliverability was evaluated by measuring the persistence of the vaccine-laden baits on the landscape and rate of uptake of vaccine baits by white-tailed prairie dogs. The ability of the vaccine to combat the effects of plague was measured by comparing abundance and survival of white-tailed prairie dogs receiving the vaccine to those receiving a placebo.

METHODS

During mid-June through mid-August 2013-2016, we conducted 4 years of surveys on colonies of white-tailed s at Pitchfork Ranch, approximately 24 km west of Meeteetse, Wyoming. Each year, we surveyed the same 2 sets of paired-plots. Within each set of paired-plots were 2 16.2-ha rectangular plots separated by ≥200 m (4 plots total). For naming convenience, plots established within paired-plot AB were labeled Plot A and Plot B, while plots within paired-plot CD were labeled Plot C and Plot D (Figure 1).

During survey years 2 and 3 (2014-2015), we assessed abundance of small mammals by establishing trapping grids within each of the 4 plots prior to distribution of vaccine-laden baits and capturing white-tailed prairie dogs. Our trapping grid in 2015 was identical to the grids surveyed in 2014. Specifically, each trapping grid for small mammals (SMG) was centered within each respective plot and labeled accordingly (i.e., SMG-A was centered on plot A, SMG-B was centered on plot B, etc.; Figure 1). Each SMG consisted of 132 small mammal traps (339A non-folding trap, Sherman Trap, Inc., Tallahassee, FL) spaced 16 m apart in a 12 x 11 array. We trapped small mammals at each grid for 8 consecutive nights. We baited all traps with steel cut oats at approximately 1700 and returned to process captures the following morning at 0800. Each captured individual was marked with a single ear tag (1005-1, National Band and Tag Co., Newport, KY). We collected hair and whisker samples and recorded sex, age, and weight from all captured animals. We collected blood samples from adult animals >15g. Biological samples were sent to USGS for analysis.

During all 4 years of surveys, we distributed SPV baits supplied by the USGS in early June on paired-plots AB and early July on paired-plot CD. Baits were provided in 2 forms,

treatment (i.e., with vaccine) and placebo (i.e., all other ingredients aside from the vaccine). Within each paired-plot, 1 plot received the treatment and the other plot received the placebo each of the 4 years. USGS pre-assigned baits to each plot in a blind manner, such that field personnel were unaware which form of bait was being distributed on each plot to prevent any bias in distribution. We distributed baits by foot evenly along transects at a rate of 100 pieces of bait per ha for a total of 1,600 baits per plot. After distribution, we noted the persistence of the baits on the landscape by observing the number of days until bait could no longer be easily found on the ground.

We trapped white-tailed prairie dogs at each paired-plot approximately 2 weeks following the distribution of the baits. Specifically, we evenly spaced 160 trapping stations over each plot at a rate of 10 stations per ha. Each trapping station received a Tomahawk live-trap (Model #102 or #103, Tomahawk Live Trap, LLC, Hazelhurst, WI). We locked traps open for 6 days prior to trapping and pre-baited with sweet horse feed (C.O.B with Molasses, Manna Pro Products LLC, Chesterfield, MI). After pre-baiting, we trapped each set of paired-plots for 8 consecutive mornings for a total of 1,280 trapping occasions per plot (160 traps x 8 occasions), except for in the first year (2013) in which trapping was conducted for 10 consecutive mornings for a total of 1,600 trapping occasions per plot (160 traps x 10 occasions). Each morning, between 0630 and 0800, we baited, opened, and reset traps. We began checking traps for captures at 1000 and closed all traps for the day by 1130.

Upon capture, we safely transported white-tailed prairie dogs to a centralized processing station. We briefly anesthetized white-tailed prairie dogs by placing animals into a sealed chamber filled with isoflurane gas. Once anesthetized, we collected flea, hair, whisker, and blood samples from white-tailed prairie dogs. Additionally, we marked each individual with a passive integrated transponder (PIT tag; AVID Microchip I.D. Systems, Folsom, LA) and 1 ear tag in each ear (1005-1, National Band and Tag Co., Newport, KY). We also recorded sex, age, and weight of each animal. We allowed each individual to recover from the effects of isoflurane, and released animals at the location of capture. We sent all biological samples to the USGS for analysis. Hair and whisker samples were used to measure bait consumption rates, as all baits contained a biomarker that would indicate whether a particular individual had consumed the bait (Fernandez and Rocke 2011). Blood samples were used to measure antibiotic titer response to SPV. Fleas were identified to species and examined to determine whether they were infected with the plague bacterium. Blood and fleas results were not available at time of writing this report.

We employed a robust design modeling approach under the Huggins formulation in program MARK to obtain annual estimates of abundance and survival for all 4 years of survey (Huggins 1989, 1991; White and Burnham 1999). Our modeling approach used here differed from the approach used in previous annual reports for this project; therefore, estimates may differ slightly than those reported previously. Specifically, we chose a robust design modeling approach for this comprehensive analysis in order to simplify our model set by modeling survival and abundance simultaneously. In addition, unlike previous years, we modeled paired-plots AB separately from paired-plots CD, since no logical link between the paired-plots existed (i.e., paired-plots were independent from each other). Our candidate model set included model combinations that considered the effect of temporary emigration (Markovian, random, and no

movement), heterogeneity, time, and sex. We did not include the covariate number of nearby burrows (bur) considered in analyses for previous years because active burrows were not mapped in 2016. We calculated the weight of each model based on Akaike's Information Criterion adjusted for small sample size (AIC*c*; Burnham and Anderson 2002). Estimates and unconditional standard error of abundance were calculated for each plot by weighted model-averaging across all models (Burnham and Anderson 2002). We used a log-transformation to calculate 95% confidence intervals (95% CI) associated with each model-averaged estimate of abundance (Chao 1987).

RESULTS

Our first 3 years of survey efforts (2013-2015) were unremarkable in terms of plague activity within our 4 plots. We observed no visual evidence that an epizootic plague outbreak had occurred (i.e., no massive die-offs, stable and/or growing white-tailed prairie dog population). However, year 4 (2016) clearly exhibited the signs of plague outbreak. Visual observations in June indicated that a significant reduction in white-tailed prairie dog abundance had transpired on all 4 plots compared to previous years, which were subsequently confirmed by plague-positive diagnostics from carcasses sent to the USGS labs to be the result of plague outbreak. The geographic extent of the plague outbreak appeared to be relatively restricted to the areas included as part of this project, whereas visual observations from other regions of the ranch and surrounding areas seemed to suggest that the outbreak had not spread into those areas as of 2016.

During small mammal trapping, we captured 5 species consisting of North American deermice, olive-backed pocket mice (*Perognathus fasciatus*), northern grasshopper mice, meadow voles (*Microtus pennsylvanicus*), and sagebrush voles (*Lemmiscus curtatus*). During trapping, several small mammals were found covered in the red dye used as a biomarker in the SPV baits, indicating that animals had come in contact with (and presumably eaten) baits. We compared annual small mammal captures by grid in Table 1. Results from hair and blood samples sent to USGS have not been provided at time of writing this report.

We distributed baits at a density of 100 baits per ha over 64.7 total ha at a rate of 1.3 ha per person per hour. For all years except 2016, baits were no longer observed within the plots after 2-3 days and scat from white-tailed prairie dogs, distinctively colored the same shade of red as the dye of the baits, was readily observed at the majority of active burrows on all 4 plots. In 2016, baits remained easily observable for weeks after distribution on plots A, C, and D. Red scat was found at only a few burrows. For plot B, a few baits remained observable but not nearly as many as the other plots. Likewise, the frequency of red scat was greater than other plots in 2016 but not as high as in previous years.

In a total of 26,800 trap occasion (6,400 in year 1, 5,120 in years 2-4), we captured white-tailed prairie dogs 5,125 times for a capture rate of 0.19 white-tailed prairie dog per trap occasion. Of those, 1,679 were unique individuals comprised of 850 males and 829 females (m:f: 1:0.97). A comparison of captures by plot for each of the 3 years is displayed in Table 2. We collected blood, hair, and whisker samples from 750 individuals, which were sent to the

USGS for analysis. Bait consumption rate measured from all captured white-tailed prairie dogs during 2013-2015 was found to range between 76-100% over all 4 plots (average = 88%). Rates from 2016 were not available at time of writing this report.

Our estimates of abundance of white-tailed prairie dogs confirmed the population trend we noted through visual observations. Specifically, estimates of abundance increased 3-4 fold from years 2013-2015 without a significant difference in estimates between plots within paired-plots (Figure 2). In 2016, estimates of abundance decreased significantly from 349.2 (95% CI: 322.3-415.4) and 446.7 (95% CI: 404.9-547.2) in 2015 to 18.4 (95% CI: 16.6-26.0) and 232.4 (95% CI: 210.1-287.4) in 2016 for plots A and B respectively and from 282.5 (95% CI: 228.5-418.6) and 335.2 (95% CI: 269.2-474.6) in 2015 to 48.3 (95% CI: 38.2-76.6) and 44.7 (95% CI: 34.7-69.6) in 2016 for plots C and D respectively. Estimates of abundance and 95% confidences intervals for each plot during each of the 4 years are shown in Figure 2. Top models for estimates of abundance for paired-plots AB and CD are shown in Tables 3 and 4, respectively.

Similarly, estimates of survival did not differ significantly between plots within paired plots or between years for the 2013-2014 and 2014-2015 time periods, but did show significant difference by year and by plot for the 2015-2016 period. Specifically, survival was estimated to be 0.366 (95% CI: 0.275-0.486) and 0.518 (95% CI: 0.419-0.640) for the 2014-15 period before declining to 0.035 (95% CI: 0.018-0.063) and 0.327 (95% CI: 0.266-0.401) for plots A and B, respectively, for the 2015-16 time period. Likewise, survival was estimated to be 0.445 (95% CI: 0.289-0.684) and 0.613 (95% CI: 0.438-0.856) for the 2014-2015 time period compared to 0.034 (95% CI: 0.014-0.086) and 0.051 (95% CI: 0.026-0.109) for C and D, respectively, for the 2015-2016 time period. Survival estimates and 95% confidence intervals for all plots for each of the 4 years are shown in Figure 3. Top models for estimates of abundance for paired-plots AB and CD are shown in Tables 3 and 4, respectively.

At the completion of the project, the form of bait assigned to each plot was revealed. Plots B and D received the treatment baits, which included the vaccine, all 4 years. Conversely, plots A and C received placebo baits, which included all other ingredients aside from the vaccine, all 4 years.

DISCUSSION

The development of tools and strategies to combat sylvatic plague in prairie dogs is paramount to the success of conservation and management of prairie dogs throughout the western US, as well as the host of species that depend on this keystone species. Recovery efforts of the Endangered black-footed ferret continue to rely on the maintenance of viable prairie dog colonies of which plague outbreak is the leading threat. The aim of this project was to evaluate the effectiveness of a newly developed vaccine at combating plague as an alternative to the only other management tool currently available, namely the application of insecticide to prairie dog burrows in an effort to reduce the presence of the vector of plague (fleas) on the landscape. Here, we assessed the effectiveness of the SPV vaccine by evaluating the deliverability of the vaccine in wild white-tailed prairie dog populations and the ability of the vaccine to increase survival and abundance in white-tailed prairie dog populations challenged with plague. Our

results, discussed below, suggest that SPV may hold great promise as a management tool for combating plague in prairie dogs, thus promoting the recovery of black-footed ferrets in Wyoming and elsewhere.

The 2 measures we evaluated to assess the deliverability of SPV indicated that the current form of the vaccine-laden baits was an effective vehicle for transferring the vaccine to white-tailed prairie dogs in Meeteetse. When distributed during the 3 years prior to plague outbreak when abundances of white-tailed prairie dogs were relatively high, a relatively short persistence on the landscape suggested that a high volume of bait was quickly consumed, presumably by white-tailed prairie dogs. This timeframe (<3 days) was well within the period in which the vaccine can withstand environmental degradation and remains viable once ingested (T. Rocke, personal communication). Notably, the red dye we observed on several of the small mammals we captured during trapping efforts in 2014-2015 suggested that a portion of the baits were consumed by non-target species including deermice, voles, and grasshopper mice. However, our second metric for assessing deliverability, namely bait uptake rates in captured white-tailed prairie dogs, suggested that a large percentage of bait consumption could be attributed to the target species. Specifically, almost 90% of all white-tailed prairie dogs we sampled from 2013-2015 had consumed the bait. We note that the bait consumption rate we observed in Meeteetse may be a slight overestimation of the number of animals within the true population (all animals within paired-plots, trapped or untrapped) that consumed the baits, given results from the nationwide SPV study which suggest that animals that consumed the baits are also more likely to be trapped (T. Rocke, unpublished data). Regardless, bait consumption appears to readily occur by the majority of white-tailed prairie dogs on within the area of SPV distribution. Therefore, both our metrics of bait persistence on the landscape and bait consumption rates suggest that delivery of the vaccine via SPV baits to white-tailed prairie dogs is effective.

In conjunction with the deliverability of the vaccine to prairie dogs, another important aspect of the deliverability of the vaccine is the efficiency in which the baits can be distributed throughout the landscape by field personnel. During this project, vaccine distribution occurred by hand, whereby personnel walked along transects dropping baits at equal spacing throughout a specified area. While this distribution technique was appropriate for this project (i.e., on 65 ha per year), alternative methods would be needed to distribute the baits over the much larger areas required to vaccinate substantial acreages of colonies for the purpose of conservation of white-tailed prairie dogs and black-footed ferrets (i.e., >3,000 acres per year, which is the minimum white-tailed prairie dog acreage per year for black-footed ferret reintroduction sites nationally). As of fall 2016, research is currently ongoing to develop techniques and equipment specifically for these large-scale applications, including distribution by all-terrain vehicles, tractors, and unmanned aerial vehicles, and promising advances have been made (Randy Matchett, personal communication). With the development of these alternative methods of distribution, large-scale application of SPV will soon be feasible.

In addition to our evaluation of SPV deliverability, our 4-year effort in Meeteetse also suggested that SPV may be effective at combating the effect of plague in white-tailed prairie dogs. The plague outbreak that occurred in 2016, while no doubt detrimental to the afflicted white-tailed prairie dogs, aided our ability to evaluate the influence of the vaccine on abundance and survival of white-tailed prairie dogs challenged by the disease. Notably, plague-positive

diagnoses from carcasses indicated that all 4 plots within our study experienced plague outbreak in 2016. Our results from paired-plots AB clearly suggested that white-tailed prairie dogs provided with the vaccine (treatment, plot B) were more likely to survive from 2015-2016 than those that were not vaccinated (placebo, plot A). Likewise, our estimates of abundance indicated that same trend, namely that abundance was significantly higher in areas where the vaccine was distributed compared to those without vaccine after both areas were challenged with plague. The ability to enhance survival and abundance in prairie dogs exposed to plague is obviously a fundamental criterion in developing an effective vaccine. Our results from paired-plot AB suggest that SPV is capable of meeting this requirement.

Importantly, survival and abundance estimates from paired-plots AB demonstrated that, although the impact of plague to the white-tailed prairie dog population was reduced compared to unvaccinated white-tailed prairie dogs, vaccination with SPV did not prevent a significant decline in both parameters between 2015 (no plague) and 2016 (plague outbreak). Vaccination with SPV should not be expected to result in full protection of all individuals within a vaccinated area during plague outbreak, at least during the first several years of SPV application, for the following reasons. Inherent with the indirect transfer method utilized by SPV (i.e., prairie dogs must willingly encounter and consume baits placed on the ground), the inability to ensure that all individuals consume the SPV bait in a given year prevents blanket vaccination throughout an area, meaning that a percentage of the population will remain unvaccinated and susceptible to the effects of plague. Likewise, vaccination is not passed from mother to pup, such that young-of-the-year may be exposed if outbreak occurs before pups have had sufficient time to consume baits upon burrow emersion. However, after multiple years of SPV application, herd immunity is likely to develop, thereby reducing the spread of plague even to unvaccinated individuals and increasing survival rates within areas where SPV is distributed (T. Rocke, personal communication). Additional research is currently ongoing to determine the relationship between herd immunity and large-scale multi-year application of SPV in prairie dogs (T. Rocke, personal communication).

Interestingly, our results from paired-plot CD failed to mirror that of AB, illustrating possible complexities of vaccination with SPV. We found no significant difference in survival or abundance between treatment and placebo plots within paired-plots CD, as both populations experience significant declines as a result of the plague outbreak. While the precise reason for the difference between paired-plots AB and CD is unclear, we speculated on 2 possible causes related to that fact that bait distribution on AB occurred 1 month earlier than on CD during all 4 years. Changes in weather conditions between June and July could possibly influence the effectiveness of the vaccine to increase titer levels after consumption or could have increased the degradation rate of the vaccine after distribution. Specifically, differences in the amount of green vegetation available to prairie dogs at the time of bait distribution (June versus July) could influence bait consumption, as the availability of alternative and more nature food resources may reduce interest in consuming the foreign SPV baits (T. Rocke, personal communication). Alternatively, since bait distribution occurred earlier on paired-plots AB, vaccinated animals on plot B would have had more time to develop titers and the associated immunization compared to vaccinated animals on plot D. If the plague epizootic outbreak occurred in late fall in 2015, the 1 month difference in distribution could have provided plot B with significantly greater protection than plot D. In sum, although our findings from AB suggest that SPV is capable of combating

the effects of plague, our results from CD suggest that additional factors possibly related to the timing of bait distribution need to be explored further to determine the impact on efficacy.

Our assessment of small rodent populations suggested that alternative hosts of sylvatic plague, most notably North American deermice and northern grasshopper mice, could play a significant role in the dynamics of the disease and vaccination efforts within prairie dog colonies where SPV application is being considered. Extrapolation of our estimates of abundance suggested an average of nearly 4 deermice and 1.5 grasshopper mice per hectare occurred within the confines of each plot during the summer prior to the plague outbreak that occurred in 2016. The high density of both of these species likely accelerates the spread of fleas throughout our colonies, while simultaneously providing a suitable alternative host for the persistence of plague during enzootic periods. Additionally, the high density of deermice undoubtedly reduced the number of SPV baits available to prairie dogs, as deermice also readily consumed baits at our colonies. SPV consumption by non-target species such as deermice may provide immunization from plague, and efforts to quantify the benefits to non-target species are currently ongoing within the collaborative project with USGS (T. Rocke, personal communication). However, consideration of the amount of non-target consumption, likely correlated to abundance, is vital to determining the appropriate density and pattern of distribution of SPV for vaccinating prairie dogs. The influence of the other small rodent species we detected on our plots, including olive-backed pocket mice, meadow voles, and sagebrush voles, is unknown, although these species are also capable of carrying fleas and consuming baits.

In summary, the results from our efforts to evaluate the effectiveness of the sylvatic plague vaccine at combating plague in white-tailed prairie dogs in Wyoming suggest that the vaccine may be effective. However, additional research may be required to elucidate other factors that could influence the level of immunization (i.e., timing of distribution, herd immunity) provided by the vaccine in order to maximize the survival rate after plague exposure. We note that this report summarizes only the results collected from Meeteetse, which will be included in the nationwide evaluation of SPV being conducted by the USGS. When analyses at the nationwide and multi-species scale are completed, many of the fine details related to SPV application are likely to be considered at a level we could not address here. In addition, other publications based on our results in Wyoming are likely to be drafted in coming months and may provide greater insight into relationships between SPV, plague, and white-tailed prairie dogs. However, our results specific to white-tailed prairie dogs in Meeteetse suggest that the SPV is both deliverable and effective and, therefore, could become an impactful tool for the management and conservation of prairie dogs, black-footed ferrets, and the associated community in the near future.

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Table 1. Captures of small mammals on grids at Pitchfork Ranch, Meeteetse, Wyoming conducted June-July 2014-2015. We captured small mammals at 4 grids located in the center of each of the 4 plots: small mammal grid (SMG) A, B, C, and D. Values represent number of unique animals captured on 8 trapping occasions.

Species	SMG-A		SMG-B		SMG-C		SMG-D		Total	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Peromyscus maniculatus	40	67	22	39	30	47	21	48	113	201
Microtus pennsylvanicus	1	10	2	5	2	43	0	0	5	58
Onychomys leucogaster	1	12	1	2	2	13	0	8	4	35
Lemmiscus curtatus	0	0	0	0	0	5	0	6	0	11
Perognathus fasciatus	7	2	6	2	3	0	0	0	16	4
Total	49	91	31	48	37	108	21	62	138	309

Table 2. Captures of white-tailed prairie dogs (*Cynomys leucurus*) on each of 4 plots at Pitchfork Ranch, Meeteetse, Wyoming from surveys conducted June and July 2013-2016.

Plot	Total Marked	Recaptures	New	Total Marked	Recaptures	New	Total Marked	Recaptures	New	Total Marked
	2013		2014			2015			2016	
A	75	37 (49%)	79	116	37 (31%)	265	302	10 (3%)	6	16
B*	85	41 (48%)	79	120	58 (48%)	309	367	105 (28%)	90	195
C	57	16 (28%)	79	95	30 (33%)	162	192	5 (2%)	28	33
D*	65	14 (21%)	101	115	47 (41%)	159	206	11 (5%)	19	30
Total	282	108 (38%)	338	446	172 (39%)	895	1067	131 (12%)	143	274

*Plot received the treatment form of bait, which included the vaccine

Table 3. Top models from robust design modeling using the Huggins formulation to assess abundance and survival of white-tailed prairie dogs (*Cynomys leucurus*) at Pitchfork Ranch, Meeteetse, Wyoming during surveys conducted July-August 2013-2016. Our candidate model set included model combinations that considered the effect of plot, time, sex, sex x plot, and sex x time on probability of survival (Φ), temporary immigration (γ), individual heterogeneity (*π*), probability of capture (*p*), and probability of recapture (c). Only the top 5 models are shown. We calculated the weight of each model based on Akaike's Information Criterion adjusted for small sample size (AIC*c*; Burnham and Anderson 2002). Estimates and of survival were calculated for each plot by weighted model-averaging across all models (Burnham and Anderson 2002). 95% confidence intervals (95% CI) for each estimate of survival are reported in parentheses.

Paired-Plots AB				
Model	AIC*c*	Delta AIC*c*	AIC*c* weight	k
Φ(plot, time, sex, sex*plot, sex*time),γ(no movement),π(plot)p(plot, time),c(plot, time)	13682.6	0.00	0.41	34
Φ(plot, time, sex, sex*plot, sex*time),γ(no movement),π(plot)p(plot, time, sex),c(plot, time, sex)	13683.4	0.85	0.27	36
Φ(plot, time, sex, sex*plot, sex*time),γ(plot, random),π(plot)p(plot, time),c(plot, time)	13684.5	1.91	0.16	36
Φ(plot, time, sex, sex*plot, sex*time),γ(no movement),π(plot)p(plot, time, sex),c(plot, time)	13684.6	1.99	0.15	35
Φ(plot, time, sex, sex*plot,),γ(plot, random),π(plot)p(plot, time),c(plot, time)	13698.2	15.7	<0.001	34
Paired-Plots CD				
Model	AIC*c*	Delta AIC*c*	AIC*c* weight	k
Φ(plot, time, sex, sex*plot, sex*t),γ(no movement),π(plot)p(plot, time, sex),c(plot, time)	8216.9	0.00	0.50	35
Φ(plot, time, sex, sex*plot, sex*t),γ(no movement),π(plot)p(plot, time, sex),c(plot, time, sex)	8218.2	1.32	0.26	36
Φ(plot, time, sex, sex*plot, sex*t),γ(no movement),π(plot,time),p(plot, time, plot*time, sex,sex*time)=c(plot, time, plot*time, sex,sex*time)	8218.6	1.72	0.21	51
Φ(plot, time, sex, sex*plot,),γ(plot, random),π(plot)p(plot, time),c(plot, time)	8224.2	7.36	0.01	32
Φ(plot, time, sex, sex*plot,),γ(no movement),π(plot)p(plot, time),c(plot, time)	8225.1	8.25	0.008	34

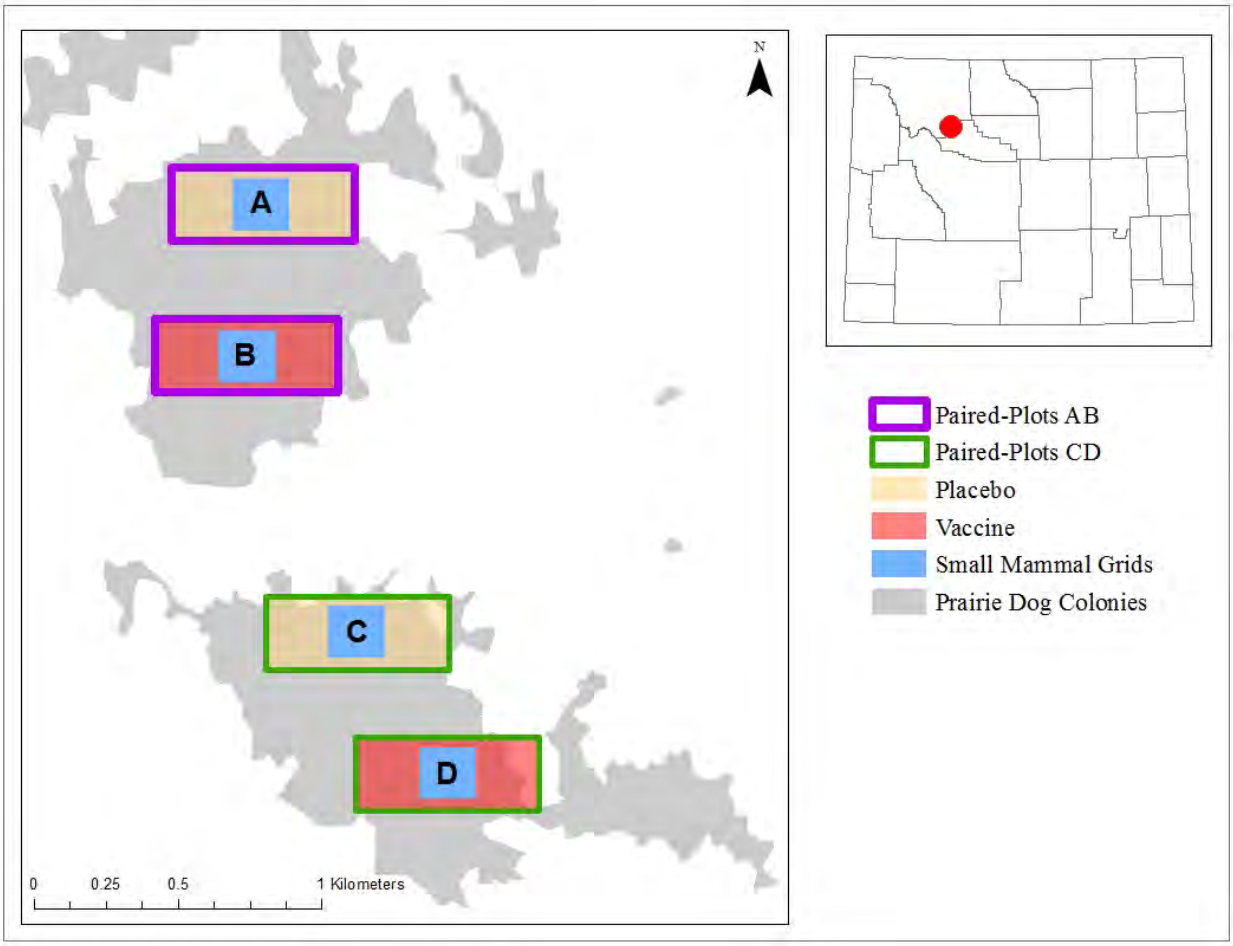

Figure 1. Location of colonies, plots, and small mammal grids at Pitchfork Ranch, Meeteetse, Wyoming. Plots were paired such that one plot in each colony received the vaccine-laden bait, while the other received a placebo (paired-plots). Bait was distributed in a blind manner until the completion of the project. Small mammal grids were located at the center of each plot and trapped prior to the distribution of bait.

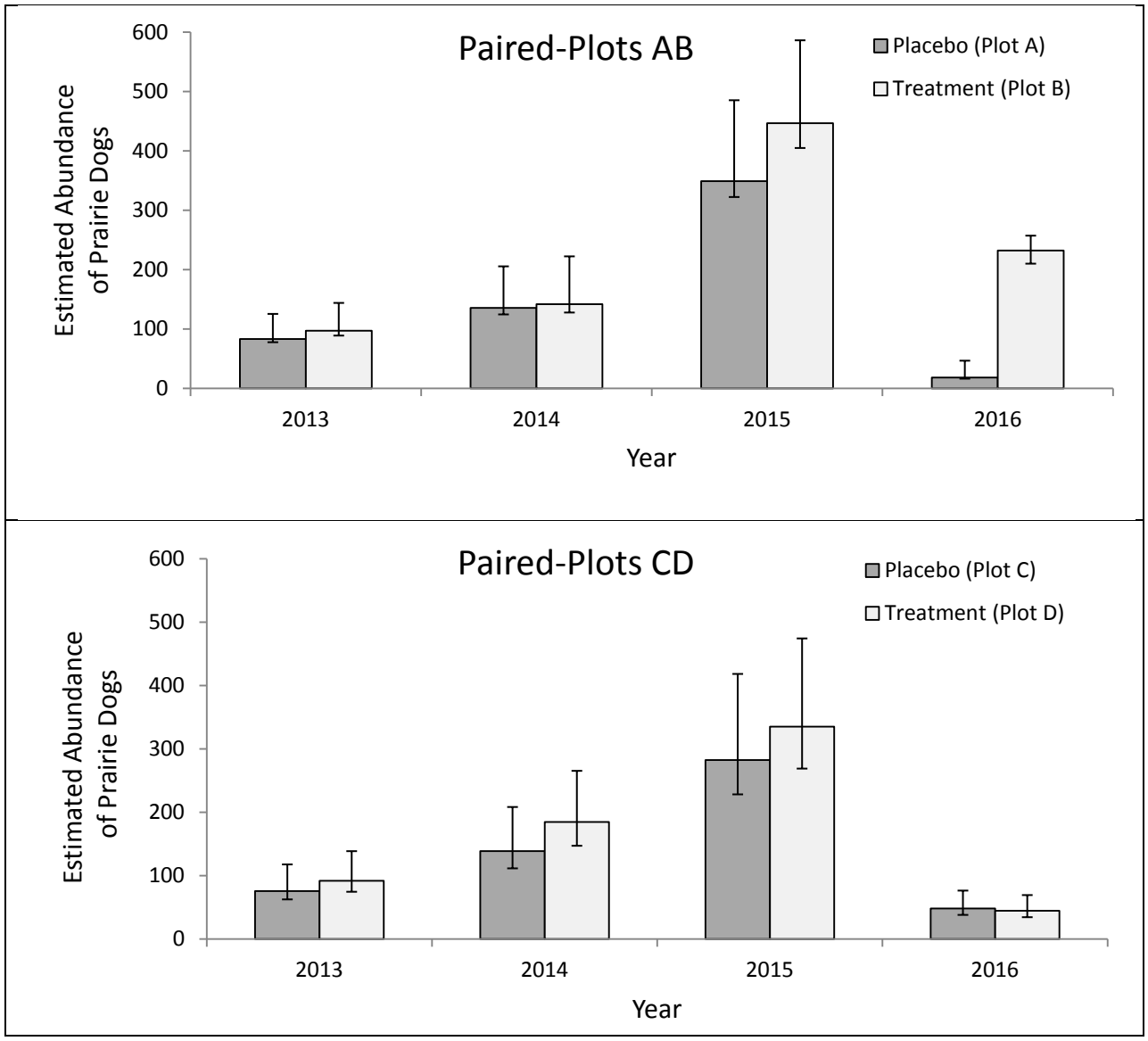

Figure 2. Estimates of abundance of white-tailed prairie dogs (*Cynomys leucurus*) within each plot at Pitchfork Ranch, Meeteetse, Wyoming from June to August 2013-2016. Estimates were derived under closed population models using robust design modeling under Huggins conditional likelihood formulation (Huggins 1989, White and Burnham 1999). Error bars indicate log-transformed 95% confidence intervals for each estimate (Chao 1987). All estimates were obtained by weighted modeling averaging based on AIC*c* weights.

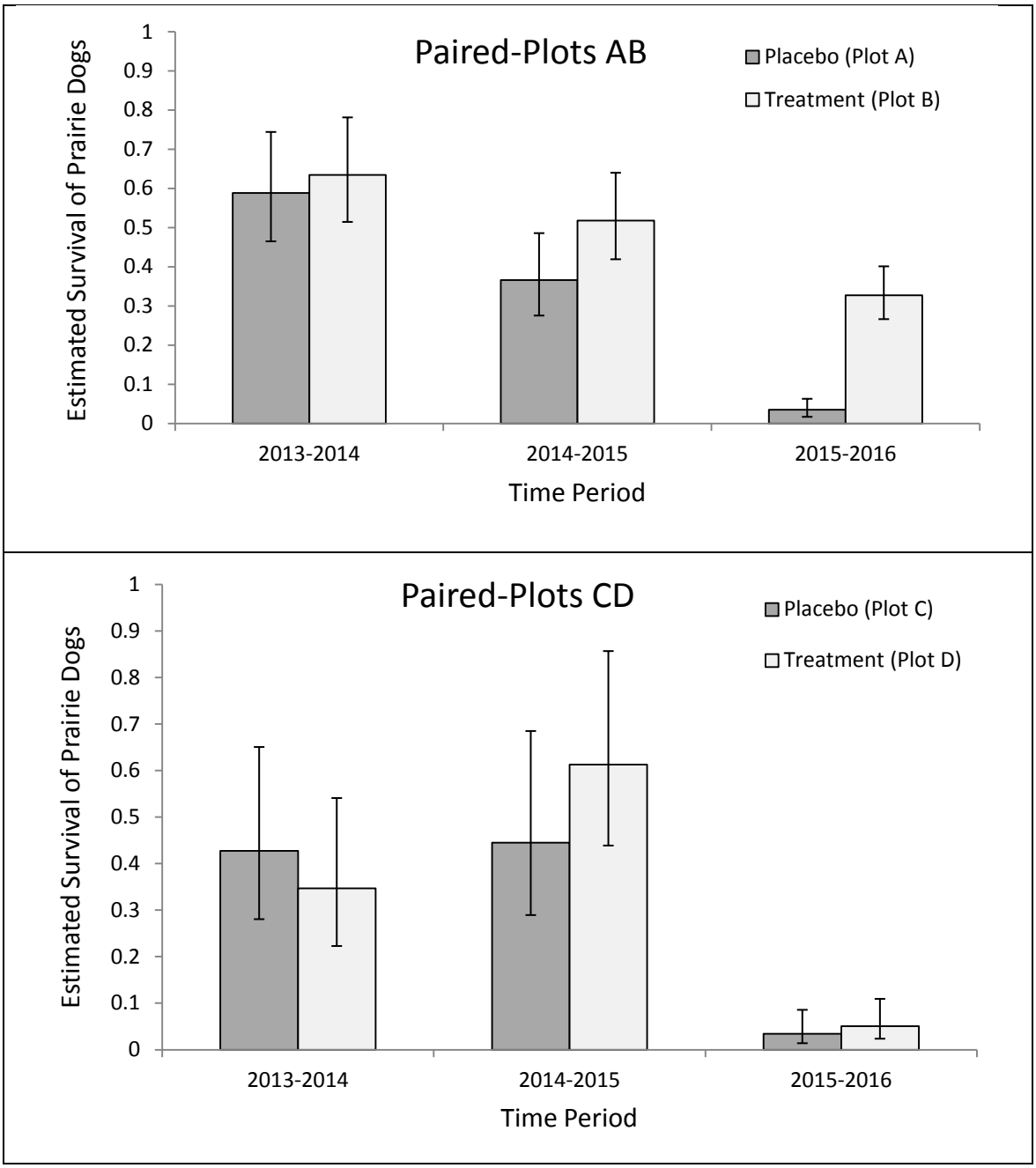

Figure 3. Estimated probability of annual survival of white-tailed prairie dogs (*Cynomys leucurus*) within each plot at Pitchfork Ranch, Meeteetse, Wyoming from June to August 2012-2016. Estimates were derived using robust design modeling approach under the Huggins formulation. Error bars indicate 95% confidence interval of each estimate.

TECHNICAL COMMITTEES AND WORKING GROUPS

SUMMARY OF THE ANNUAL ACTIVITIES OF THE CENTRAL FLYWAY NONGAME MIGRATORY BIRD TECHNICAL COMMITTEE

STATE OF WYOMING

NONGAME BIRDS: Nongame Migratory Birds

FUNDING SOURCE: Wyoming State Legislature General Fund Appropriations
Wyoming Game and Fish Department

PROJECT DURATION: Annual

PERIOD COVERED: 15 April 2015 – 14 April 2016

PREPARED BY: Jim Dubovsky, US Fish and Wildlife Service
Andrea Orabona, Nongame Bird Biologist

SUMMARY

The Central Flyway Council (CFC) was established in 1951 to represent the 10 states (Montana, Wyoming, Colorado, New Mexico, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas) and 3 Canadian provinces (Saskatchewan, Alberta, and the Northwest Territories) that occur within the flyway. The function of the CFC is to work with the US Fish and Wildlife Service (USFWS), in conjunction with the councils of the Atlantic and Mississippi Flyways, in the cooperative management of North American migratory game birds. Specific responsibilities include season setting of migratory bird hunting regulations. The CFC, via technical committees, also conducts and contributes to a wide variety of migratory bird research and management programs throughout the United States, Canada, and Mexico.

Considerable technical information is required for the Flyway Councils to accomplish their objectives. Various Technical Committees (TCs) have been established to fulfill this role. The Central Flyway Waterfowl TC and the Pacific Flyway Study Committee were established in 1953 and 1948, respectively. The Central Management Unit TC was formed in 1966 to provide technical input on Mourning Dove management and research issues. In 1967, the scope of this TC was broadened to include species other that doves, and the name was changed to the Central Migratory Shore and Upland Game Bird TC. In 1999, the name was changed to the Central Flyway Webless Game Bird TC, and in 2001, the name was again changed to the Central Flyway Webless Migratory Game Bird TC. The Central Management Unit Mourning Dove TC was established in 2003, and its name was changed to the Central Management Unit Dove TC in 2007 to recognize responsibility for all dove species with regulated hunting seasons. In 2006, the Central Flyway Council established the Central Flyway Nongame Migratory Bird TC to address a growing number of regulatory issues for migratory birds that were not currently

addressed by the other TCs, and to broaden the Flyway Council's focus beyond traditional game bird issues.

It is the intent of the CFC and TCs that the division of responsibilities for avian species follows the definition for game birds as defined in the migratory bird conventions with Canada and Mexico. The Central Flyway Waterfowl TC is responsible for the families Anatidae (i.e., ducks, geese, and swans) and Rallidae (i.e., American Coots). The Central Flyway Webless Migratory Bird TC is responsible for the families Rallidae (i.e., rails, gallinules, and other coots), Gruidae (i.e., cranes), Charadriidae (i.e., plovers and lapwings), Haematopodidae (i.e., oystercatchers), Recurvirostridae (i.e., stilts and avocets), Scolopacidae (i.e., sandpipers, phalaropes, and allies), Corvidae (i.e., jays, crows, and their allies), and Columbidae (i.e., pigeons). The Central Management Unit Mourning Dove TC is responsible for the Columbidae family (i.e., doves only). The Central Flyway Nongame Migratory Bird TC is responsible for all migratory birds, as per the Migratory Bird Treaty Act, not included in the above division of responsibilities. Technical Committee members do recognize, however, that they may need to collaborate on some issues. For example, the webless TC should coordinate with the nongame TC on issues related to shorebirds, rails, and federally threatened or endangered species that are not hunted.

The state, provincial, and territorial representatives to the TCs are usually biologists with considerable training and experience in the field of waterfowl, migratory shore and upland game bird, dove, or migratory nongame bird management and research. The function of the TCs is to serve the CFC, with primary responsibility for the technical information needs of the Flyway Council related to management of migratory game birds, wetland resources, and nongame migratory birds. The TCs may also recommend research projects, surveys, and management programs to the Flyway Council for their collective consideration or implementation. The Wyoming Game and Fish Department's Nongame Bird Biologist serves as the state's representative on the Central Flyway Nongame Migratory Bird Technical Committee (CFNMBTC). All current and ex-officio members of the CFNMBTC are presented in Table 1.

Since the its inception, the CFNMBTC has submitted 15 recommendations to the CFC for signing and submission, and 38 letters of correspondence to a variety of recipients on a diversity of nongame issues, both regulatory and non-regulatory. A summary of the recommendations and correspondence is presented below in Tables 2 and 3, respectively.

Table 1. Members of the Central Flyway Nongame Migratory Bird Technical Committee.

State, Province, Agency	Name	Representing
CO	Liza Rossi	Colorado Parks and Wildlife
KS	Rich Schultheis	Kansas Department of Wildlife, Parks, and Tourism
KS	Daren Riedle	Kansas Department of Wildlife, Parks, and Tourism
MT	Allison Begley	Montana Fish, Wildlife, and Parks
ND	Sandy Johnson	North Dakota Game and Fish Department
NE	Joel Jorgensen	Nebraska Game and Parks Commission
NM	Peggy Darr	New Mexico Department of Game and Fish
OK	Mark Howery	Oklahoma Department of Wildlife Conservation
SD	Eileen Dowd-Stukel	South Dakota Department of Game, Fish, and Parks
TX	Clifford Shackelford	Texas Parks and Wildlife Department
WY	Andrea Orabona	Wyoming Game and Fish Department
AB	Jason Caswell	Alberta Environment and Parks
NT	Suzanne Carriere	Northwest Territories Department of Environment and Natural Resources
SK	Katherine Conkin	Saskatchewan Ministry of Environment
CWS*	Samantha Song	Canadian Wildlife Service
USFWS*	Jim Dubovsky	United States Fish and Wildlife Service
USFWS*	Kammie Kruse	United States Fish and Wildlife Service
USFWS*	Scott Somershoe	United States Fish and Wildlife Service

* Ex-officio members

Table 2. Summary of recommendations submitted by the Central Flyway Nongame Migratory Bird Technical Committee since 2007. Atlantic Flyway (AF); Central Flyway (CF); Central Flyway Council (CFC); Central Flyway Nongame Migratory Bird Technical Committee (CFNMBTC); Mississippi Flyway (MF); Technical Committee (TC).

Date	Recommendation #	Pertaining to	Recommendation
March 20, 2007	10	Selection of shorebird species for Avian Influenza surveillance.	The CFC recommends that the USFWS prohibit lethal collection of certain shorebird species during avian influenza surveillance activities. Samples from highly imperiled species should be taken by nonlethal means.
March 20, 2007	11	Comment period during proposed rule stage.	The CFC recommends that the USFWS allows for comment periods for all nongame migratory bird regulations to be 90 days, but no less than 60 days, and considers the option of establishing nongame migratory bird regulatory cycles similar to that which exists for the Waterfowl, Webless, and Central Management Unit-Dove TCs.
March 20, 2007	12	Finalization of MOU for the Cooperative Exchange, Interpretation, and Evaluation of Data and Information Used for Developing Migratory Bird Regulations.	The CFC recommends that the MOU listed above be finalized and signed by the Director of the USFWS and the Chairperson of the CFC.
March 17, 2009	14	Allocation of permits for the passage take of 1st year Peregrine Falcons for falconry purposes in the US east of 100° W longitude.	The CFC recommends an equitable distribution of 36 1st year migrant Peregrine Falcon take permits among the CF, MF, AF, for the 20 September to 20 October 2009 trapping season; 12 permits each for the CF, MF, and AF. Of the Central Flyway's allocation, the CFC recommends 10 1st year migrant peregrine falcons for Texas and 2 1st year migrant Peregrine Falcons for Oklahoma for the 20 September to 20 October 2009 trapping season only.

Table 2. Continued.

Date	Recommendation #	Pertaining to	Recommendation
March 17, 2009	15	Allocation of permits for the nestling/post-fledgling 1st year take of Peregrine Falcons for falconry purposes in the US east of 100° W longitude.	The CFC recommends allocating 5 nestling/post-fledgling 1st year Peregrine Falcons to Montana, 5 to Wyoming, 4 to Colorado, and 2 to New Mexico for take during the nesting period through 31 August 2009 only.
March 23, 2010	14	Allocation of permits for the passage take of 1st year Peregrine Falcons for falconry purposes in the US east of 100° W longitude.	The CFC recommends that 12 of the 36 1st year migrant Peregrine Falcon take permits be allocated to the CF for the fall of the 2010 trapping season, with 11 of the 12 permits designated for Texas and 1 of the 12 permits designated for Oklahoma for the fall 2010 trapping season only.
March 15, 2011	14	Participation in the USFWS Eagle Technical Assessment Team.	The CFC recommends that a Central Flyway Nongame Migratory Bird TC representative is included on the USFWS's Eagle Technical Assessment Team.
March 15, 2011	15	Allocation of permits for the passage take of 1st year Peregrine Falcons for falconry purposes in the US east of 100° W longitude.	The CFC recommends adoption of Alternative A (allocation of 12-12-12) for allocation of permits for the take of passage immature Peregrine Falcons for falconry, and that states consider the use of a quota system to provide additional opportunity where the probability of take is expected to be less than 1 permit:1 falcon captured.
March 15, 2012	16	Allocation of permits for the passage take of 1st year Peregrine Falcons for falconry purposes in the US east of 100° W longitude.	The CFC recommends a continuation of the alternative outlined above (Recommendation #15).

Table 2. Continued.

Date	Recommendation #	Pertaining to	Recommendation
July 25, 2013	12	Allocation of permits for the passage take of 1st year Peregrine Falcons for falconry purposes in the US east of 100° W longitude.	The CFC recommends a continuation of the equal distribution of the 36 passage Peregrine Falcon permits between 3 flyways. The Central Flyway's 12 permits would be allocated as such: 10 to Texas, 2 to Oklahoma.
July 24, 2014	8	Allocation of permits for the passage take of 1st year Peregrine Falcons for falconry purposes in the US east of 100° W longitude.	The CFC recommends a continuation of the equal distribution of the 36 passage Peregrine Falcon permits between 3 flyways. The Central Flyway's 12 permits would be allocated as such: 10 to Texas, 2 to Oklahoma.
March 4, 2015	12	Allocation of permits for the passage take of 1st year Peregrine Falcons for falconry purposes in the US east of 100° W longitude.	The CFC recommends a continuation of the equal distribution of the 36 passage Peregrine Falcon permits between 3 flyways. The Central Flyway's 12 permits would be allocated as such: 10 to Texas, 2 to Oklahoma.
March 15, 2016	6	Allocation of permits for the passage take of 1st year Peregrine Falcons for falconry purposes in the US east of 100° W longitude.	The CFC recommends a continuation of the equal distribution of the 36 passage Peregrine Falcon permits between 3 flyways. The Central Flyway's 12 permits would be allocated as such: 10 to Texas, 2 to Oklahoma.
September 21, 2016	19	Allocation of permits for the passage take of 1st year Peregrine Falcons fro falconry in the US east of 100° W longitude and south of 31° N latitude.	The CFC supports continuing the equal distribution of the 36 permits for passage take of Peregrine Falcons for the 20 September to 20 October 2017 trapping season. Twelve permits each would be allocated to the Central, Mississippi, and Atlantic flyways.

Table 2. Continued.

Date	Recommendation #	Pertaining to	Recommendation
March 7, 2017	6	Allocation of permits for the passage take of 1st year Peregrine Falcons fro falconry in the US east of 100° W longitude and south of 31° N latitude.	The Central Flyway Council requests that the USFWS increase the maximum allowable take from 36 to 144 passage Peregrine Falcons, with an equal allocation of 48 permits to the Central, Mississippi, and Atlantic Flyways, beginning in 2017.

Table 3. Summary of correspondence submitted by the Central Flyway Nongame Migratory Bird Technical Committee since 2006. Central Flyway (CF); Central Flyway Council (CFC); Central Flyway Nongame Migratory Bird Technical Committee (CFNMBTC), Technical Committee (TC).

Date	Recipient	Issue(s)	CF Key Remark(s)
June 9, 2006 -and- June 12, 2006	Michelle Morgan, Chief, Branch of Recovery and Delisting, USFWS, -and- Brian Millsap, Chief, Division of Migratory Bird Management, USFWS	• Proposed Rule to delist the Bald Eagle • Definition of "disturb" • Review of Draft National Bald Eagle Management Guidelines	• Support the delisting, but "recommend the post-delisting monitoring plan be finalized to coincide with the final delisting". • Definition too narrowly focused on nest sites; "recommend that the term "nest abandonment" be replaced with "nest site or communal roost abandonment". • "Recommend that voluntary habitat protection and management activities be maintained and enhanced in the Guidelines, and that a positive, voluntary, non-regulatory tone be maintained"; represent the most liberal estimates of acceptable disturbance; and "recommend the guidelines be reviewed after 5 years for efficiency and accuracy".

Table 3. Continued.

Date	Recipient	Issue(s)	CF Key Remark(s)
November 3, 2006	Paul Schmidt, USFWS, -and- Dr. Bea Van Horne, USFS	• Review of "Opportunities for Improving North American Avian Monitoring"	• Support the four goals proposed, but believe the report needs to provide more recognition of the realities of personnel, budgets, and time restraints to reach these goals.
November 15, 2006	Robert Blohm, Acting Chief, Division of Migratory Bird Management, USFWS	• Draft EA on Take of Raptors from the Wild under the Falconry Regulations and the Raptor Propagation Regulations	• "Substantially more detail is required regarding the population model, reporting and data management, oversight and communication, and enforcement." • "Concerned that other proposed changes to the regulations governing falconry have not been adequately addressed to-date."
January 11, 2007	Robert Blohm, Acting Chief, Division of Migratory Bird Management, USFWS	• Reopening of comment period: Protection of Bald Eagles; Definition of ''Disturb''	• Reinforced our June 9th and 12th 2006 comments. • Suggested this definition, with our additions in italics: "Disturb means to agitate or bother a bald or golden eagle to the degree that causes *or is likely or predicted to cause* (i) *repeated displacement*, injury, or death to an eagle (including chicks and eggs) due to interference with breeding, feeding, or sheltering behavior, or (ii) nest *site or communal roost* abandonment or *likely or predictable abandonment of nest site or communal roost*."
March 6, 2007	Central Flyway Council	• Participation of Canadian provinces in CFNMBTC activities	• "Our Committee suggests that an invitation be extended to Northwest Territories, Alberta, and Saskatchewan to nominate an individual to serve on the Central Flyway Nongame Migratory Bird TC for input on issues that affect bird species or populations that are common to provinces and states within the CF."

Table 3. Continued.

Date	Recipient	Issue(s)	CF Key Remark(s)
March 6, 2007	Dr. Thomas DeLiberto, USDA APHIS-Wildlife Services, -and- Dr. Thomas J. Roffe, USFWS	• Avian influenza surveillance in 2007	• Samples from Buff-breasted Sandpiper and other highly imperiled species should be taken by nonlethal methods.
August 31, 2007	Jody Millar, Bald Eagle Monitoring Coordinator, USFWS	• Draft Post-delisting Monitoring Plan for Bald Eagles	• The plan is generally well developed, but "we are disappointed that the sampling plan was not completed, approved, and ready for implementation prior to delisting of the Bald Eagle". • "Troubled at the apparent lack of dedicated funding to support the monitoring effort." • Unclear as to what exactly is expected of the states.
August 31, 2007	Division of Migratory Bird Management, USFWS	• Proposed Rule: Authorizations Under the Bald and Golden Eagle Protection Act for Take of Eagles	• Recommend the Service "include state agency expertise in defining regions that may be used to assess the impact of take". • "It has been our understanding that take permits will not be issued and take resulting from disturbance of Bald Eagles will not be prosecuted as long as the national guidelines have been followed." • "Take should be based on state guidelines when they differ from federal guidelines." • Lacks specific information relating to Golden Eagles. Recommend a document similar to Bald Eagle Management Guidelines be developed. • Recommend the Service consider development of monitoring strategy for Golden Eagles. Lacking "defensible information on the status and trends of Golden Eagle populations".

Table 3. Continued.

Date	Recipient	Issue(s)	CF Key Remark(s)
January 21, 2008	Robert Blohm, Chief, Division of Migratory Bird Management, USFWS	• Draft Environmental Assessment and Management Plan for the take of migrant Peregrine Falcons in the US for use in falconry	• The DEA asserts that Canadian provinces will be involved in the allocation through the Flyways; however, the Canadian Provinces have not accepted our offer to provide representation on the Central Flyway Nongame Migratory Bird TC.
August 14, 2008	H. Dale Hall, Director USFWS	• Eagle Take Permit comment period	• Extend comment period from 30 to 60 days.
September 15, 2008	Diana Whittington, Division of Policy and Directives Management, USFWS	• Draft Environmental Assessment for the Proposal to Permit Take Provided Under the Bald and Golden Eagle Protection Act	• "Based on this review, the CFC does not support any of the proposed alternatives in the Draft Environmental Assessment." • "We request that Golden Eagles be removed from consideration for take permits until such time that sufficient supporting information can be collected and presented. We also recommend that the Service develop an Alternative 4 in the Draft Environmental Assessment to address a proposed take permitting system that includes Bald Eagles only." • "We continue to be concerned at the very short public comment periods provided by the Service for significant issues."
October 1, 2008	Alan Peoples (OK)	• Participation of Oklahoma in CFNMBTC activities	• Request they identify a representative ASAP, or contact the current Council chair if and when they decide to do so.

Table 3. Continued.

Date	Recipient	Issue(s)	CF Key Remark(s)
March 6, 2009	George Allen Division of Policy and Directives Management	• Proposed Rule for Removal of Rusty Blackbird and Tamaulipas (Mexican) Crow From the Depredation Order and other changes	• We do not believe Rusty Blackbird is a nuisance species warranting depredation measures. Agree to remove it from the depredation order. • Agree to remove the Tamaulipas Crow from the order.
March 9, 2009	Central Flyway Council	• Allocation of nestling/post-fledgling first-year Peregrine Falcons between the Central and Pacific Flyways	• Nongame Technical Committee members of the Central Flyway whose state is split with the Pacific Flyway provided recommendations on the level at which take should be authorized.
March 15, 2010	CFNMBTC	• Developed a flyway-wide list of Species of Greatest Conservation Need	• Illustrated the diversity of the species with which we work and demonstrated the Central Flyway Nongame Migratory Bird TC's interest in all native habitat types.
March 23, 2010	US Senators Feinstein and Alexander, -and- US Representatives Dicks and Simpson	• State Wildlife Grants program appropriation	• Requests funding for the State Wildlife Grants program at a level of $90 million during FY2011 and retention of the 65:35 cost-share ratio, which Congress enacted during FY2010.
March 23, 2010	George Allen, Chief Branch of Permits and Regulations, USFWS	• Bird Banding Lab letter	• The CFC requested that each of the four flyways be allowed a 120-day review period in order to evaluate and prepare a coordinated response among our TC.
March 4, 2011 (original) August 10, 2011 (signed)	USFWS	• Double-crested Cormorant letter	• The CFC had several questions about the USFWS's long-term vision to manage Double-crested Cormorants before we develop a flyway management plan.

Table 3. Continued.

Date	Recipient	Issue(s)	CF Key Remark(s)
March 23, 2011	USFWS	• Eagle Technical Assessment letter	• We requested the USFWS to include the CFNMBTC in inaugural and on-going efforts to address Bald and Golden Eagle issues.
October 3, 2011	USFWS	• Bald and Golden Eagle captive propagation letter	• In general, we do not see the need and, therefore, do not support captive propagation of Bald and Golden Eagles.
October 3, 2011	Senators Reed and Murkowski, and Representatives Simpson and Moran	• State Wildlife Grants support letter	• Support the continuation of State Wildlife Grants funding at $90 million for FY2012 and retention of the 65:35 cost-share ratio.
December 20, 2011	USFWS	• Double-crested Cormorant management	• Request 60-day comment period extension for Federal Register Notice of Intent regarding Double-crested Cormorant management.
March 13, 2012	USFWS	• Double-crested Cormorant management	• Comments to Federal Register Notice of Intent regarding Double-crested Cormorant management.
October 5, 2014	George Allen, USFWS	• Blackbird depredation	• Informal comments regarding a Pre-publication Draft Proposed Rule Regarding Amendments to the Migratory Bird Treaty Act.
October 9, 2012	Central Flyway Webless and Waterfowl Technical Committees	• Technical Committees' species responsibility	• Request for dialogue to improve how the different TCs address issues related to species based current Flyway structure. Non-hunted species currently fall under the responsibility of the TCs that traditionally focus on game species.
January 29, 2013	Central Flyway Council	• 2013 meeting schedule	• Inform Council of the CFNMBTC plan to meet in July rather than March.
April 8, 2013	George Allen, USFWS	• Raptor rehabilitation and falconry regulations	• Courtesy response expressing gratitude for the opportunity to comment on pre-publication draft Proposed Rule regarding revisions to rehabilitation and falconry regulations.

Table 3. Continued.

Date	Recipient	Issue(s)	CF Key Remark(s)
November 26, 2013	USFWS	• Proposed rule to list the *rufa* Red Knot as a threatened species	• USFWS needs to evaluate the Red Knot's life history and migration strategy, and identify a network of key Red Knot habitats or sites. • Geographic range should only include areas where the Red Knot occurs regularly (annually or near annually). • USFWS needs to evaluate different populations of the *rufa* Red Knot as Distinct Population Segments.
March 31, 2014	USFWS	• Draft Environmental Assessment management of Double-crested Cormorants	• Need a more thorough editorial review. • Double-crested Cormorant population size needs to be revised using the best available information.
July 22, 2014 (email sent)	Dave Morrison (TX)	• Double-crested Cormorant management	• Management Plan that the CFNMBTC compiled, as requested by the CFC.
March 6, 2015	Central Flyway Council	• Southern Wings Program	• Increased awareness of the Southern Wings Program, and support from the CFNMBTC.
March 6, 2015	Central Flyway Council	• CFNMBTC activities	• A brief update to the CFC on CFNMBTC activities to-date. Included correspondence and recommendations logs.
March 10, 2015	Dan Ashe, USFWS	• Results of stable isotope analysis of Peregrine Falcon feathers	• Request for analysis to be completed so that the next steps for passage Peregrine Falcon harvest may be considered.
July 23, 2015	Central Flyway Council	• CFNMBTC activities	• A brief presentation to the CFC on CFNMBTC activities to-date. Included general activities, 2012 NTC review, CFNMBTC thoughts, CFNMBTC recent activities, and MBTA Take Notice of Intent.

Table 3. Continued.

Date	Recipient	Issue(s)	CF Key Remark(s)
July 24, 2015	USFWS	• PEIS for evaluating the potential to authorize incidental take of migratory birds under the MBTA	• Comments were provided on 13 of the 15 various points of consideration, as well as in the "other comments" section.
February 24, 2016	Scott McNuff	• Comments on increasing the take quota for Peregrine Falcons	• CFNMBTC will review the newly released "Population Estimates for Northern Juvenile Peregrine Falcons with Implications for Harvest Levels in North America". • Requested a final isotope analysis report from USFWS prior to the annual CFNMBTC meeting in September 2016. • Will recommend to the CFC to continue the same level of take.
February 24, 2016	Brian Millsap	• Peregrine Falcon isotope analysis	• Formal request from the CFNMBTC for a complete isotope analysis report prior to the September 2016 CFNMBTC meeting.
March 7, 2017	Jerome Ford, USFWS	• Comments on increasing the take quota for Peregrine Falcons	• Take can be increased based on recent population estimate. • Stable isotope analyses show that ~75% of hatch-year peregrines originate from the Northern Management Population. • Split increased take between the 3 flyways at 48 each. • Use adaptive management for setting the population estimate.

WYOMING BIRD RECORDS COMMITTEE

STATE OF WYOMING

NONGAME BIRDS: Rare and Unusual Birds

FUNDING SOURCE: Wyoming State Legislature General Fund Appropriations
Bureau of Land Management Cooperative Agreement

PROJECT DURATION: Annual

PERIOD COVERED: 1 January 2015 – 31 December 2016

PREPARED BY: Andrea Orabona, Nongame Bird Biologist
Courtney Rudd, Nongame Biologist

SUMMARY

The Wyoming Bird Records Committee (WBRC) was established by the Wyoming Game and Fish Department (Department) Nongame Program in 1989 to accomplish the following goals:

1) To solicit, organize, and maintain records, documentation, photographs, audio recordings, and any other material relative to the birds of Wyoming.
2) To review records of new or rare species or species difficult to identify and offer an intelligent, unbiased opinion of the validity or thoroughness of these reports. From these reviews, the WBRC will develop and maintain an Official State List of Birds in Wyoming.
3) To disseminate useful and pertinent material concerning the field identification of Wyoming birds in order to assist Wyoming birders and ornithologists with increasing their knowledge and skill.

The WBRC is interested in promoting and maintaining quality and integrity in the reporting of Wyoming bird observations, and it treats all bird records as significant historical documents. The WBRC operates under a set of bylaws approved in 1991 and updated in 1992, 1998, and 2015.

As of 31 December 2016, the WBRC has reviewed 1,387 reports of rare and unusual birds in Wyoming. A total of 1,135 (82%) have been accepted and 252 (18%) have not been accepted. A total of 26 reports were submitted in 2016 and are currently in the review process.

The WBRC Database is a dynamic document, typically updated once or twice a year following the WBRC meetings. A full report of all sightings submitted to the WBRC through 2016, species for which the WBRC requests documentation, rare and unusual bird sighting forms,

information on how to document rare and unusual birds, and the WBRC bylaws are available from the Nongame Bird Biologist in the Department's Lander Regional Office or on the Department's website: https://wgfd.wyo.gov/Wildlife-in-Wyoming/More-Wildlife/Nongame-Birds.

ACKNOWLEDGEMENTS

Funding was provided by the Wyoming State Legislature General Fund Appropriations and through a Cooperative Agreement with the Bureau of Land Management, for which we are extremely grateful. We wish to thank all observers for taking the time to submit their sightings to the WBRC. We are also indebted to the following Wyoming Bird Records Committee members for their invaluable efforts: M. Fraker, B. Hargis, G. Johnson, J. Maley, and S. Patla.

APPENDIX I – OTHER REPORTS

(NOTE: SOME OF THESE REPORTS HAVE NOT BEEN EDITED, AND APPEAR HERE AS THEY WERE SUBMITTED TO THE NONGAME PROGRAM)

THE EFFECT OF GREATER SAGE-GROUSE (*CENTROCERCUS UROPHASIANUS*) CONSERVATION ON WILDLIFE SPECIES OF CONCERN: IMPLICATIONS FOR THE UMBRELLA SPECIES CONCEPT

STATE OF WYOMING

NONGAME BIRDS: Species of Greatest Conservation Need – Greater Sage-Grouse and habitat-associated Species of Greatest Conservation Need

FUNDING SOURCE: United States Fish and Wildlife Service State Wildlife Grant

PROJECT DURATION: 1 July 2013 – 30 June 2016

PERIOD COVERED: 1 July 2015 – 20 June 2016

PREPARED BY: Jason D. Carlisle, Ph.D. Program in Ecology, University of Wyoming

SUMMARY

A portion of this Master of Science project was funded by the Wyoming Game and Fish Department through the US Fish and Wildlife Service State Wildlife Grants program. A summary of the work is presented below (Carlisle 2017).

The umbrella species concept is a conservation shortcut wherein multiple species are protected under the umbrella of areas protected for one species. While appealing in theory, empirical tests of the concept have been scarce. Greater Sage-Grouse (*Centrocercus urophasianus*, "sage-grouse") have high conservation priority across western North America, and many hope sage-grouse serve as an umbrella species, whereby conservation actions taken for sage-grouse benefit the many other at-risk wildlife species ("background species") in sagebrush ecosystems. We used a multifaceted approach (i.e., broad-scale spatial models, local empirical studies, and a controlled field experiment) in Wyoming, USA to address the following questions: Chapter 1) How much protection does a reserve established for sage-grouse offer 52 background species? Chapters 2 and 3) Do finer-scale measures of sage-grouse abundance, habitat preference, and habitat quality align with those of sagebrush-associated songbirds of concern? Chapter 4) How do mowing treatments meant to enhance sage-grouse habitat affect non-target songbirds? The reserve contained 21% of the habitat of background species on average; however, coverage varied substantially across species, with species dissimilar to sage-grouse covered least. The size of the reserve was key to its umbrella function. We found little evidence that local abundances of songbirds aligned with those of sage-grouse. Moreover, there was little concordance between sage-grouse and songbirds on which nesting habitats were preferred or associated with higher survival. Habitat treatments implemented for sage-grouse had mixed effects on songbirds, and resulted in the loss of nesting habitat for shrub-nesting species. Our

results suggest that broad-scale habitat protections implemented for Greater Sage-Grouse benefited many, but not all co-occurring species of concern. Moreover, the utility of sage-grouse as an umbrella species was limited at finer spatial scales. Our findings help identify background species missed by the sage-grouse umbrella and illustrate the need to consider spatial scale in surrogate-species conservation strategies.

LITERATURE CITED

Carlisle, J. D. 2017. The effect of Sage-Grouse conservation on wildlife species of concern: implications for the umbrella species concept. Dissertation. University of Wyoming, Laramie, USA.

ABUNDANCE OF BLACK-BACKED WOODPECKERS (*PICOIDES ARCTICUS*) IN THE BLACK HILLS OF SOUTH DAKOTA AND WYOMING

STATE OF WYOMING

NONGAME BIRDS: Species of Greatest Conservation Need – Black-backed Woodpecker

FUNDING SOURCE: Wyoming Governor's Endangered Species Account Fund

PROJECT DURATION: 1 March 2015 – 30 June 2016

PERIOD COVERED: 1 March 2015 – 20 June 2016

PREPARED BY: Elizabeth Matseur, Master of Science Student, University of Missouri – Columbia

SUMMARY

A portion of this Master of Science project was funded by the Wyoming Game and Fish Department through the Wyoming Governor's Endangered Species Account Fund. A summary of the work is presented below (Matseur 2017).

Black-backed Woodpeckers (*Picoides arcticus*) are rare residents of northern conifer forests and are almost always associated with disturbances, such as fire and beetle infestation. The Black Hills population of Black-backed Woodpeckers has been petitioned to be considered a Distinct Population Segment under the Endangered Species Act, and more information on their population size in the region is needed. Our objective was to map abundance of Black-backed Woodpeckers in the Black Hills and Bear Lodge Mountains of South Dakota and Wyoming, and provide a population estimate for Black-backed Woodpeckers in the region. We located 124 and 115 transects across the Black Hills in South Dakota (n = 100) and Wyoming (n = 24; Figures 1-3), containing 1,232 and 1,138 sampling points, in 2015 and 2016, respectively. In Wyoming's portion of our study area, the 24 transects had a total of 240 points. We conducted 5-minute point count surveys from late-March to late-June and visited each point 3 times to estimate detection probability. We characterized vegetation around each point using GIS derived landscape variables that included: percent cover of green trees, beetle killed trees, dead trees, and year since wildfire. We detected 362 Black-backed Woodpeckers across both years. We fit 3-level hierarchical time-removal models that simultaneously estimated abundance, availability, and detection probability in R package "unmarked" using *gmultmix* and ranked models using Akaike Information Criterion. The global abundance model received the most support. Abundance was negatively related to percent cover of dead trees and green trees and a positively related to percent cover of beetle killed trees, and percent area of 1- to 2-, 3-, and 4- to 5-year-old wildfires. Abundance of Black-backed Woodpeckers varied the greatest across present cover of

beetle killed trees and wildfires that had burned within the last 5 years. Mean density was 0.00528 birds/ha in 2015 and 0.00626 birds /ha in 2016. An estimated 2,920 (LCL: 1,449; UCL: 5,917) and 3,439 (LCL: 1,739; UCL: 6,908) individual Black-backed Woodpeckers, which is equivalent to 1,460 and 1,720 pairs of Black-backed Woodpeckers, in the Black Hills in 2015 and 2016, respectively. Our study is the most extensive survey of Black-backed Woodpecker abundance in the region and sets the stage for future analyses of the species population viability in the region.

LITERATURE CITED

Matseur, E. A. 2017. Abundance of Black-backed Woodpeckers and other birds in relation to disturbance and forest structure in the Black Hills and Bear Lodge Mountains of South Dakota and Wyoming. Thesis. University of Missouri – Columbia, USA.

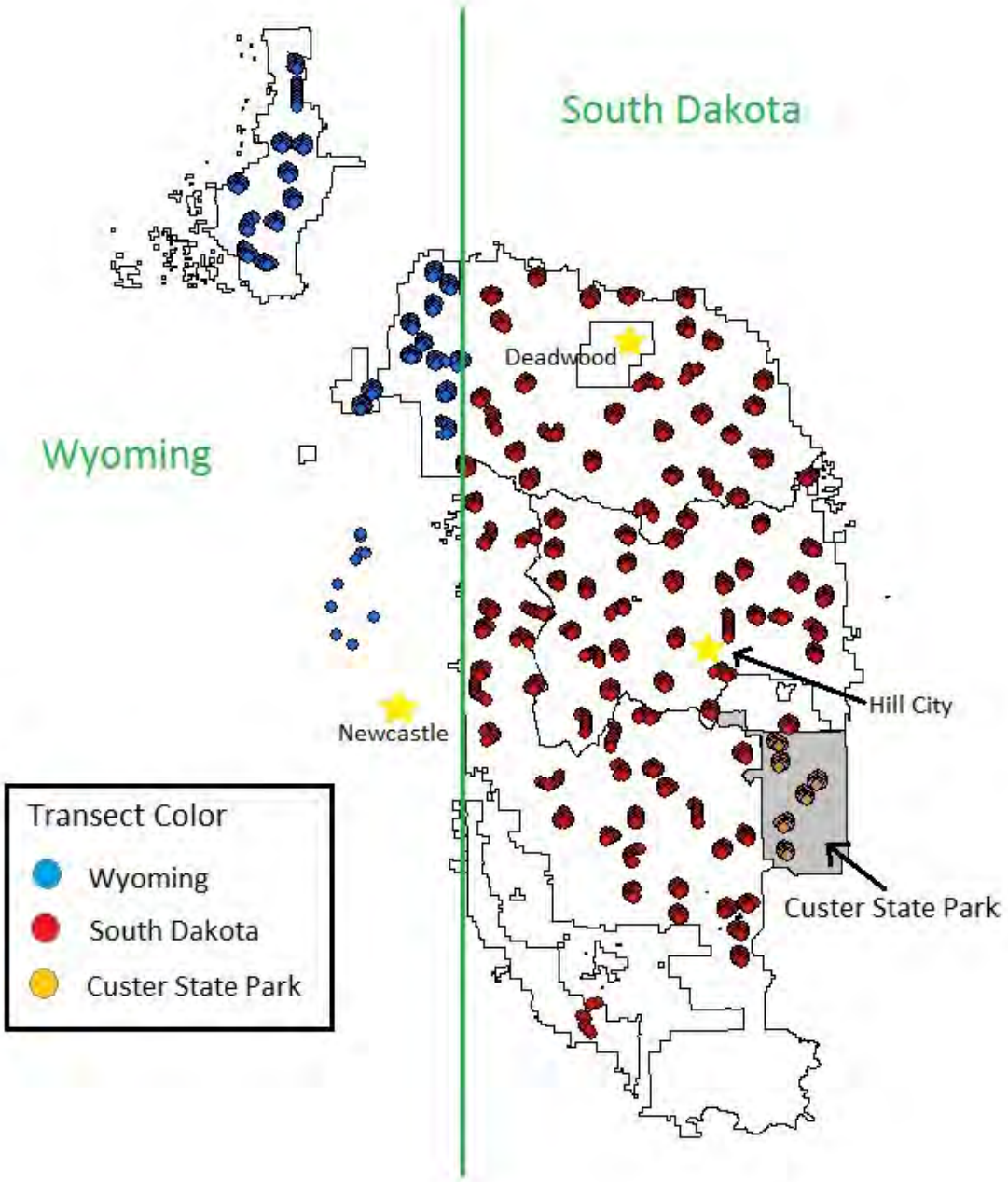

Figure 1. Locations of the 124 Black-backed Woodpecker (*Picoides arcticus*) transects we distributed across the Black Hills in South Dakota (n = 100) and Wyoming (n = 24).

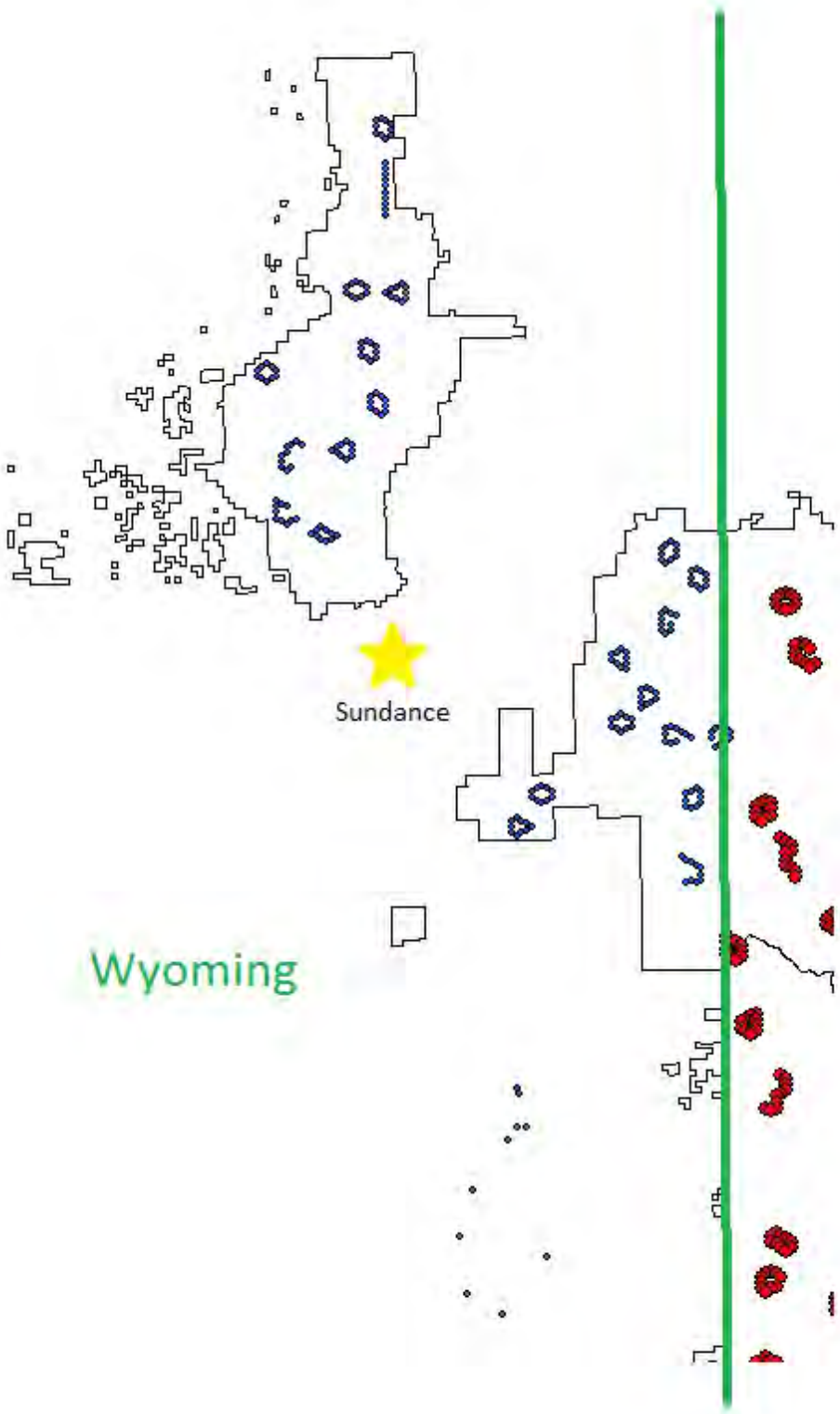

Figure 2. Locations of the 24 Black-backed Woodpecker (*Picoides arcticus*) transects we distributed in the Wyoming portion of our study area in the Black Hills.

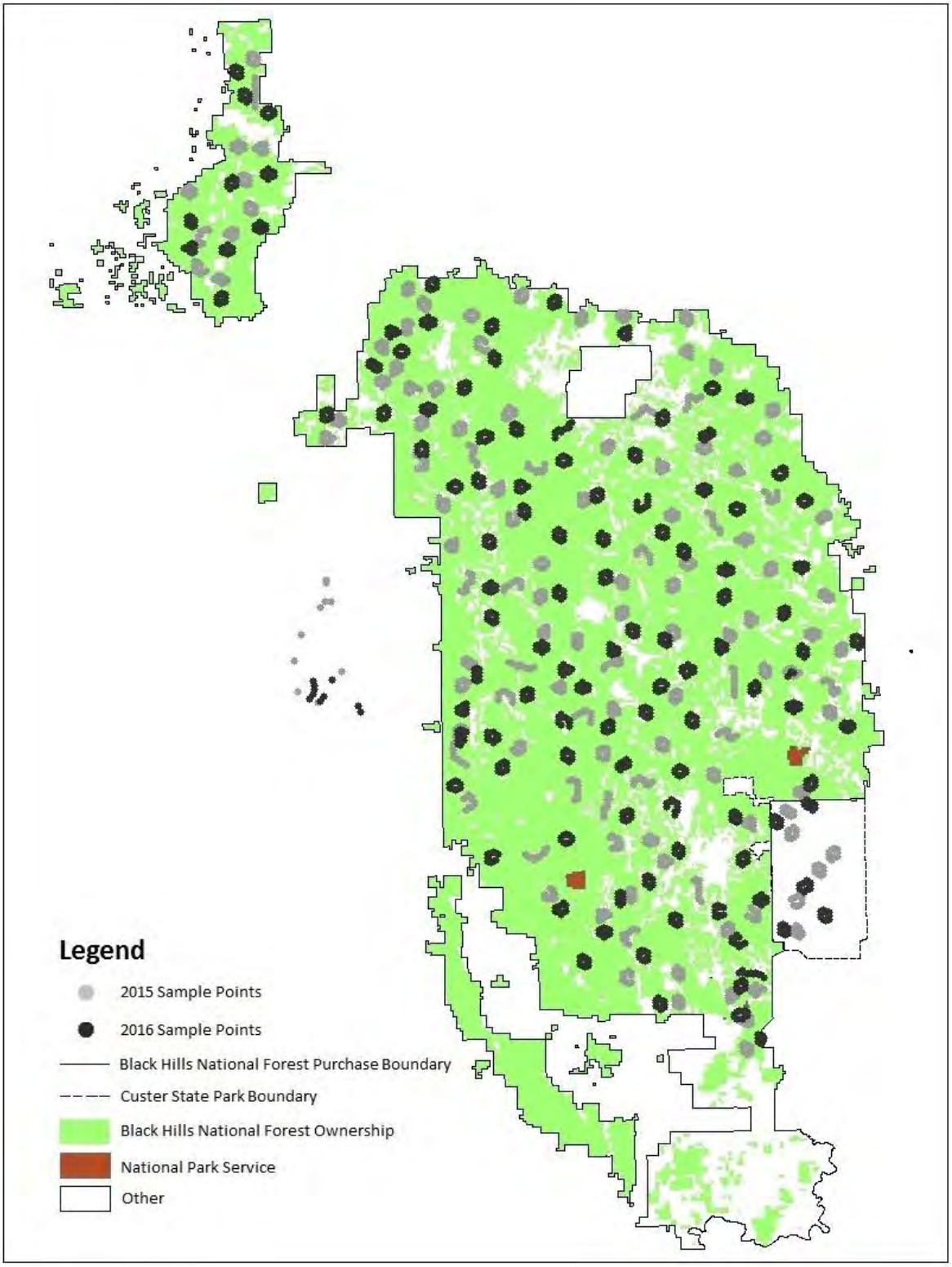

Figure 3. Black-backed Woodpecker sample point locations (N = 2,370) for 2015 (light gray circles) and 2016 (dark gray circles) in the Black Hills National Forest and Custer State Park, South Dakota and Wyoming between the end of March and the end of June.

BLACK ROSY-FINCH (*LEUCOSTICTE ATRATA*) DISTRIBUTION, ABUNDANCE, AND HABITAT SELECTION DURING THE BREEDING SEASON

STATE OF WYOMING

NONGAME BIRDS: Species of Greatest Conservation Need – Black Rosy-Finch

FUNDING SOURCE: United States Fish and Wildlife Service State Wildlife Grant
Wyoming State Legislature General Fund Appropriations

PROJECT DURATION: 1 July 2015 – 30 June 2018

PERIOD COVERED: 1 January 2016 – 31 August 2016

PREPARED BY: Carl Brown, Master of Science Student, University of Wyoming
Susan Patla, Nongame Biologist, Wyoming Game and Fish Department

ABSTRACT

Alpine habitat is considered to be the most effected by climate, and can be a logistically challenging environment to collect data. The Black Rosy-Finch (*Leucosticte atrata*) is not only the highest-elevation breeding species, but also one of the least studied species in North America. Only a handful of parties have reached nests, and roughly 1 paper per decade has been published on any rosy-finch species since the 1960s. Field work to date on this project has documented Black Rosy-Finches in 3 additional mountain ranges in Wyoming, and field work will continue for another season to measure habitat associations and distribution of the species. Initial results are not yet available for most data, but we have seen evidence of Black Rosy-Finches tracking retreating snow and the importance of tundra.

INTRODUCTION

Predicted climate models suggest increased drought, earlier spring onset, and declining snowpack in the Intermountain West (Mote 2006). For the first time, temperatures in 2015 were 1°C higher than those of the pre-industrial mid- to late 19th century (Blunden et al. 2016). In addition, 14 of the last 15 years since 2000 were the warmest on record (Blunden et al. 2016). The northern Rocky Mountains have already experienced a 3-fold increase in the average global temperature change (Shuman 2012). Additionally, snowmelt is projected to advance by 30 to 40 days during this period (Stewart et al. 2004). In alpine zones, climatologists have recorded increases in spring and winter temperatures, a decline in the ratio of precipitation falling as snow, and a decrease in snow and ice cover (Walther et al. 2002, Shuman 2012). Additionally,

increased dust deposition up to 500% has caused melting to advance by 3 weeks in Colorado (Neff et al. 2008).

Species that depend on alpine environments for critical life stages are predicted to be those most negatively impacted by increasing temperatures (Parmesan 2006, Lenoir et al. 2008). Vegetation in montane regions has shown evidence of thermophilization, where warm-adapted species have increased and cold-adapted species have declined (Chen et al. 2011). Upslope movement of vegetation has resulted in an average of 4 additional species on the summits of Europe's boreal mountains (Gottfried et al. 2012). Vertebrates, such as the American pika (*Ochotona princeps*), have seen population reductions as high as 28% in the Great Basin, while montane avian communities have experienced upslope shifts and loss of biodiversity (Beever et al. 2003, Tingley and Beissinger 2013, Zamora and Barea-Azcón 2015). Addressing key habitats and resources for alpine dependent species at different spatial and temporal scales will lead to a greater understanding of their threats and adaptive capacity (Beever et al. 2015).

The Black Rosy-Finch (*Leucosticte atrata*; BLRF) is the highest-elevation breeding bird in Wyoming and is associated with alpine environments during the breeding season (French 1959). This remoteness has contributed to the BLRF being one of the least studied North American birds, with distribution and most aspects of its life history poorly researched (Johnson 2002). All 3 rosy-finch species in North America are associated with foraging on snowpack and tundra, and recent work on the similar Brown-capped Rosy-Finch (*Leucosticte australis*) in Colorado has focused on habitat selection (Stanek 2009). This study found rosy-finch abundance to be negatively associated with snow cover and inversely associated with snow-free tundra. Foraging preferentially occurred on tundra, and birds tracked receding snowfield edges during the early breading season while foraging at a distance from the snow-edge during late breeding season. Furthermore, while cliffs are critical for nesting (Johnson 2002, Stanek 2009), other metrics critical to the rosy-finch's life history need further attention (Johnson 2002).

Past studies suggest a long-term negative impact of climate change, resulting in a loss of tundra and the upslope movements of lower-elevation species. However, these studies do not explore the shorter-term impacts of climate change on rosy-finches. Understanding the importance of late-season snowpack and thermal gradients should reveal immediate threats.

The Black Rosy-Finch is not only the highest-elevation breeding bird in North America, but is also one of its least-studied avian species (Johnson 2002). The BLRF is a Species of Greatest Conservation Need in Wyoming with an unknown Native Species Status (NSSU, Tier II) ranking, reflecting the lack of available information (WGFD 2017). Additionally, the State Wildlife Action Plan (WGFD 2017) lists climate change as one of 5 leading wildlife conservation challenges. With alpine ecological processes set to irreversibly change (or already irreversibly changed), documentation of this species' habitat associations and the range it occupies needs to be done immediately if we are to have the capacity to observe range shifts or contractions.

Rosy-finches are known to associate with the damp snow/tundra edges during the earlier breeding season, possibly consuming last year's seeds that as they are exposed. During the late breeding/post fledging period, foraging occurs on tundra further away from these snow edges,

possibly focused on this year's seed crop (Johnson 2002, Stanek 2009). Personal observations suggest that rosy-finches also associate with tundra that has higher moisture levels during the post-fledging period and on tundra that has gone to seed. If rosy-finches do select for areas of greater moisture content during the post-fledging period, then the effects of the loss of late season snowpack would constrain available habitat when fledged young are most vulnerable (Sullivan 1989). Furthermore, if rosy-finches are selecting for regions of cooler temperatures, then we would expect available habitat to be further constrained with increasing temperatures.

In addition, we propose to analyze an assortment of metrics that have previously been examined for Brown-capped Rosy-Finches in order to compare the two species (Stanek 2009). We will also examine critical habitat elements at different spatial and temporal scales (Figures 1 and 2) to obtain a well-rounded understanding of BLRF habitat needs. Habitat associations investigated will range in scale from that of the state, down to macro-habitat and that of the foraging individual. Recommendations for long-term monitoring protocol efforts will be provided at the completion of this study, along with distribution maps for the state.

Hypothesis and predictions to be tested include (breeding period only):

Hypothesis 1: BLRF adjust resource use over time.
Predictions: BLRF select for different foraging habitat at the site level during different survey periods. BLRF forage at different distances from snow/tundra edged during different survey periods. BLRF select variables whose values remain static at different rates during different survey periods. Habitat that is represented by a single value throughout the entire breeding season (GIS-derived layers such as heat load index, elevation, and measures of temperature) might be linked over time to different foraging selection at the individual level, and densities of BLRF at the site level.

Hypothesis 2: A loss of late season snowpack will negatively affect BLRF.
Prediction: BLRF will select for tundra that has higher soil moisture levels during later survey periods. BLRF will select more strongly for foraging on or in close proximity to snowpack relative to its abundance during later survey periods.

Hypothesis 3: Accelerated snowpack retreat will negatively affect BLRF.
Prediction: BLRF preferentially forage in close proximity to snowpack while snowpack levels are at higher densities.

Hypothesis 4: Densities of BLRF in relation to proximities to cliffs are a function of elevation.
Prediction: BLRF densities will be greater when in closer proximities to cliffs. At lower elevations, BLRF will be in greater relative densities at closer proximities to cliffs than at higher elevations.

Hypothesis 5: Increasing climatic temperatures will negatively affect BLRF habitat selection.
Prediction: BLRF select for locations with lower temperatures. BLRF are found at higher densities at sites with higher levels of tundra.

Additionally: Develop a predictive distribution map for northwest Wyoming.

Predictions: GIS layers cab be used that represent variables believed to be biologically important to BLRF (distance to cliffs, elevation, heat load index, soil moisture) will be ranked as significant while developing predictive distribution maps.

In addition to answering questions stated above, our specific research objectives are to: 1) Assess the abundance of Black Rosy-Finches across latitudinal and alpine habitat gradients in northwestern Wyoming; 2) Use habitat and climatic data to develop predictive distribution maps for Black Rosy-Finches in Wyoming; 3) Evaluate the specific attributes of alpine snowfields most used for foraging; and 4) Provide insight for locations and protocols for long-term black rosy-finch monitoring efforts.

METHODS

Study Area

We are conducting breeding season surveys in northwestern Wyoming over the course of 2 years. In 2016, transects were placed evenly across the Beartooth, Greys River (Salt and Wyoming), Gros Ventre, and Teton mountain ranges. Two ranges will be repeated from those surveyed in 2016 during the 2017 field season to look at seasonal effects. Two new ranges will be added in 2017. These ranges will be selected to represent Wyoming by choosing different longitudinal, elevational, and geological gradients. We excluded smaller ranges, such as those found in Yellowstone National Park, as they are too logistically challenging. Surveys in 2016 took place in the Caribou-Targhee, Bridger-Teton, and Shoshone National Forests, as well as in Grand Teton National Park (Figure 3).

Transect Locations

We conducted transects at each mountain range at sites approximately 2 km or greater apart from one another (Figure 4). Transect locations were randomly selected from a list of potential sites that appeared to fall across a gradient of habitat described in the literature (Johnson 2002, Stanek 2009) and personal observations. These characteristics included elevation greater than 10,000', alpine tundra, nesting cliffs and late season snowpack.

We selected randomized starting points via random number tables, but kept within several hundred meters of pre-defined start locations. Pre-defined start locations accounted for survey space being limited at lower elevation sites and avoidance of logistical hazards. General location and direction of transects were usually determined prior to entering sites.

Transect starting points were selected before entering the field due to environmental constraints and avalanche hazards. Random starting points were determined prior to field work, or shifted with random number generation on site. Transects usually required long hikes to reach, which led to a clustering of sites within each range. Six transects were conducted in 2016 at each mountain range, for a total for 23 individual transects when accounting for a pair-walked site. With an increase in staff for 2017, 36-48 transect sites are expected to be surveyed during the 2nd field season.

Transect Shape and Size

Surveyors acted to strike a balance between walking as straight a path as possible in order to avoid resurveying prior locations and the need for many angles to ensure habitat gradients were crossed (Buckland et al. 2004). Rosy-finches avoid trees and forage on and around cliffs, and surveyors angled transects ~45° to cliffs and nearby forests (Figure 5). Large sweeping transects with fewer large turns were favored over those which might result in a saw-tooth pattern to minimize resurveying areas (Figure 6). Transect length was targeted at 2 km, with all bird observations recorded.

Survey Periods

All transects at each survey location were repeated 3 times during each field season, approximately once in June, July, and August (Figure 7). Accounting for a lost week of surveys due to fire, 63 transects were walked in 2016. Approximately 144 transects are proposed to be walked in 2017.

Habitat Data

We used the line intercept method to record habitat information (Canfield 1941, Kaiser 1983). Bird observations and habitat information were recorded simultaneously while conducting transects. An observer marked their starting location with a hand-held Geographic Positioning System (GPS) unit, taking note of habitat type underfoot (Figure 8). Whenever an observer transitioned from either boulder, snow, or tundra, this location was recorded, along with its corresponding habitat type. This allowed for a habitat profile for each transect each time it was walked. Different lengths of habitat types were binned (e.g., 48% tundra, 34% snow, and 18% boulder).

Bird Observations

Observers walked transects quietly at a moderate pace recording bird observations. The location of the bird and distance to snow edge were taken, along with individual information (Figure 9). Locations were determined by taking the observer's location with a GPS, distance to bird with laser range finder, and bearing and inclination with a compass. This allowed for bird locations to be re-projected with computer software. Closest distance to snowpack was taken when birds were foraging, and either estimated via arithmetic in the field, or a separate point was taken if perpendicular to the bird to be re-projected for a distance estimation. Birds flying overhead were recorded without location information. Birds visually identified had locations recorded, and those only heard had an estimated location taken along with how detected (Figure 10).

Data Extraction:

Spatial Data Extraction

We are projecting BLRF locations using packages 'NISTunit', and 'reshape2' within program R 3.3.3 (Gama 2016, R Core Team 2013, Wickham 2007; Figure 11). Inclination is used, in addition to distance and bearing from observer, to project BLRF locations without over- or under-projecting distance from observer (Figure 10). Distances of BLRF from transects for density estimations and distances from cliffs for habitat analysis are conducted using packages 'sp', 'rgdal', and 'rgeos' in R 3.3.3 (Pebesma and Bivand 2005, Bivand et al. 2016, Bivand and

Rundel 2016). Density of birds at the transect level is estimated using Distance Sampling methods using program 'unmarked' in R 3.3.3 (Buckland et al. 2005, Fiske and Chandler 2011; Figure 12).

Novel cliff layers are being created through manipulation of 10 m DEM rasters, and other landscape and thermal metrics are being created in ArcGIS 10.4.1 using the 'Toolbox for Surface Gradient' package (Evans et al. 2014, Esri 2015; Figure 13).

Proportion of Habitat Recorded at Sites

We are using line-intercept method collected habitat data broken by line segment using the 'points to line' toolbox in ArcGIS. Binning segments of different habitat types is providing a habit profile of each transect walked.

Distance to Snowpack

We are estimating the availability of habitat at different distances for each transect through R 3.3.3 (Figure 14).

Elevation and Other DEM Derived Information

The elevation of bird locations is estimated by extracting the location of projected BLRF observations from a 10 m DEM. DEM derived layers, including a measure of heat load index (thermal information), are being derived from ArcGIS 10.3 Toolbox for Surface Gradient and Geomorphometric Modeling (Evans et al. 2014).

Data Analysis:

State Level Habitat Associations and Distribution

For the analysis of those data, we are using the machine learning approach of Classification and Regression Trees (CARTs; Breiman et al. 1984), specifically Random Forest (Breiman 2001, Cutler et al. 2007, Rogan et al. 2008, Evans et al. 2010). This will provide a predictive distribution map for northwest Wyoming (Figure 15). Initial results using data from mountain ranges previously known to have breeding BLRF populations have projected occupation in only recently discovered ranges.

Site Level Habitat Associations

Densities of BLRF and habitat data collected using the line-intercept method (e.g., % tundra, % snow, etc.) will be used in a mixed linear effects model with transect as a random effect. We will run these in accordance to the period in which they were collected.

Individual Foraging Trends

We are calculating the proportion or probability of foraging events against the proportion of available habitat. Analyses are being done for each survey period and also collectively.

Distance to Snowpack

Foraging observations and the distance of individual BLRFs to the nearest snowpack are calculated for each survey period. The available habitat for each distance bin is also to be provided. We are contemplating whether all transects should be binned together to run a GLM

where percent snowpack is on the y-axis, and distance to snow-edge is provided on the x-axis. This might uncomplicate situations where transects during the later end of survey periods start to look more like the subsequent survey period.

Cliff Edge Associations

In addition to analyzing BLRF densities to distances from cliffs, an interactive term of elevation will be calculated. We believe that lower elevation sites will have greater proportions of BLRFs in closer proximity to cliffs than at higher elevations. At lower elevation sites, the interior of cirques are often filled with sagebrush and trees, while at higher elevations, tundra. Furthermore, BLRFs seem to forage further from cliffs later in season when they are not tied to cliff nesting sites.

Elevation

BLRF densities will be compared to the gradient of elevations in which they are found. This will be done by series, as there is anecdotal observational evidence that BLRFs will forage at lower elevations after fledging their young. While densities are expected to rise with elevation, we will look to see if there is an elevation threshold at which densities begin to decline.

Heat Load Index and Soil Moisture

Heat load index and soil moisture (Evans et al. 2014) values for individual BLRF observations will run as a regression or bar chart for the entire season, and by each survey period to look for shifts in habitat use (Figure 16). If we buffer the length of the transect by the maximum distance of birds used for distance sampling, we would be able to place random points within this polygon to inquire into selection. This might be the closest metric we have for quantifying thermal gradients.

RESULTS

See discussion and figures, as preliminary results are limited at this time. Initial predictive distribution maps have been generated (Figure 15), along with snow-edge foraging information (Figure 16).

DISCUSSION

The availability of different habitat types on which BLRF can forage changes as snowpack recedes. Additionally, last year's forage is hidden underneath snowpack, and distances at which an individual forages from this snow-edge provide different resources (Johnson 2002, Stanek 2009). These shifts in available habitat, in conjunction with different BLRF life stages, should lead to different resource selection over time.

Starvation is one of the most important mortality factors in recently fledged juvenile songbirds (Sullivan 1989). Recently fledged BLRF have been seen utilizing tundra, often foraging on arthropods and current year's seed (Johnson 2002). Juveniles often congregate in

areas of tundra with higher moisture levels than those surrounding areas. A reduction in soil moisture due to reduced late season snowpack could constrict foraging habitat preferentially selected. Additionally, as insects are a critical food source for BLRF juveniles during their first week after hatching (Johnson 2002), available snowpack where adult BLRF's collect windblown insects could be reduced.

If the early snow-edge acts as an important food source exposing last year's seeds and a source of arthropod activity (Johnson 2002, Mani 1968), then an accelerated snowpack retreat will reduce the amount of time this resource is available for exploitation. Initial results reflect that BLRF are selecting for snow-edge during pre-nesting periods, and for tundra interior near fledging periods, similar to that of Brown-capped Rosy-Finches.

BLRF place the majority of their nests on cliff faces adjacent to alpine tundra (Johnson 2002). Brown-capped Rosy-Finch densities decrease with an increasing distance from cliffs (Stanek 2009). Lower elevation nesting cliffs have non-tundra plant communities such as sagebrush or trees immediately adjacent to these cliffs' boulder and scree slopes. Higher elevation nesting cliffs have alpine tundra stretching several hundred meters to several kilometers away from rock and scree slopes originating from these cliffs. As BLRF are associated with foraging on tundra, we would expect to see an interaction between densities of BLRF adjacent to cliffs and elevation.

Additionally, if BLRF select for locations with lower relative temperatures, an increase in temperature due to climate change will constrict habitats BLRF select. Increasing temperatures will negatively affect tundra communities due to upslope movement in species communities.

ACKNOWLEDGEMENTS

Full funding for this project was provided by the Wyoming Game and Fish Department through the US Fish and Wildlife Service State Wildlife Grants program and the Wyoming State Legislature General Fund Appropriations. Pilot season funding was provided by the Meg and Bert Raynes Wildlife Fund. We appreciate the input and help from the following people: A. Chalfoun (advisor), C. Benkman and K. Gerow (committee), University of Wyoming; S. Dewey and J. Stephenson, Grand Teton National Park; K. Kanes, K. Murphy, and D. Witsen, Bridger-Teton National Forest; A. Harper, Shoshone National Forest; N. Yorganson, Caribou-Targhee National Forest; N. Bosworth, field technician; K. Duffy, Yellowstone National Park; D. Johnson, Washington State University; J. Stanek, former University of Wyoming graduate student.

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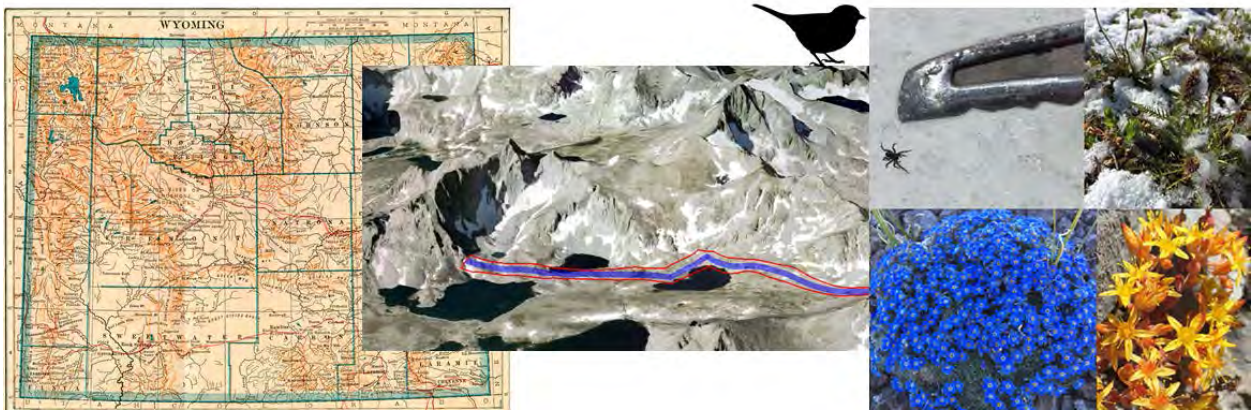

Figure 1. Three scales of importance: the state, transect, and the foraging individual.

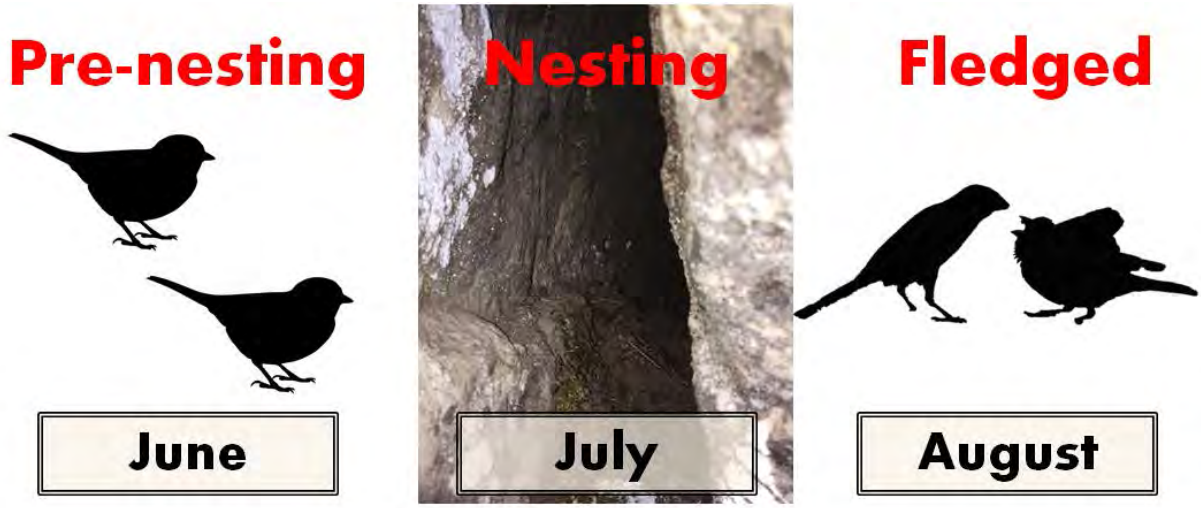

Figure 2. Periods of time in question that reflect different biological landmarks.

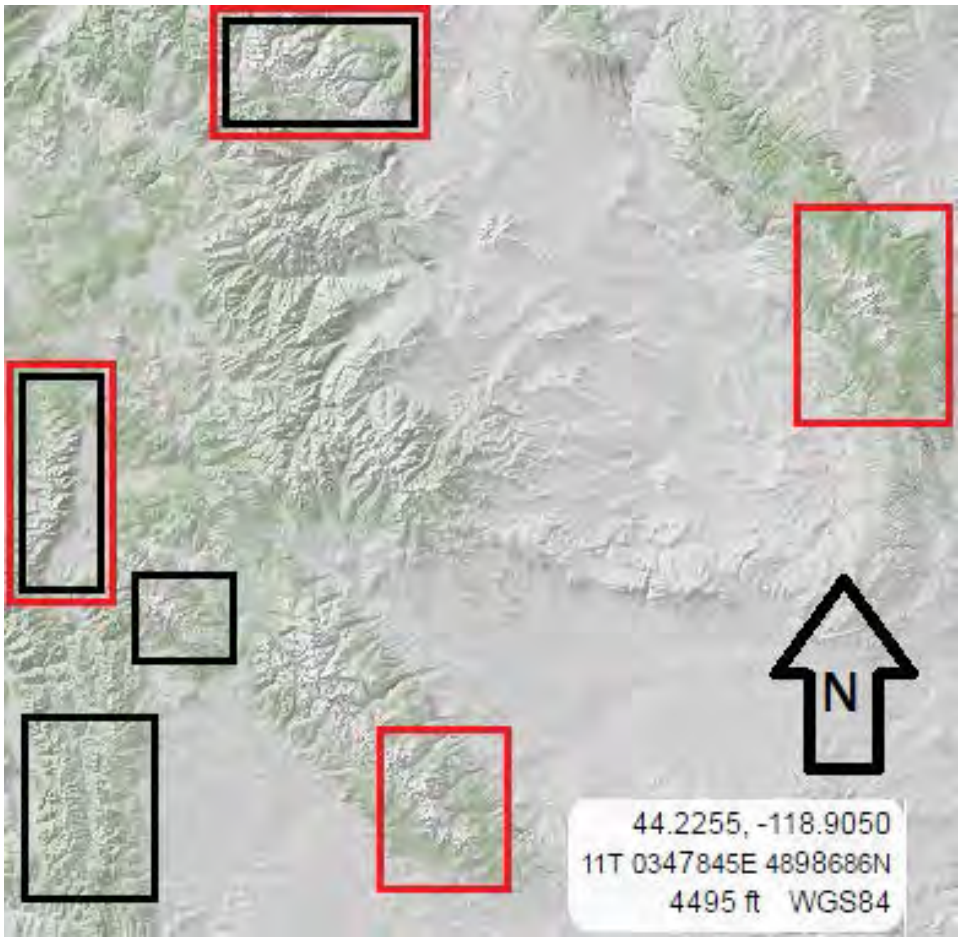

Figure 3. Ranges surveyed in 2016 in black, ranges to be surveyed in 2017 in red, northwestern Wyoming.

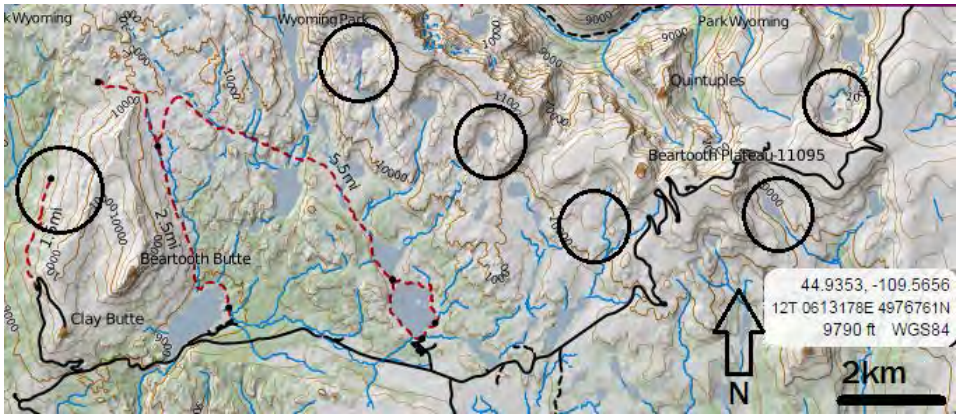

Figure 4. An example of survey locations within 1 mountain range, Beartooth Mountains.

Figure 5. An example of a transect (blue) that runs parallel to a cliff and associated habitat, and 1 in pink that crosses habitat types. White represents boulder, and green tundra.

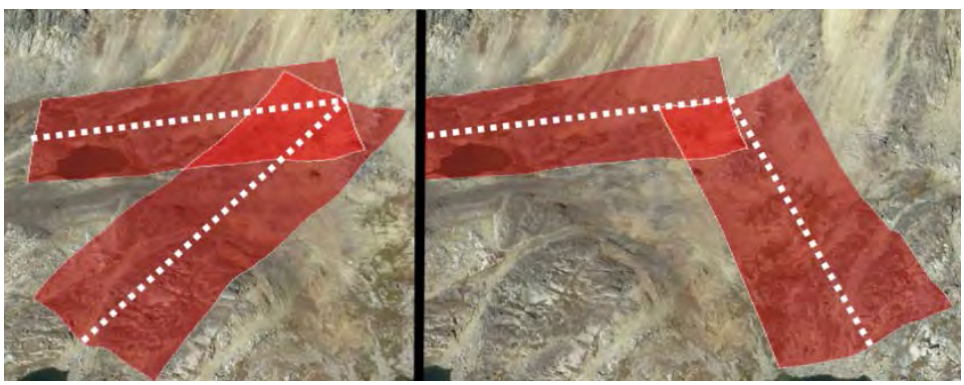

Figure 6. An example of a transect that resurveys a greater area of a transect on the left than its associated transect on the right.

Figure 7. Theoretical transect that runs 'through time' to demonstrate the seasonal variance of a single survey site.

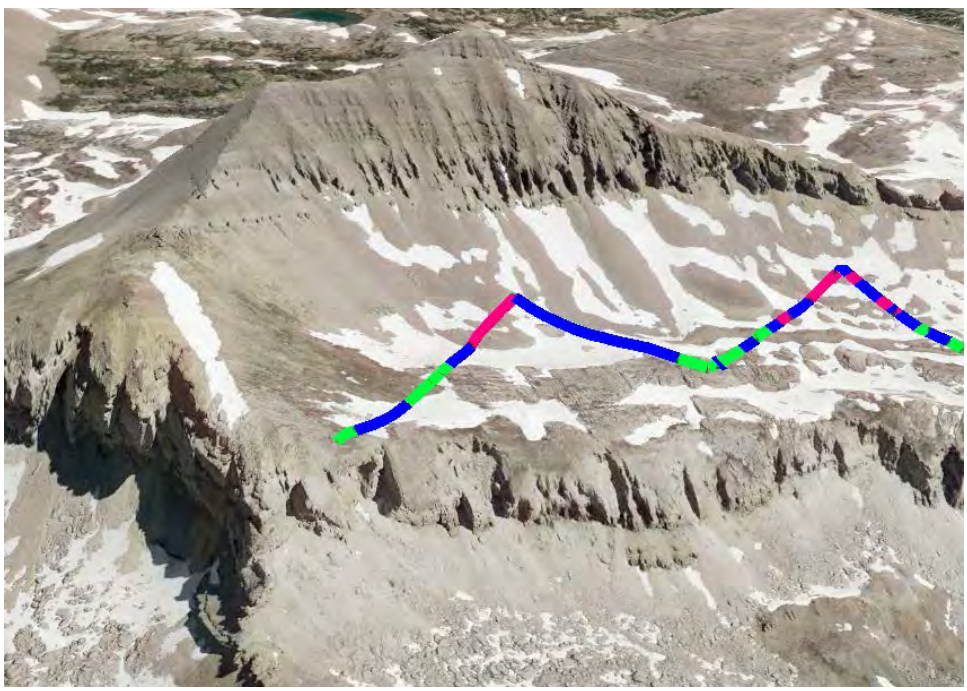

Figure 8. Representation of habitat data gathered in the field. Green represents segments of tundra, blue being snow, and pink that of boulder fields.

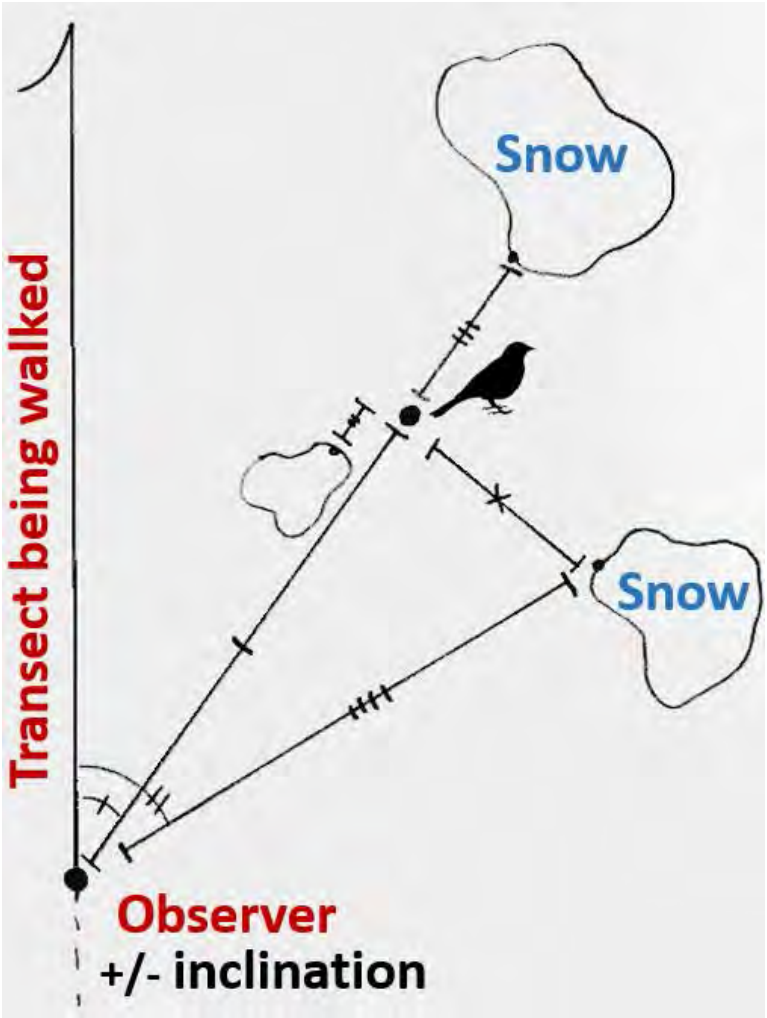

Figure 9. Diagram of how bird locations and distance to snowpack are measured in the field.

Black Rosy-Finch transect												Mtn range:												Start :						Fin :					
Date: M D 2017												Transect Name:												Sky		C°				Sky		C°			
Observer:				GPS Unit#:								Transect Series : 1 2 3												Wind 0 1 2 3 4						0 1 2 3 4					
Sky: 0=0-15% 1=16-50% 2=51-75% 3=76-100% 4=fog 5=drizzle 6=light snow																								Sunrise:						Pg /					
FORag FLY RESt PREen NESt build TERritorial																		VIsual AUditory						DO NOT USE DECLINATION											
BOulder SNow TUndra MEadow												Male Female Unknown						ADult JUv UNk						ALL DISTANCES IN METERS											
Flying Status: fly IN, fly OUT, fly OVEr, STAtionary																																			
GPSpt	Obs#	Hab_Person	Species				Age	Sex	Count	Behav		Flying?	Clin to	±	bird	Dist	to bird	Ber	xxx°	to bird	Bird Aud?	Bird Vis?	Hab_Bird	Hab_Bird	Cliff?	Bird dist	to snow	Snow patch	±	Clin	Snow patch	Dist	Snow patch	Ber	xxx°	Water	Dist
Time:			Notes:																																

Figure 10. Sample of the field form used to record observations.

Figure 11. An example of a projected transect (line), with points used to create the transect in green, projected bird observations in red, and locations taken during fly-overs in white.

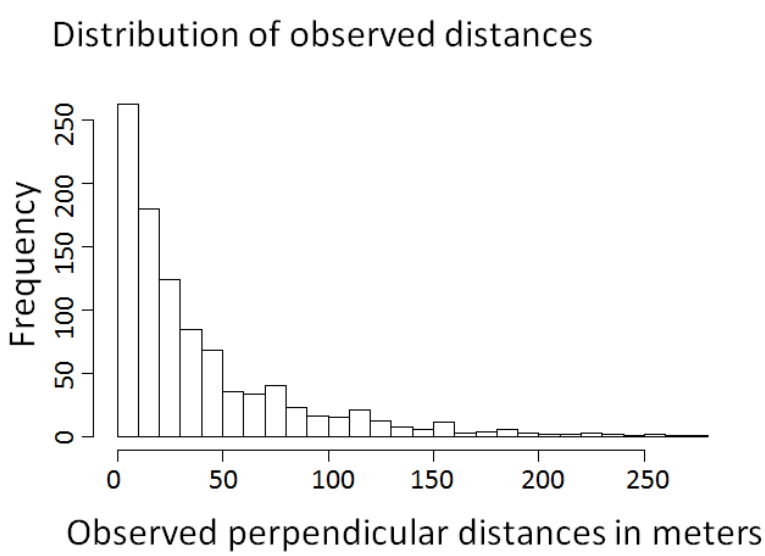

Figure 12. Initial results for detection rates of Black Rosy-Finch (*Leucosticte atrata*).

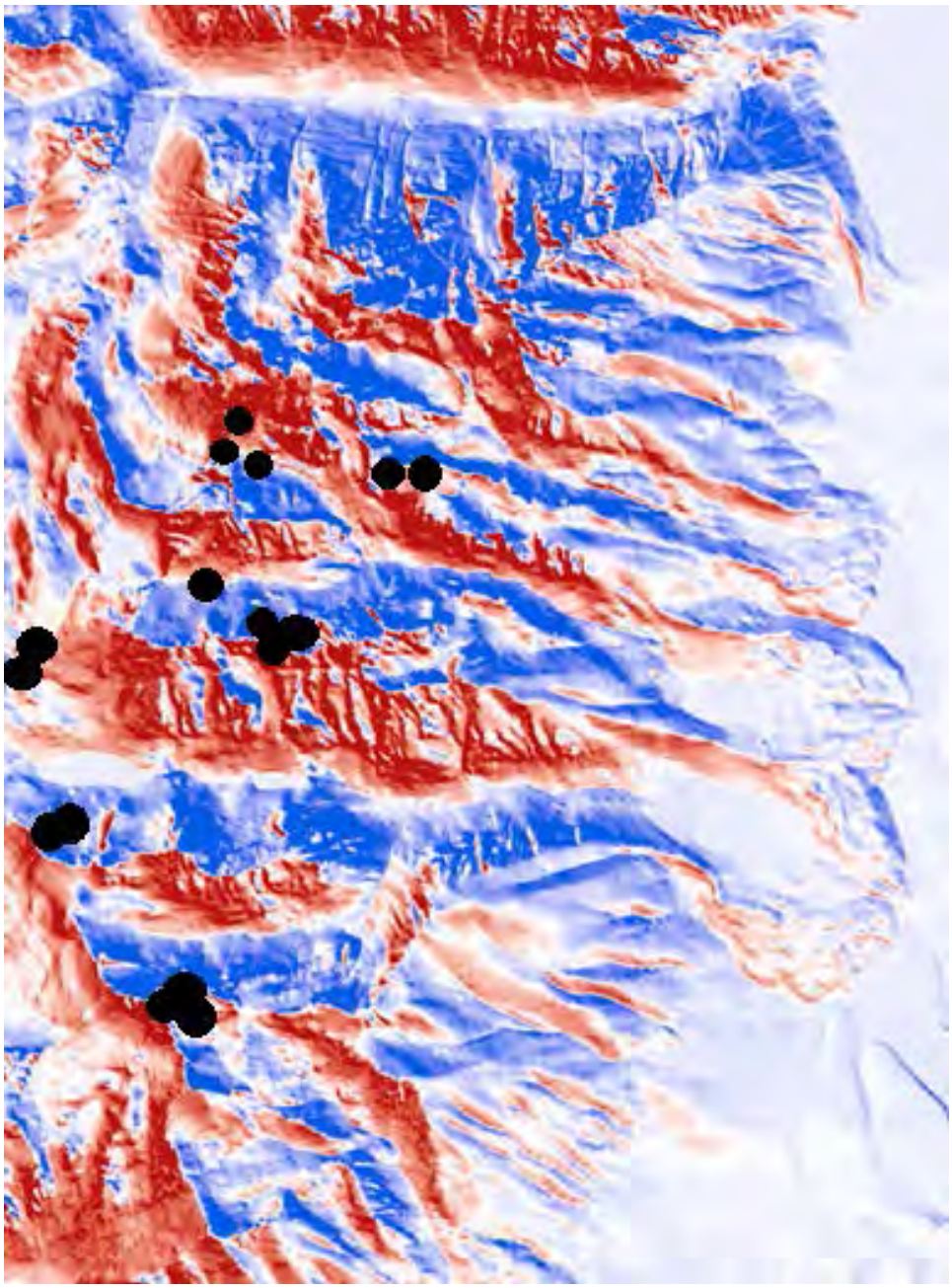

Figure 13. An example a DEM derived heat load index map, where cooler areas are represented by blue and warmer areas in red. Black Rosy-Finch (*Leucosticte atrata*) observations are represented by black dots.

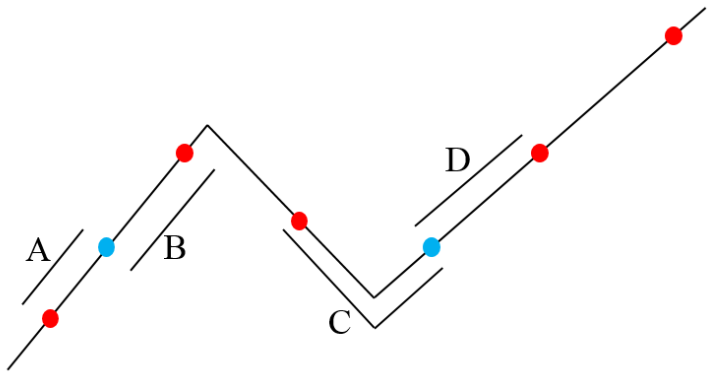

Figure 14. Transect diagram with snow-edge events marked in red and random points marked in blue. The distance to the nearest snow-edge event will be calculated fixed to the transect. In this example, A, B, C, and D represent measurements. A<B, and D<C.

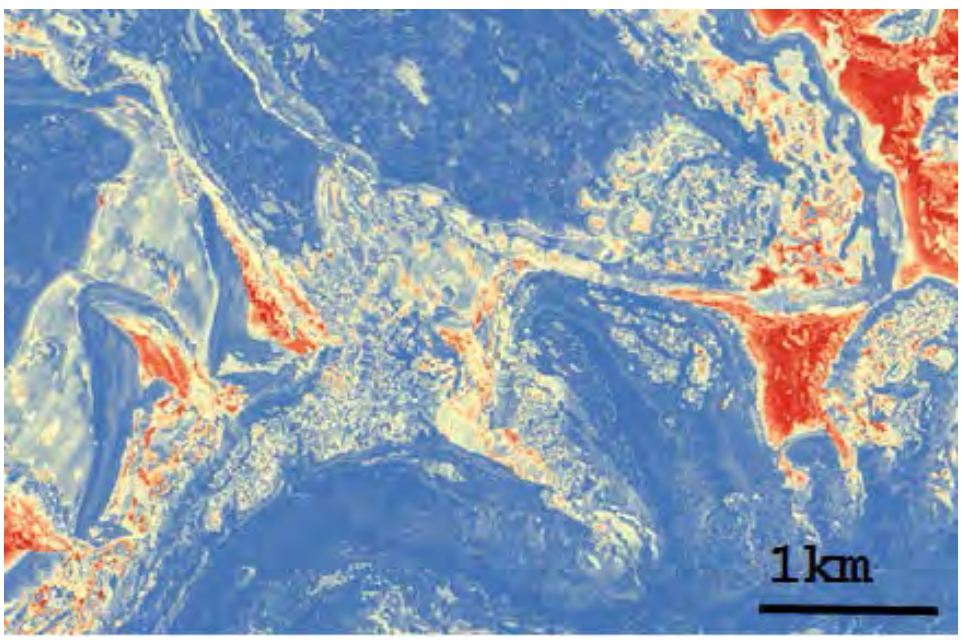

Figure 15. Preliminary results of a predictive distribution map using Random Forest.

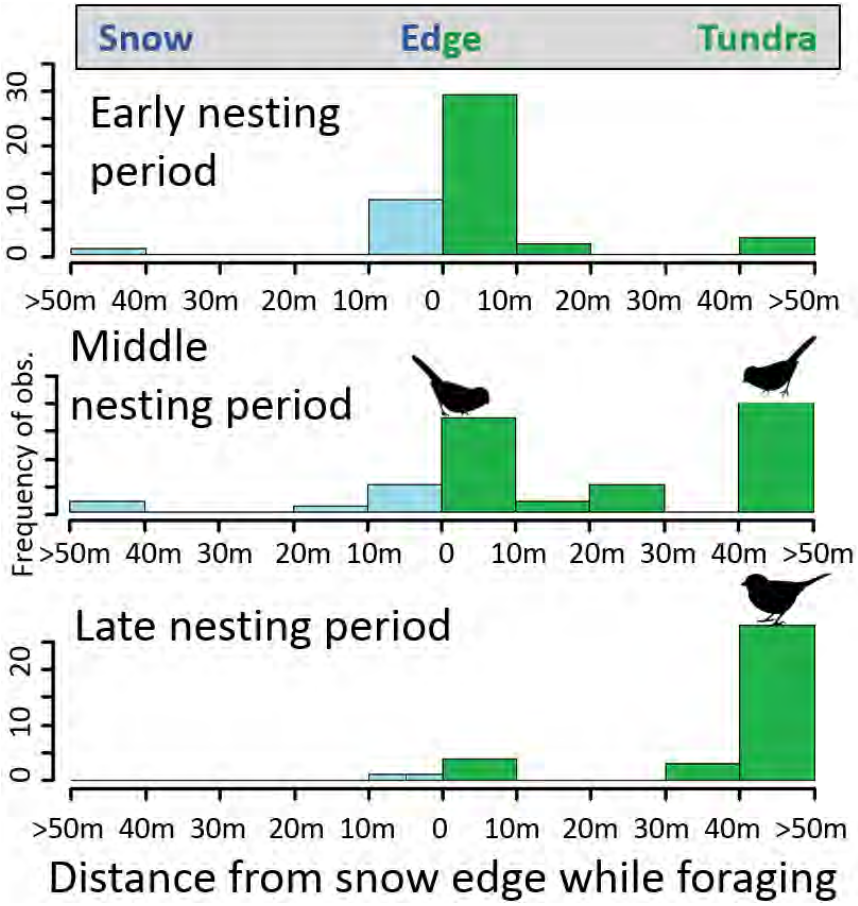

Figure 16. Frequency of Black Rosy-Finch (*Leucosticte atrata*) foraging events at different distances from the snow/tundra edge. Distances in blue represent birds foraging on snowpack, while green represents foraging on tundra.

APPENDIX II – WYOMING SPECIES LIST

THE OFFICIAL STATE LIST OF THE COMMON AND SCIENTIFIC NAMES OF THE BIRDS, MAMMALS, AMPHIBIANS, AND REPTILES IN WYOMING

THE OFFICIAL STATE LIST OF THE COMMON AND SCIENTIFIC NAMES OF THE BIRDS, MAMMALS, AMPHIBIANS, AND REPTILES IN WYOMING

Spp. code	Common name	Scientific name	Doc. type	Seasonal status and additional information [a, b]
		BIRDS [c, d]		
Waterfowl **Order: Anseriformes** **Family: Anatidae**				
171.0	Greater White-fronted Goose *	*Anser albifrons*	(FL)	M
169.0	Snow Goose *	*Chen caerulescens*		M
170.0	Ross's Goose *	*Chen rossii*	(FL)	M
174.0	Brant	*Branta bernicla*	(AS)	A, Includes Black Brant (174.0)
172.2	Cackling Goose	*Branta hutchinsii*	(FL)	A
172.0	Canada Goose *	*Branta canadensis*		R
181.0	Trumpeter Swan *	*Cygnus buccinator*	(FL)	R, NSS2/II, No season
180.0	Tundra Swan *	*Cygnus columbianus*		W, No season
179.0	Whooper Swan	*Cygnus cygnus*	(AS)	A
144.0	Wood Duck *	*Aix sponsa*		S
135.0	Gadwall *	*Anas strepera*		R
136.0	Eurasian Wigeon	*Anas penelope*	(AS)	A
137.0	American Wigeon *	*Anas americana*		R
133.0	American Black Duck	*Anas rubripes*	(AS)	A
132.0	Mallard *	*Anas platyrhynchos*		R
134.0	Mottled Duck	*Anas fulvigula*	(AS)	A
140.0	Blue-winged Teal *	*Anas discors*		S
141.0	Cinnamon Teal *	*Anas cyanoptera*		S
142.0	Northern Shoveler *	*Anas clypeata*		S
143.0	Northern Pintail *	*Anas acuta*		R
139.2	Garganey	*Anas querquedula*	(AS)	A
139.0	Green-winged Teal *	*Anas crecca*		R
147.0	Canvasback *	*Aythya valisineria*		S
146.0	Redhead *	*Aythya americana*		S
150.0	Ring-necked Duck *	*Aythya collaris*		S
149.1	Tufted Duck	*Aythya fuligula*	(AS)	A
148.0	Greater Scaup *	*Aythya marila*	(FL)	M
149.0	Lesser Scaup *	*Aythya affinis*		S
155.0	Harlequin Duck *	*Histrionicus histrionicus*		S, NSS3/II
166.0	Surf Scoter *	*Melanitta perspicillata*	(FL)	M
165.0	White-winged Scoter *	*Melanitta fusca*	(FL)	M
163.0	Black Scoter	*Melanitta americana*	(AS)	A
154.0	Long-tailed Duck *	*Clangula hyemalis*	(FL)	M
153.0	Bufflehead *	*Bucephala albeola*		R
151.0	Common Goldeneye *	*Bucephala clangula*		R
152.0	Barrow's Goldeneye *	*Bucephala islandica*		R
131.0	Hooded Merganser *	*Lophodytes cucullatus*		R
129.0	Common Merganser *	*Mergus merganser*		R
130.0	Red-breasted Merganser *	*Mergus serrator*		S
167.0	Ruddy Duck *	*Oxyura jamaicensis*		S

Spp. code	Common name	Scientific name	Doc. type	Seasonal status and additional information [a, b]
<u>Gallinaceous Birds</u> **Order: Galliformes** **Family: Odontophoridae**				
289.0	Northern Bobwhite *	*Colinus virginianus*	(AS)	R
Family: Phasianidae				
288.2	Chukar *	*Alectoris chukar*		R
288.1	Gray Partridge *	*Perdix perdix*		R
309.1	Ring-necked Pheasant *	*Phasianus colchicus*		R
300.0	Ruffed Grouse *	*Bonasa umbellus*		R
309.0	Greater Sage-Grouse *	*Centrocercus urophasianus*		R, NSS4/II
304.0	White-tailed Ptarmigan *	*Lagopus leucura*	(AS)	R, No season
297.0	Dusky Grouse *	*Dendragapus obscurus*		R
308.0	Sharp-tailed Grouse *	*Tympanuchus phasianellus*		R, NSS4/II, Includes Columbian subspecies
305.0	Greater Prairie-Chicken	*Tympanuchus cupido*	(AS)	A
310.0	Wild Turkey *	*Meleagris gallopavo*		R
<u>Grebes</u> **Order: Podicipediformes** **Family: Podicipedidae**				
006.0	Pied-billed Grebe	*Podilymbus podiceps*		S
003.0	Horned Grebe	*Podiceps auritus*		S
002.0	Red-necked Grebe	*Podiceps grisegena*	(AS)	S
004.0	Eared Grebe	*Podiceps nigricollis*		S
001.0	Western Grebe	*Aechmophorus occidentalis*		S, NSSU/II
001.1	Clark's Grebe	*Aechmophorus clarkii*		S, NSSU/II
<u>Doves and Pigeons</u> **Order: Columbiformes** **Family: Columbidae**				
313.1	Rock Pigeon	*Columba livia*		R, Invasive non-native
312.0	Band-tailed Pigeon	*Patagioenas fasciata*	(AS)	M
315.9	Eurasian Collared-Dove	*Streptopelia decaocto*		R, Invasive non-native
319.0	White-winged Dove	*Zenaida asiatica*	(FL)	A
316.0	Mourning Dove *	*Zenaida macroura*		S
315.0	Passenger Pigeon	*Ectopistes migratorius*		Extinct
<u>Cuckoos</u> **Order: Cuculiformes** **Family: Cuculidae**				
387.0	Yellow-billed Cuckoo	*Coccyzus americanus*	(FL)	S, Threatened, NSSU/II
388.0	Black-billed Cuckoo	*Coccyzus erythropthalmus*	(FL)	S, NSS4/II
<u>Nightjars</u> **Order: Caprimulgiformes** **Family: Caprimulgidae**				
421.0	Lesser Nighthawk	*Chordeiles acutipennis*	(AS)	A
420.0	Common Nighthawk	*Chordeiles minor*		S, NSS4/III
418.0	Common Poorwill	*Phalaenoptilus nuttallii*		S
<u>Swifts</u> **Order: Apodiformes** **Family: Apodidae**				
422.0	Black Swift	*<u>Cypseloides niger</u>*	(AS)	M
423.0	Chimney Swift	*Chaetura pelagica*	(FL)	S

Spp. code	Common name	Scientific name	Doc. type	Seasonal status and additional information [a, b]
424.0	Vaux's Swift	*Chaetura vauxi*	(AS)	A
425.0	White-throated Swift	*Aeronautes saxatalis*		S
<u>Hummingbirds</u> **Order: Apodiformes** **Family: Trochilidae**				
426.0	Magnificent Hummingbird	*Eugenes fulgens*	(AS)	A
428.0	Ruby-throated Hummingbird	*Archilochus colubris*	(AS)	A
429.0	Black-chinned Hummingbird	*Archilochus alexandri*	(FL)	S, NSSU/II
431.0	Anna's Hummingbird	*Calypte anna*	(AS)	A
432.0	Broad-tailed Hummingbird	*Selasphorus platycercus*		S
433.0	Rufous Hummingbird	*Selasphorus rufus*		S, NSS4/II
436.0	Calliope Hummingbird	*Selasphorus calliope*		S, NSS4/II
<u>Marshbirds</u> **Order: Gruiformes** **Family: Rallidae**				
215.0	Yellow Rail	*Coturnicops noveboracensis*	(AS)	A
216.0	Black Rail	*Laterallus jamaicensis*	(AS)	A
212.0	Virginia Rail *	*Rallus limicola*		S, NSSU/III
214.0	Sora *	*Porzana carolina*		S
218.0	Purple Gallinule	*Porphyrio martinicus*	(AS)	A
219.0	Common Gallinule	*Gallinula chloropus*	(AS)	A
221.0	American Coot *	*Fulica americana*		S
Family: Gruidae				
206.0	Sandhill Crane *	*Antigone canadensis*		S, Includes Greater Sandhill Crane subspecies
204.0	Whooping Crane	*Grus americana*	(AS)	S, Endangered
<u>Shorebirds</u> **Order: Charadriiformes** **Family: Recurvirostridae**				
226.0	Black-necked Stilt	*Himantopus mexicanus*		S
225.0	American Avocet	*Recurvirostra americana*		S
Family: Charadriidae				
270.0	Black-bellied Plover	*Pluvialis squatarola*		M
272.0	American Golden-Plover	*Pluvialis dominica*	(FL)	M
278.0	Snowy Plover	*Charadrius nivosus*	(AS)	S, NSSU/III
274.0	Semipalmated Plover	*Charadrius semipalmatus*		M
277.0	Piping Plover	*Charadrius melodus*	(AS)	M, Threatened
273.0	Killdeer	*Charadrius vociferus*		S
281.0	Mountain Plover	*Charadrius montanus*		S, NSSU/I
Family: Scolopacidae				
261.0	Upland Sandpiper	*Bartramia longicauda*	(FL)	S, NSSU/II
265.0	Whimbrel	*Numenius phaeopus*	(FL)	M
264.0	Long-billed Curlew	*Numenius americanus*		S, NSS3/II
251.0	Hudsonian Godwit	*Limosa haemastica*	(AS)	M
249.0	Marbled Godwit	*Limosa fedoa*		M
283.0	Ruddy Turnstone	*Arenaria interpres*	(FL)	M
234.0	Red Knot	*Calidris canutus*	(AS)	M, Threatened
233.0	Stilt Sandpiper	*Calidris himantopus*		M
248.0	Sanderling	*Calidris alba*		M

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243.0	Dunlin	*Calidris alpina*	(FL)	M
241.0	Baird's Sandpiper	*Calidris bairdii*		M
242.0	Least Sandpiper	*Calidris minutilla*		M
240.0	White-rumped Sandpiper	*Calidris fuscicollis*	(FL)	M
262.0	Buff-breasted Sandpiper	*Calidris subruficollis*	(AS)	M
239.0	Pectoral Sandpiper	*Calidris melanotos*		M
246.0	Semipalmated Sandpiper	*Calidris pusilla*		M
247.0	Western Sandpiper	*Calidris mauri*		M
231.0	Short-billed Dowitcher	*Limnodromus griseus*	(AS)	M
232.0	Long-billed Dowitcher	*Limnodromus scolopaceus*		M
230.0	Wilson's Snipe	*Gallinago delicata*		S
228.0	American Woodcock	*Scolopax minor*	(AS)	A
263.0	Spotted Sandpiper	*Actitis macularius*		S
256.0	Solitary Sandpiper	*Tringa solitaria*		M
254.0	Greater Yellowlegs	*Tringa melanoleuca*		M
258.0	Willet	*Tringa semipalmata*		S
255.0	Lesser Yellowlegs	*Tringa flavipes*		M
224.0	Wilson's Phalarope	*Phalaropus tricolor*		S
223.0	Red-necked Phalarope	*Phalaropus lobatus*		M
222.0	Red Phalarope	*Phalaropus fulicarius*	(AS)	A
<u>Seabirds, Gulls, and Terns</u> **Order: Charadriiformes** **Family: Stercorariidae**				
036.0	Pomarine Jaeger	*Stercorarius pomarinus*	(AS)	A
037.0	Parasitic Jaeger	*Stercorarius parasiticus*	(AS)	A
038.0	Long-tailed Jaeger	*Stercorarius longicaudus*	(AS)	A
Family: Alcidae				
023.0	Long-billed Murrelet	*Brachyramphus perdix*	(AS)	A
021.0	Ancient Murrelet	*Synthliboramphus antiquus*	(AS)	A
Family: Laridae				
040.0	Black-legged Kittiwake	*Rissa tridactyla*	(AS)	A
062.0	Sabine's Gull	*Xema sabini*	(FL)	M
060.0	Bonaparte's Gull	*Chroicocephalus philadelphia*		M
055.1	Black-headed Gull	*Chroicocephalus ridibundus*	(AS)	A
060.1	Little Gull	*Hydrocoloeus minutus*	(AS)	A
061.0	Ross's Gull	*Rhodostethia rosea*	(AS)	A
058.0	Laughing Gull	*Larus atricilla*	(AS)	A
059.0	Franklin's Gull	*Larus pipixcan*		S, NSSU/II
057.0	Heermann's Gull	*Larus heermanni*	(AS)	A
055.0	Mew Gull	*Larus canus*	(AS)	A
054.0	Ring-billed Gull	*Larus delawarensis*		S
053.0	California Gull	*Larus californicus*		S
051.0	Herring Gull	*Larus argentatus*		M
043.1	Thayer's Gull	*Larus thayeri*	(AS)	A
043.0	Iceland Gull	*Larus glaucoides*	(AS)	A
050.0	Lesser Black-backed Gull	*Larus fuscus*	(AS)	A
044.0	Glaucous-winged Gull	*Larus glaucescens*	(AS)	A
042.0	Glaucous Gull	*Larus hyperboreus*	(AS)	A
047.0	Great Black-backed Gull	*Larus marinus*	(AS)	A, (AS) except L19 and L27

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074.0	Least Tern	*Sternula antillarum*	(AS)	A, Endangered
064.0	Caspian Tern	*Hydroprogne caspia*		S, NSS3/II
077.0	Black Tern	*Chlidonias niger*		S, NSS3/II
070.0	Common Tern	*Sterna hirundo*	(FL)	M
071.0	Arctic Tern	*Sterna paradisaea*	(AS)	A
069.0	Forster's Tern	*Sterna forsteri*		S, NSS3/II
Loons **Order: Gaviiformes** **Family: Gaviidae**				
011.0	Red-throated Loon	*Gavia stellata*	(AS)	M
010.0	Pacific Loon	*Gavia pacifica*	(FL)	M
007.0	Common Loon	*Gavia immer*		S, NSS1/I
008.0	Yellow-billed Loon	*Gavia adamsii*	(AS)	A
Shearwaters **Order: Procellariiformes** **Family: Procellariidae**				
088.1	Streaked Shearwater	*Calonectris leucomelas*	(AS)	A
Storks **Order: Ciconiiformes** **Family: Ciconiidae**				
188.0	Wood Stork	*Mycteria americana*	(AS)	A, Threatened
Cormorants and Frigatebirds **Order: Suliformes** **Family: Fregatidae**				
128.2	Lesser Frigatebird	*Fregata ariel*	(AS)	A
Family: Phalacrocoracidae				
120.0	Double-crested Cormorant	*Phalacrocorax auritus*		S
Pelicans and Wading Birds **Order: Pelecaniformes** **Family: Pelecanidae**				
125.0	American White Pelican	*Pelecanus erythrorhynchos*		S, NSS4/II
126.0	Brown Pelican	*Pelecanus occidentalis*	(AS)	A
Family: Ardeidae				
190.0	American Bittern	*Botaurus lentiginosus*	(FL)	S, NSS3/II
191.0	Least Bittern	*Ixobrychus exilis*	(AS)	A
194.0	Great Blue Heron	*Ardea herodias*		S, NSS4, II
196.0	Great Egret	*Ardea alba*	(FL)	A
197.0	Snowy Egret	*Egretta thula*		S, NSS3/II
200.0	Little Blue Heron	*Egretta caerulea*	(AS)	A
199.0	Tricolored Heron	*Egretta tricolor*	(AS)	A
200.1	Cattle Egret	*Bubulcus ibis*	(FL)	S, NSS3/II
201.0	Green Heron	*Butorides virescens*	(AS)	M
202.0	Black-crowned Night-Heron	*Nycticorax nycticorax*		S, NSS3/II
203.0	Yellow-crowned Night-Heron	*Nyctanassa violacea*	(AS)	A
Family: Threskiornithidae				
184.0	White Ibis	*Eudocimus albus*	(AS)	A
186.0	Glossy Ibis	*Plegadis falcinellus*	(AS)	A
187.0	White-faced Ibis	*Plegadis chihi*		S, NSS3/II

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<u>New World Vultures</u> **Order: Cathartiformes** **Family: Cathartidae**				
326.0	Black Vulture	*Coragyps atratus*	(AS)	A
325.0	Turkey Vulture	*Cathartes aura*		S
<u>Ospreys, Hawks, Kites, and Eagles</u> **Order: Accipitriformes** **Family: Pandionidae**				
364.0	Osprey	*Pandion haliaetus*		S
Family: Accipitridae				
328.0	White-tailed Kite	*Elanus leucurus*	(AS)	A
329.0	Mississippi Kite	*Ictinia mississippiensis*	(AS)	A
352.0	Bald Eagle	*Haliaeetus leucocephalus*		R, NSS3/II
331.0	Northern Harrier	*Circus cyaneus*		S
332.0	Sharp-shinned Hawk	*Accipiter striatus*		S
333.0	Cooper's Hawk	*Accipiter cooperii*		S
334.0	Northern Goshawk	*Accipiter gentilis*		R, NSSU/I
335.0	Harris's Hawk	*Parabuteo unicinctus*	(AS)	A
339.0	Red-shouldered Hawk	*Buteo lineatus*	(AS)	A
343.0	Broad-winged Hawk	*Buteo platypterus*	(FL)	S
342.0	Swainson's Hawk	*Buteo swainsoni*		S, NSSU/II
337.0	Red-tailed Hawk	*Buteo jamaicensis*		R, Includes Harlan's Hawk (338.0)
347.0	Rough-legged Hawk	*Buteo lagopus*		W
348.0	Ferruginous Hawk	*Buteo regalis*		R, NSS4/II
349.0	Golden Eagle	*Aquila chrysaetos*		R, NSS4/II
<u>Owls</u> **Order: Strigiformes** **Family: Tytonidae**				
365.0	Barn Owl	*Tyto alba*	(AS)	S,
Family: Strigidae				
374.0	Flammulated Owl	*Psiloscops flammeolus*	(AS)	S, NSSU/III
373.2	Western Screech-Owl	*Megascops kennicottii*	(AS)	R
373.0	Eastern Screech-Owl	*Megascops asio*	(FL)	R
375.0	Great Horned Owl	*Bubo virginianus*		R
376.0	Snowy Owl	*Bubo scandiacus*	(AS)	W
377.0	Northern Hawk Owl	*Surnia ulula*	(AS)	A
379.0	Northern Pygmy-Owl	*Glaucidium gnoma*	(FL)	R, NSSU/II
378.0	Burrowing Owl	*Athene cunicularia*		S, NSSU/I
368.0	Barred Owl	*Strix varia*	(AS)	A
370.0	Great Gray Owl	*Strix nebulosa*		R, NSSU/II
366.0	Long-eared Owl	*Asio otus*		R
367.0	Short-eared Owl	*Asio flammeus*		R, NSS4/II
371.0	Boreal Owl	*Aegolius funereus*	(FL)	R, NSS3/II
372.0	Northern Saw-whet Owl	*Aegolius acadicus*	(FL)	R
<u>Kingfishers</u> **Order: Coraciiformes** **Family: Alcedinidae**				
390.0	Belted Kingfisher	*Megaceryle alcyon*		R

Spp. code	Common name	Scientific name	Doc. type	Seasonal status and additional information [a, b]
<u>Woodpeckers</u> **Order: Piciformes** **Family: Picidae**				
408.0	Lewis's Woodpecker	*Melanerpes lewis*		S, NSSU/II
406.0	Red-headed Woodpecker	*Melanerpes erythrocephalus*	(FL)	S, NSS4/II
407.0	Acorn Woodpecker	*Melanerpes formicivorus*	(AS)	A
409.0	Red-bellied Woodpecker	*Melanerpes carolinus*	(AS)	A
404.0	Williamson's Sapsucker	*Sphyrapicus thyroideus*		S, NSS3/II
402.0	Yellow-bellied Sapsucker	*Sphyrapicus varius*	(AS)	A
402.1	Red-naped Sapsucker	*Sphyrapicus nuchalis*		S
394.0	Downy Woodpecker	*Picoides pubescens*		R
393.0	Hairy Woodpecker	*Picoides villosus*		R
399.0	White-headed Woodpecker	*Picoides albolarvatus*	(AS)	A
401.0	American Three-toed Woodpecker	*Picoides dorsalis*		R
400.0	Black-backed Woodpecker	*Picoides arcticus*	(FL)	R, NSSU/II
412.2	Northern Flicker	*Colaptes auratus*		R, Includes Red-shafted and Yellow-shafted
405.0	Pileated Woodpecker	*Dryocopus pileatus*	(AS)	A
<u>Falcons</u> **Order: Falconiformes** **Family: Falconidae**				
362.0	Crested Caracara	*Caracara cheriway*	(AS)	A
360.0	American Kestrel	*Falco sparverius*		S, NSS4/III
357.0	Merlin	*Falco columbarius*		R, NSSU/III
354.0	Gyrfalcon	*Falco rusticolus*	(AS)	W
356.0	Peregrine Falcon	*Falco peregrinus*	(FL)	R, NSS3/II
355.0	Prairie Falcon	*Falco mexicanus*		R
<u>Passerines</u> **Order: Passeriformes** **Family: Tyrannidae**				
459.0	Olive-sided Flycatcher	*Contopus cooperi*		S
462.0	Western Wood-Pewee	*Contopus sordidulus*		S
461.0	Eastern Wood-Pewee	*Contopus virens*	(AS)	A
466.0	Willow Flycatcher	*Empidonax traillii*		S, NSS3/III
467.0	Least Flycatcher	*Empidonax minimus*	(FL)	S
468.0	Hammond's Flycatcher	*Empidonax hammondii*	(FL)	S
469.1	Gray Flycatcher	*Empidonax wrightii*	(FL)	S
469.0	Dusky Flycatcher	*Empidonax oberholseri*		S
464.0	Cordilleran Flycatcher	*Empidonax occidentalis*		S
456.0	Eastern Phoebe	*Sayornis phoebe*	(AS)	S
457.0	Say's Phoebe	*Sayornis saya*		S
471.0	Vermilion Flycatcher	*Pyrocephalus rubinus*	(AS)	A
454.0	Ash-throated Flycatcher	*Myiarchus cinerascens*	(FL)	S, NSS3/II
452.0	Great Crested Flycatcher	*Myiarchus crinitus*	(AS)	A
448.0	Cassin's Kingbird	*Tyrannus vociferans*	(FL)	S
447.0	Western Kingbird	*Tyrannus verticalis*		S
444.0	Eastern Kingbird	*Tyrannus tyrannus*		S
443.0	Scissor-tailed Flycatcher	*Tyrannus forficatus*	(AS)	A
Family: Laniidae				
622.0	Loggerhead Shrike	*Lanius ludovicianus*		S, NSS4/II

Spp. code	Common name	Scientific name	Doc. type	Seasonal status and additional information [a, b]
621.0	Northern Shrike	*Lanius excubitor*		W
Family: Vireonidae				
631.0	White-eyed Vireo	*Vireo griseus*	(AS)	A
634.0	Gray Vireo	*Vireo vicinior*	(AS)	S, NSSU/II
628.0	Yellow-throated Vireo	*Vireo flavifrons*	(AS)	A
629.2	Cassin's Vireo	*Vireo cassinii*	(AS)	M
629.3	Blue-headed Vireo	*Vireo solitarius*	(AS)	M
629.1	Plumbeous Vireo	*Vireo plumbeus*		S
626.0	Philadelphia Vireo	*Vireo philadelphicus*	(AS)	M
627.0	Warbling Vireo	*Vireo gilvus*		S
624.0	Red-eyed Vireo	*Vireo olivaceus*		S, NSS4/II
Family: Corvidae				
484.0	Gray Jay	*Perisoreus canadensis*		R
492.0	Pinyon Jay	*Gymnorhinus cyanocephalus*		R
478.0	Steller's Jay	*Cyanocitta stelleri*		R
477.0	Blue Jay	*Cyanocitta cristata*		R
481.0	Woodhouse's Scrub-Jay	*Aphelocoma woodhouseii*	(FL)	R, NSS3/II
491.0	Clark's Nutcracker	*Nucifraga columbiana*		R, NSS4/II
475.0	Black-billed Magpie	*Pica hudsonia*		R
488.0	American Crow	*Corvus brachyrhynchos*		R
486.0	Common Raven	*Corvus corax*		R
Family: Alaudidae				
474.0	Horned Lark	*Eremophila alpestris*		R
Family: Hirundinidae				
611.0	Purple Martin	*Progne subis*	(AS)	S, NSSU/III
614.0	Tree Swallow	*Tachycineta bicolor*		S
615.0	Violet-green Swallow	*Tachycineta thalassina*		S
617.0	Northern Rough-winged Swallow	*Stelgidopteryx serripennis*		S
616.0	Bank Swallow	*Riparia riparia*		S
612.0	Cliff Swallow	*Petrochelidon pyrrhonota*		S
613.0	Barn Swallow	*Hirundo rustica*		S
Family: Paridae				
735.0	Black-capped Chickadee	*Poecile atricapillus*		R
738.0	Mountain Chickadee	*Poecile gambeli*		R
733.0	Juniper Titmouse	*Baeolophus ridgwayi*	(FL)	R, NSS3/II
Family: Aegithalidae				
743.0	Bushtit	*Psaltriparus minimus*	(FL)	S, NSS3/II
Family: Sittidae				
728.0	Red-breasted Nuthatch	*Sitta canadensis*		R
727.0	White-breasted Nuthatch	*Sitta carolinensis*		R
730.0	Pygmy Nuthatch	*Sitta pygmaea*		R, NSS3/II
Family: Certhiidae				
726.0	Brown Creeper	*Certhia americana*		R
Family: Troglodytidae				
715.0	Rock Wren	*Salpinctes obsoletus*		S
717.0	Canyon Wren	*Catherpes mexicanus*		R, NSS4/III
721.0	House Wren	*Troglodytes aedon*		S
722.1	Pacific Wren	*Troglodytes pacificus*	(AS)	M
722.0	Winter Wren	*Troglodytes troglodytes*	(AS)	M

Spp. code	Common name	Scientific name	Doc. type	Seasonal status and additional information [a, b]
724.0	Sedge Wren	*Cistothorus platensis*	(AS)	A
725.0	Marsh Wren	*Cistothorus palustris*		S
718.0	Carolina Wren	*Thryothorus ludovicianus*	(AS)	A
719.0	Bewick's Wren	*Thryomanes bewickii*	(FL)	S, NSS4/III
Family: Polioptilidae				
751.0	Blue-gray Gnatcatcher	*Polioptila caerulea*		S, NSS4/III
Family: Cinclidae				
701.0	American Dipper	*Cinclus mexicanus*		R
Family: Regulidae				
748.0	Golden-crowned Kinglet	*Regulus satrapa*		R
749.0	Ruby-crowned Kinglet	*Regulus calendula*		S
Family: Turdidae				
766.0	Eastern Bluebird	*Sialia sialis*	(FL)	S
767.0	Western Bluebird	*Sialia mexicana*	(AS)	S
768.0	Mountain Bluebird	*Sialia currucoides*		S
754.0	Townsend's Solitaire	*Myadestes townsendi*		R
756.0	Veery	*Catharus fuscescens*		S
757.0	Gray-cheeked Thrush	*Catharus minimus*	(AS)	M
758.0	Swainson's Thrush	*Catharus ustulatus*		S
759.0	Hermit Thrush	*Catharus guttatus*		S
755.0	Wood Thrush	*Hylocichla mustelina*	(AS)	M
761.0	American Robin	*Turdus migratorius*		R
763.0	Varied Thrush	*Ixoreus naevius*	(AS)	M
Family: Mimidae				
704.0	Gray Catbird	*Dumetella carolinensis*		S
705.0	Brown Thrasher	*Toxostoma rufum*		S
702.0	Sage Thrasher	*Oreoscoptes montanus*		S, NSS4/II
703.0	Northern Mockingbird	*Mimus polyglottos*		S
Family: Sturnidae				
493.0	European Starling	*Sturnus vulgaris*		R, Invasive non-native
Family: Passeridae				
688.2	House Sparrow	*Passer domesticus*		R, Invasive non-native
Family: Motacillidae				
697.0	American Pipit	*Anthus rubescens*		S, NSS4/III
700.0	Sprague's Pipit	*Anthus spragueii*	(AS)	M
Family: Fringillidae				
514.1	Brambling	*Fringilla montifringilla*	(AS)	A
524.0	Gray-crowned Rosy-Finch	*Leucosticte tephrocotis*		R
525.0	Black Rosy-Finch	*Leucosticte atrata*		R, NSSU/II
526.0	Brown-capped Rosy-Finch	*Leucosticte australis*	(FL)	R, NSSU/II
515.0	Pine Grosbeak	*Pinicola enucleator*		R
519.0	House Finch	*Haemorhous mexicanus*		R
517.0	Purple Finch	*Haemorhous purpureus*	(AS)	W
518.0	Cassin's Finch	*Haemorhous cassini*		R
521.0	Red Crossbill	*Loxia curvirostra*		R, NSS4/II
522.0	White-winged Crossbill	*Loxia leucoptera*	(FL)	R
528.0	Common Redpoll	*Acanthis flammea*		W
527.0	Hoary Redpoll	*Acanthis hornemanni*	(AS)	W
533.0	Pine Siskin	*Spinus pinus*		R

Spp. code	Common name	Scientific name	Doc. type	Seasonal status and additional information [a, b]
530.0	Lesser Goldfinch	*Spinus psaltria*	(FL)	M
531.0	Lawrence's Goldfinch	*Spinus lawrencei*	(AS)	A
529.0	American Goldfinch	*Spinus tristis*		R
514.0	Evening Grosbeak	*Coccothraustes vespertinus*		R
Family: Bombycillidae				
618.0	Bohemian Waxwing	*Bombycilla garrulus*		W
619.0	Cedar Waxwing	*Bombycilla cedrorum*		R
Family: Calcariidae				
536.0	Lapland Longspur	*Calcarius lapponicus*		W
538.0	Chestnut-collared Longspur	*Calcarius ornatus*	(FL)	S, NSS4/II
537.0	Smith's Longspur	*Calcarius pictus*	(AS)	A
539.0	McCown's Longspur	*Rhynchophanes mccownii*		S, NSS4/II
534.0	Snow Bunting	*Plectrophenax nivalis*		W
Family: Parulidae				
674.0	Ovenbird	*Seiurus aurocapilla*		S
639.0	Worm-eating Warbler	*Helmitheros vermivorum*	(AS)	A
675.0	Northern Waterthrush	*Seiurus noveboracensis*		M
642.0	Golden-winged Warbler	*Vermivora chrysoptera*	(AS)	A
641.0	Blue-winged Warbler	*Vermivora cyanoptera*	(AS)	A
636.0	Black-and-white Warbler	*Mniotilta varia*	(FL)	M
637.0	Prothonotary Warbler	*Protonotaria citrea*	(AS)	A
647.0	Tennessee Warbler	*Oreothlypis peregrina*	(FL)	M
646.0	Orange-crowned Warbler	*Oreothlypis celata*		S
645.0	Nashville Warbler	*Oreothlypis ruficapilla*	(FL)	M
644.0	Virginia's Warbler	*Oreothlypis virginiae*	(FL)	S, NSSU/II
678.0	Connecticut Warbler	*Oporornis agilis*	(AS)	A
680.0	MacGillivray's Warbler	*Geothlypis tolmiei*		S, NSS4/II
679.0	Mourning Warbler	*Geothlypis philadelphia*	(AS)	A
677.0	Kentucky Warbler	*Geothlypis formosus*	(AS)	A
681.0	Common Yellowthroat	*Geothlypis trichas*		S, NSS4/III
684.0	Hooded Warbler	*Setophaga citrina*	(AS)	A
687.0	American Redstart	*Setophaga ruticilla*		S
650.0	Cape May Warbler	*Setophaga tigrina*	(AS)	A
648.0	Northern Parula	*Setophaga americana*	(FL)	M
657.0	Magnolia Warbler	*Setophaga magnolia*	(FL)	M
660.0	Bay-breasted Warbler	*Setophaga castanea*	(AS)	M
662.0	Blackburnian Warbler	*Setophaga fusca*	(AS)	M
652.0	Yellow Warbler	*Dendroica petechia*		S
659.0	Chestnut-sided Warbler	*Setophaga pensylvanica*	(FL)	M
661.0	Blackpoll Warbler	*Setophaga striata*	(FL)	M
654.0	Black-throated Blue Warbler	*Setophaga caerulescens*	(FL)	M
672.0	Palm Warbler	*Setophaga palmarum*	(AS)	M
671.0	Pine Warbler	*Setophaga pinus*	(AS)	A
655.0	Yellow-rumped Warbler	*Setophaga coronata*		S
663.0	Yellow-throated Warbler	*Setophaga dominica*	(AS)	A
673.0	Prairie Warbler	*Setophaga discolor*	(AS)	A
665.0	Black-throated Gray Warbler	*Setophaga nigrescens*	(FL)	S, NSS4/II
668.0	Townsend's Warbler	*Setophaga townsendi*		S
669.0	Hermit Warbler	*Setophaga occidentalis*	(AS)	A

Spp. code	Common name	Scientific name	Doc. type	Seasonal status and additional information [a, b]
667.0	Black-throated Green Warbler	*Setophaga virens*	(AS)	A
686.0	Canada Warbler	*Cardellina canadensis*	(AS)	A
685.0	Wilson's Warbler	*Cardellina pusilla*		S
690.0	Red-faced Warbler	*Cardellina rubrifrons*	(AS)	A
683.0	Yellow-breasted Chat	*Icteria virens*		S
Family: Emberizidae				
590.0	Green-tailed Towhee	*Pipilo chlorurus*		S
587.0	Spotted Towhee	*Pipilo maculatus*		S
591.0	Canyon Towhee	*Pipilo fusca*	(AS)	A
578.0	Cassin's Sparrow	*Peucaea cassinii*	(AS)	A, (AS) except confirmed breeding in Torrington area
559.0	American Tree Sparrow	*Spizelloides arborea*		W
560.0	Chipping Sparrow	*Spizella passerina*		S
561.0	Clay-colored Sparrow	*Spizella pallida*		S
562.0	Brewer's Sparrow	*Spizella breweri*		S, NSS4/II
563.0	Field Sparrow	*Spizella pusilla*	(AS)	S
540.0	Vesper Sparrow	*Pooecetes gramineus*		S
552.0	Lark Sparrow	*Chondestes grammacus*		S
573.0	Black-throated Sparrow	*Amphispiza bilineata*	(AS)	S
574.3	Sagebrush Sparrow	*Artemisiospiza nevadensis*		S, NSS4/II
605.0	Lark Bunting	*Calamospiza melanocorys*		S
542.0	Savannah Sparrow	*Passerculus sandwichensis*		S
546.0	Grasshopper Sparrow	*Ammodramus savannarum*		S, NSS4/II
545.0	Baird's Sparrow	*Ammodramus bairdii*	(AS)	S, NSS4/II
548.0	Le Conte's Sparrow	*Ammodramus leconteii*	(AS)	M
549.1	Nelson's Sparrow	*Ammodramus nelsoni*	(AS)	A
585.0	Fox Sparrow	*Passerella iliaca*		R
581.0	Song Sparrow	*Melospiza melodia*		R
583.0	Lincoln's Sparrow	*Melospiza lincolnii*		S
584.0	Swamp Sparrow	*Melospiza georgiana*	(FL)	M
558.0	White-throated Sparrow	*Zonotrichia albicollis*		M
553.0	Harris's Sparrow	*Zonotrichia querula*		W
554.0	White-crowned Sparrow	*Zonotrichia leucophrys*		S
557.0	Golden-crowned Sparrow	*Zonotrichia atricapilla*	(AS)	A
567.7	Dark-eyed Junco	*Junco hyemalis*		R, Includes White-winged (566.0), Slate-colored (567.0), Oregon (567.1), Pink-sided (568.0), and Gray-headed (569.0)
Family: Cardinalidae				
609.0	Hepatic Tanager	*Piranga flava*	(AS)	A
610.0	Summer Tanager	*Piranga rubra*	(FL)	M
608.0	Scarlet Tanager	*Piranga olivacea*	(AS)	A
607.0	Western Tanager	*Piranga ludoviciana*		S
593.0	Northern Cardinal	*Cardinalis cardinalis*	(AS)	M
594.1	Yellow Grosbeak	*Pheucticus chrysopeplus*	(AS)	A
595.0	Rose-breasted Grosbeak	*Pheucticus ludovicianus*	(FL)	S
596.0	Black-headed Grosbeak	*Pheucticus melanocephalus*		S

Spp. code	Common name	Scientific name	Doc. type	Seasonal status and additional information [a, b]
597.0	Blue Grosbeak	*Passerina caerulea*		S, NSS4/III
599.0	Lazuli Bunting	*Passerina amoena*		S
598.0	Indigo Bunting	*Passerina cyanea*	(FL)	S
601.0	Painted Bunting	*Passerina ciris*	(AS)	A
604.0	Dickcissel	*Spiza americana*	(FL)	S, NSS4/II
Family: Icteridae				
494.0	Bobolink	*Dolichonyx oryzivorus*	(FL)	S, NSSU/II
498.0	Red-winged Blackbird	*Agelaius phoeniceus*		S
501.0	Eastern Meadowlark	*Sturnella magna*	(AS)	A
501.1	Western Meadowlark	*Sturnella neglecta*		S
497.0	Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*		S
509.0	Rusty Blackbird	*Euphagus carolinus*	(AS)	M
510.0	Brewer's Blackbird	*Euphagus cyanocephalus*		S
511.0	Common Grackle	*Quiscalus quiscula*		S
512.0	Great-tailed Grackle	*Quiscalus mexicanus*	(FL)	A
495.0	Brown-headed Cowbird	*Molothrus ater*		S
506.0	Orchard Oriole	*Icterus spurius*	(FL)	S
508.0	Bullock's Oriole	*Icterus bullockii*		S
507.0	Baltimore Oriole	*Icterus galbula*	(AS)	A
504.0	Scott's Oriole	*Icterus parisorum*	(AS)	S, NSSU/II
Note: the following avian species have been documented in Wyoming, but these are human-assisted species and, as such, are not recognized as wild, naturally occurring species in the state. **<u>Controlled Species</u>** **Waterfowl** **Order: Anseriformes** **Family: Anatidae**				
178.0	Fulvous Whistling-Duck	*Dendrocygna bicolor*	(AS)	A, Controlled
178.2	Mute Swan	*Cygnus olor*	(AS)	A, Controlled
141.2	Ruddy Shelduck	*Tadorna ferruginea*		A, Controlled
141.1	Common Shelduck	*Tadorna tadorna*		A, Controlled
Pigeons and Doves **Order: Columbiformes** **Family: Columbidae**				
315.2	African Collared-Dove	*Streptopelia roseogrisea*		A, Controlled
Passerines **Order: Passeriformes** **Family: Fringillidae**				
526.1	European Goldfinch	*Carduelis carduelis*		A, Controlled
MAMMALS [d, e]				
<u>Marsupials</u> **Order: Didelphimorphia** **Family: Didelphidae**				
800.0	Virginia Opossum	*Didelphis virginiana*		A
<u>Insectivores</u> **Order: Soricomorpha** **Family: Soricidae**				
801.0	Masked Shrew	*Sorex cinereus*		R
801.1	Hayden's Shrew	*Sorex haydeni*		R
806.0	American Pygmy Shrew	*Sorex hoyi*		R, NSS2/II
805.0	Merriam's Shrew	*Sorex merriami*		R

Spp. code	Common name	Scientific name	Doc. type	Seasonal status and additional information [a, b]
807.0	Dusky Shrew	*Sorex monticolus*		R
803.0	Dwarf Shrew	*Sorex nanus*		R, NSS3/II
804.0	Western Water Shrew	*Sorex navigator*		R
804.1	Preble's Shrew	*Sorex preblei*		R, NSS3/III
802.0	Vagrant Shrew	*Sorex vagrans*		R
Family: Talpidae				
810.0	Eastern Mole	*Scalopus aquaticus*		R
Bats **Order: Chiroptera** **Family: Vespertilionidae**				
815.1	California Myotis	*Myotis californicus*		U
816.0	Western Small-footed Myotis	*Myotis ciliolabrum*		U, NSS4/II
818.0	Long-eared Myotis	*Myotis evotis*		U, NSS3/II
819.0	Northern Long-eared Myotis	*Myotis septentrionalis*		U, Threatened, NSS3/II
815.0	Little Brown Myotis	*Myotis lucifugus*		U, NSS4/II
826.0	Fringed Myotis	*Myotis thysanodes*		U, NSS3/II
817.0	Long-legged Myotis	*Myotis volans*		U, NSS3/II
817.1	Yuma Myotis	*Myotis yumanensis*		U
821.0	Eastern Red Bat	*Lasiurus borealis*		S, NSSU/II
822.0	Hoary Bat	*Lasiurus cinereus*		S
820.0	Silver-haired Bat	*Lasionycteris noctivagans*		U
820.1	American Perimyotis	*Perimyotis subflavus*		U
825.0	Big Brown Bat	*Eptesicus fuscus*		U
824.0	Spotted Bat	*Euderma maculatum*		S, NSS3/II
823.0	Townsend's Big-eared Bat	*Corynorhinus townsendii*		U, NSS2/I
827.0	Pallid Bat	*Antrozous pallidus*		S, NSS3/III
Family: Molossidae				
828.0	Brazilian Free-tailed Bat	*Tadarida brasiliensis*		A
829.0	Big Free-tailed Bat	*Nyctinomops macrotis*		A
Lagomorphs **Order: Lagomorpha** **Family: Ochotonidae**				
830.0	American Pika	*Ochotona princeps*		R, NSSU/II
Family: Leporidae				
837.0	Pygmy Rabbit	*Brachylagus idahoensis*		R, NSS3/II
833.0	Desert Cottontail *	*Sylvilagus audubonii*		R
834.0	Eastern Cottontail *	*Sylvilagus floridanus*		R
835.0	Mountain Cottontail *	*Sylvilagus nuttallii*		R
836.0	Snowshoe Hare *	*Lepus americanus*		R
832.0	Black-tailed Jackrabbit *	*Lepus californicus*		R, Predatory animal
831.0	White-tailed Jackrabbit *	*Lepus townsendii*		R, Predatory animal
Rodents **Order: Rodentia** **Family: Sciuridae**				
841.0	Yellow-pine Chipmunk	*Tamias amoenus*		R, NSS4/III
842.0	Cliff Chipmunk	*Tamias dorsalis*		R, NSS3/II
840.0	Least Chipmunk	*Tamias minimus*		R
843.0	Uinta Chipmunk	*Tamias umbrinus*		R, NSS4/III
844.0	Yellow-bellied Marmot	*Marmota flaviventris*		R
846.0	Uinta Ground Squirrel	*Urocitellus armatus*		R

Spp. code	Common name	Scientific name	Doc. type	Seasonal status and additional information [a, b]
845.0	Wyoming Ground Squirrel	*Urocitellus elegans*		R
849.0	Golden-mantled Ground Squirrel	*Callospermophilus lateralis*		R
847.0	Spotted Ground Squirrel	*Xerospermophilus spilosoma*		R, NSS4/III
848.0	Thirteen-lined Ground Squirrel	*Ictidomys tridecemlineatus*		R
851.0	White-tailed Prairie Dog	*Cynomys leucurus*		R
850.0	Black-tailed Prairie Dog	*Cynomys ludovicianus*		R
855.0	Abert's Squirrel	*Sciurus aberti*		R
856.0	Eastern Gray Squirrel *	*Sciurus carolinensis*		R
852.0	Eastern Fox Squirrel *	*Sciurus niger*		R
854.0	Red Squirrel *	*Tamiasciurus hudsonicus*		R
853.0	Northern Flying Squirrel	*Glaucomys sabrinus*		R, NSS4/II
Family: Geomyidae				
862.0	Wyoming Pocket Gopher	*Thomomys clusius*		R, NSS3/II
863.0	Idaho Pocket Gopher	*Thomomys idahoensis*		R, NSS3/II
860.0	Northern Pocket Gopher	*Thomomys talpoides*		R
861.0	Sand Hills Pocket Gopher	*Geomys lutescens*		R, NSS4/II
Family: Heteromyidae				
865.0	Olive-backed Pocket Mouse	*Perognathus fasciatus*		R, NSS4/II
893.0	Plains Pocket Mouse	*Perognathus flavescens*		R, NSS4/II
866.0	Silky Pocket Mouse	*Perognathus flavus*		R, NSS3/II
867.0	Great Basin Pocket Mouse	*Perognathus mollipilosus*		R, NSS3/II
868.0	Hispid Pocket Mouse	*Chaetodipus hispidus*		R, NSS3/II
869.0	Ord's Kangaroo Rat	*Dipodomys ordii*		R
Family: Castoridae				
875.0	Beaver *	*Castor canadensis*		R
Family: Muridae				
877.0	Western Harvest Mouse	*Reithrodontomys megalotis*		R
876.0	Plains Harvest Mouse	*Reithrodontomys montanus*		R, NSS3/II
878.0	Canyon Deermouse	*Peromyscus crinitus*		R, NSS3/II
881.0	White-footed Deermouse	*Peromyscus leucopus*		R
880.0	North American Deermouse	*Peromyscus maniculatus*		R
879.0	Piñon Deermouse	*Peromyscus truei*		R, NSS3/II
882.0	Northern Grasshopper Mouse	*Onychomys leucogaster*		R
883.0	Bushy-tailed Woodrat	*Neotoma cinerea*		R
884.0	Southern Red-backed Vole	*Myodes gapperi*		R
885.0	Western Heather Vole	*Phenacomys intermedius*		R
888.0	Long-tailed Vole	*Microtus longicaudus*		R
887.0	Montane Vole	*Microtus montanus*		R
890.0	Prairie Vole	*Microtus ochrogaster*		R
886.0	Meadow Vole	*Microtus pennsylvanicus*		R
889.0	Water Vole	*Microtus richardsoni*		R, NSS3/II
891.0	Sagebrush Vole	*Lemmiscus curtatus*		R
892.0	Common Muskrat *	*Ondatra zibethicus*		R
894.2	Norway Rat	*Rattus norvegicus*		R
894.1	House Mouse	*Mus musculus*		R
Family: Didopidae				
895.0	Meadow Jumping Mouse	*Zapus hudsonius*		R
895.1	Preble's Meadow Jumping Mouse	*Zapus hudsonius preblei*		R, NSS4/II, Threatened
896.0	Western Jumping Mouse	*Zapus princeps*		R

Spp. code	Common name	Scientific name	Doc. type	Seasonal status and additional information [a, b]
Family: Erethizontidae				
900.0	North American Porcupine *	*Erethizon dorsatum*		R, Predatory animal
<u>Carnivores</u> **Order: Carnivora** **Family: Canidae**				
901.0	Coyote *	*Canis latrans*		R, Predatory animal
902.0	Gray Wolf *	*Canis lupus*		R
904.0	Swift Fox	*Vulpes velox*		R, NSS4/II
903.0	Red Fox *	*Vulpes vulpes*		R, Predatory animal
905.0	Common Gray Fox	*Urocyon cinereoargenteus*		R
Family: Ursidae				
940.0	Black Bear *	*Ursus americanus*		R
941.0	Grizzly Bear *	*Ursus arctos*		R, Threatened
Family: Procyonidae				
906.0	Ringtail	*Bassariscus astutus*		R
907.0	Northern Raccoon *	*Procyon lotor*		R, Predatory animal
Family: Mustelidae				
908.0	Pacific Marten *	*Martes caurina*		R
909.0	Fisher	*Pekania pennanti*		R
910.0	Short-tailed Weasel (Ermine) *	*Mustela erminea*		R
911.0	Long-tailed Weasel *	*Mustela frenata*		R
913.0	Black-footed Ferret	*Mustela nigripes*		R, Endangered, NSS1/I
919.0	Least Weasel	*Mustela nivalis*		R, NSSU/III
912.0	American Mink *	*Vison vison*		R
914.0	Wolverine	*Gulo gulo*		R, NSS3/II
915.0	American Badger *	*Taxidea taxus*		R
916.1	Western Spotted Skunk *	*Spilogale gracilis*		R, Predatory animal
916.0	Eastern Spotted Skunk *	*Spilogale putorius*		R, Predatory animal
917.0	Striped Skunk *	*Mephitis mephitis*		R, Predatory animal
918.0	Northern River Otter	*Lontra canadensis*		R, NSSU/II
Family: Felidae				
922.0	Mountain Lion (Puma) *	*Puma concolor*		R
920.0	Canada Lynx	*Lynx canadensis*		R, Threatened, NSS1/I
921.0	Bobcat *	*Lynx rufus*		R
<u>Ungulates</u> **Order: Artiodactyla** **Family: Cervidae**				
930.0	Wapiti (Elk) *	*Cervus canadensis*		R
932.0	Mule Deer (Black-tailed Deer) *	*Odocoileus hemionus*		R
933.0	White-tailed Deer *	*Odocoileus virginianus*		R
931.0	Moose *	*Alces americanus*		R, NSS4/II
Family: Antilocapridae				
935.0	Pronghorn *	*Antilocapra americana*		R
Family: Bovidae				
925.0	Bison *	*Bos bison*		R
926.0	Mountain Goat *	*Oreamnos americanus*		R
927.0	Bighorn Sheep (Mountain Sheep) *	*Ovis canadensis*		R, NSS4/II

Spp. code	Common name	Scientific name	Doc. type	Seasonal status and additional information [a, b]
AMPHIBIANS [f]				
<u>Salamanders</u> **Order: Caudata** **Family: Ambystomatidae**				
950.0	Tiger Salamander	*Ambystoma mavortium*		R; includes Blotched, Western (NSS4/III), and Arizona subspecies
<u>Toads and Frogs</u> **Order: Anura** **Family: Pelobatidae**				
951.0	Plains Spadefoot	*Spea bombifrons*		R, NSSU/III
951.1	Great Basin Spadefoot	*Spea intermontana*		R, NSSU/I
Family: Bufonidae				
951.2	Western Toad	*Anaxyrus boreas*		R, NSS1/I
951.3	Great Plains Toad	*Anaxyrus cognatus*		R, NSSU/III
951.5	Wyoming Toad	*Anaxyrus baxteri*		R, NSS1/I
951.4	Rocky Mountain Toad (Woodhouse's Toad)	*Anaxyrus woodhousii woodhousii*		R
Family: Ranidae				
952.1	American Bullfrog	*Lithobates catesbeianus*		R
952.2	Northern Leopard Frog	*Lithobates pipiens*		R, NSSU/III
952.3	Columbia Spotted Frog	*Rana luteiventris*		R, NSS3/II
952.4	Wood Frog	*Lithobates sylvaticus*		R, NSS2/II
Family: Hylidae				
952.0	Boreal Chorus Frog	*Pseudacris maculata*		R
REPTILES [f]				
<u>Turtles</u> **Order: Testudines** **Family: Trionychidae**				
953.0	Eastern Spiny Softshell	*Apalone spinifera spinifera*		R, NSS4/III
Family: Testudinidae				
953.2	Plains Box Turtle	*Terrapene ornata ornata*		R, NSSU/III
953.3	Western Painted Turtle	*Chrysemys picta bellii*		R, NSS4/III
Family: Chelydridae				
953.1	Snapping Turtle	*Chelydra serpentina*		R
<u>Lizards</u> **Order: Squamata** **Family: Teiidae**				
954.0	Prairie Racerunner	*Aspidoscelis sexlineata viridis*		R, NSSU/II
Family: Scincidae				
954.1	Northern Many-lined Skink	*Plestidon multivirgatus multivirgatus*		R, NSSU/III
954.9	Great Basin Skink	*Plestiodon skiltonianus utahensis*		R, NSSU/III
Family: Iguanidae				
954.3	Northern Sagebrush Lizard	*Sceloporus graciosus graciosus*		R
954.4	Plateau Fence Lizard	*Sceloporus tristichus*		R
954.6	Prairie Lizard	*Sceloporus consobrinus*		R, NSSU/II
954.8	Northern Tree Lizard	*Urosaurus ornatus wrighti*		R, NSS1/II
954.2	Greater Short-horned Lizard	*Phrynosoma hernandesi*		R, NSS4/III
954.7	Great Plains Earless Lizard	*Holbrookia maculata maculata*		R, NSSU/III

Spp. code	Common name	Scientific name	Doc. type	Seasonal status and additional information [a, b]
<u>Snakes</u> **Order: Squamata** **Family: Boidae**				
955.2	Northern Rubber Boa	*Charina bottae*		R, NSS3/II
Family: Colubridae				
955.3	Plains Hog-nosed Snake	*Heterodon nasicus*		R, NSSU/II
956.2	Eastern Yellow-bellied Racer	*Coluber constrictor flaviventris*		R
956.6	Desert Striped Whipsnake	*Coluber taeniatus taeniatus*		R
956.3	Smooth Greensnake	*Opheodrys vernalis*		R, NSS3/II
955.4	Black Hills Red-bellied Snake	*Storeria occipitomaculata pahasapae*		R, NSSU/II
956.1	Pale Milksnake	*Lampropeltis triangulum multistriata*		R, NSS3/II
955.6	Great Basin Gophersnake	*Pituophis catenifer deserticola*		R, NSS2/II
955.5	Bullsnake	*Pituophis catenifer sayi*		R
956.4	Plains Black-headed Snake	*Tantilla nigriceps*		R, NSSU/II
955.8	Wandering Gartersnake	*Thamnophis elegans vagrans*		R
956.0	Valley Gartersnake	*Thamnophis sirtalis fitchi*		R, NSSU/II
955.9	Red-sided Gartersnake	*Thamnophis sirtalis parietalis*		R, NSSU/II
955.7	Plains Gartersnake	*Thamnophis radix*		R, NSSU/II
Family: Crotalidae				
955.0	Prairie Rattlesnake	*Crotalus viridis*		R
955.1	Midget Faded Rattlesnake	*Crotalus oreganus concolor*		R, NSS1/I

[a] Species seasonal status: R = year-round resident, S = summer resident, W = winter resident, M = migrant, A = accidental occurrence in Wyoming, U = residency status in Wyoming is unknown.

[b] Wyoming Game and Fish Department Species of Greatest Conservation Need with a Native Species Status (NSS) of 1, 2, 3, 4, or unknown and Conservation Tier I, II, or III (WGFD 2017) .

[c] Common and scientific names and species order are from the American Ornithologists' Union (1983, 2016). An "(AS)" indicates species for which full written documentation of all sightings is requested by the Wyoming Bird Records Committee; an "(FL)" indicates species for which documentation is only requested for the first sighting in each latilong and all nesting observations. In addition, full documentation is required for any species not listed here and for observations of breeding attempts.

[d] An asterisk following a species common name indicates those species classified as game, predacious bird, predatory animal, or furbearer by state statute or Wyoming Game and Fish Commission Regulation.

[e] Common and scientific names and species order are from Bradley et al. (2014).

[f] Common and scientific names and species order are from Baxter and Stone (1992) and Crother (2012).

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