The Wyoming Mule Deer Initiative

Prepared by the Mule Deer Working Group, Wyoming Game and Fish Department

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EXECUTIVE SUMMARY

The Wyoming Mule Deer Initiative (WMDI) was formally adopted by the Wyoming Game and Fish Commission (Commission) in July, 2007. Both the 2007 version and this update were products of a collaborative effort by the Wyoming Game and Fish Department's (WGFD) Mule Deer Working Group (MDWG). The MDWG was established in spring, 1998 to explore solutions to the many formidable challenges impacting health and viability of our mule deer herds. The current revision is a natural progression toward improving management and focusing resources on this species. Since 2007, the Mule Deer Initiative has gained traction throughout the state and has realized considerable success engaging the public. Our collaborative efforts have improved management decisions through more effective public involvement and interaction.

The revised WMDI is tiered from the Western Association of Fish and Wildlife Agency's (WAFWA's) North American Mule Deer Conservation Plan (Mule Deer Working Group, 2004). Many of the management challenges we face in Wyoming are impacting mule deer throughout their range in the United States, Canada, and Mexico. For that reason, similar initiatives and management plans have been, or are being developed in other States and Provinces.

From the perspectives of many stakeholders, mule deer management would seem a relatively basic and straightforward endeavor. In reality a myriad of complex environmental and anthropogenic stressors affect mule deer populations throughout their range. This Initiative will lay the groundwork for future conservation and management of mule deer in Wyoming. Many of the objectives and strategies are currently being implemented by WGFD's existing management programs. Others will provide an essential pathway for adapting to the changing environmental and social pressures affecting mule deer and their management.

We need to recognize at the outset that our understanding of mule deer ecology and management is incomplete. As the knowledge base continues to grow, the WMDI and WGFD's mule deer management program will be appropriately adjusted and adapted to apply new, more effective techniques and strategies that enable us to improve the management of this valuable resource. The WMDI also advocates research to address key gaps in our knowledge.

Employing the best available science and effectively involving the public in decision-making will best position WGFD to address mule deer management challenges in the 21st century. The overarching goals and objectives outlined in this initiative will provide guidance for developing individual herd unit management plans and strategies. Successful implementation will depend on our ability to identify and manage the factors that limit mule deer populations, which are primarily related to habitat conditions. Success in turn will depend on our ability to secure funding and public support. Forging cooperative relationships with private landowners will also be crucial as will the need to work closely with federal land managers.

MULE DEER IN WYOMING

Wyoming's mule deer are valued for the important aesthetic, cultural, economic, and ecological roles they fulfill. The species thrives in habitats ranging from salt desert shrublands to alpine tundra. By most historical accounts, mule deer were uncommon in the 19th and early 20th centuries, then reached their maximum abundance during the 1950's and 60's. Today, most wildlife managers acknowledge the high mule deer densities of the 1950's and 60's were unsustainable, and likely exceeded the long-term carrying capacity of the landscape resulting in widespread over-use and degradation of key habitats. Mule deer throughout the West declined markedly in the last decade of the 20th century and first decade of the 21st century. The most recent population peak in Wyoming was in 1991, when about 578,000 mule deer inhabited the state. By 2016, mule deer had declined 31% to an estimated 396,000 animals.

Densities of mule deer vary greatly across the species' range. Some productive habitats support comparatively dense populations, whereas others sustain sparser numbers. Many formerly productive habitats have been depleted by historically overabundant mule deer herds and/or have been degraded and fragmented by development and land uses. In the absence of controlled harvest, mule deer typically increase until they overuse the available forage, leading to a higher likelihood of disease and weather-related mortality. Under such conditions, mule deer are prone to "boom and bust" cycles, increasing to unhealthy levels and then declining abruptly to extremely low densities. Recovery of habitat conditions following boom cycles can be very protracted. In light of current habitat conditions and public expectations, allowing extreme boom and bust cycles is not acceptable mule deer management. The Wyoming Game and Fish Commission establish harvest quotas and season frameworks to maintain sustainable mule deer populations commensurate with the availability and condition of key habitats, and to manage numbers and distribution of hunters.

Mule deer and other big game in Wyoming are managed based on a "herd unit" (or delineated population) concept. There are 37 recognized mule deer herds in the state (Fig. 1). A herd is a distinct population of mule deer having limited interchange with other herds. The mule deer that comprise each herd tend to remain in certain geographic regions (although the regions can be quite large), and use traditional birthing areas, summer habitats, migration corridors and winter ranges from year to year. Herd sizes vary from a few hundred in the smallest herds, to tens of thousands in the largest. WGFD has further divided each herd into one or more hunt areas in which specific harvest regulations are prescribed.

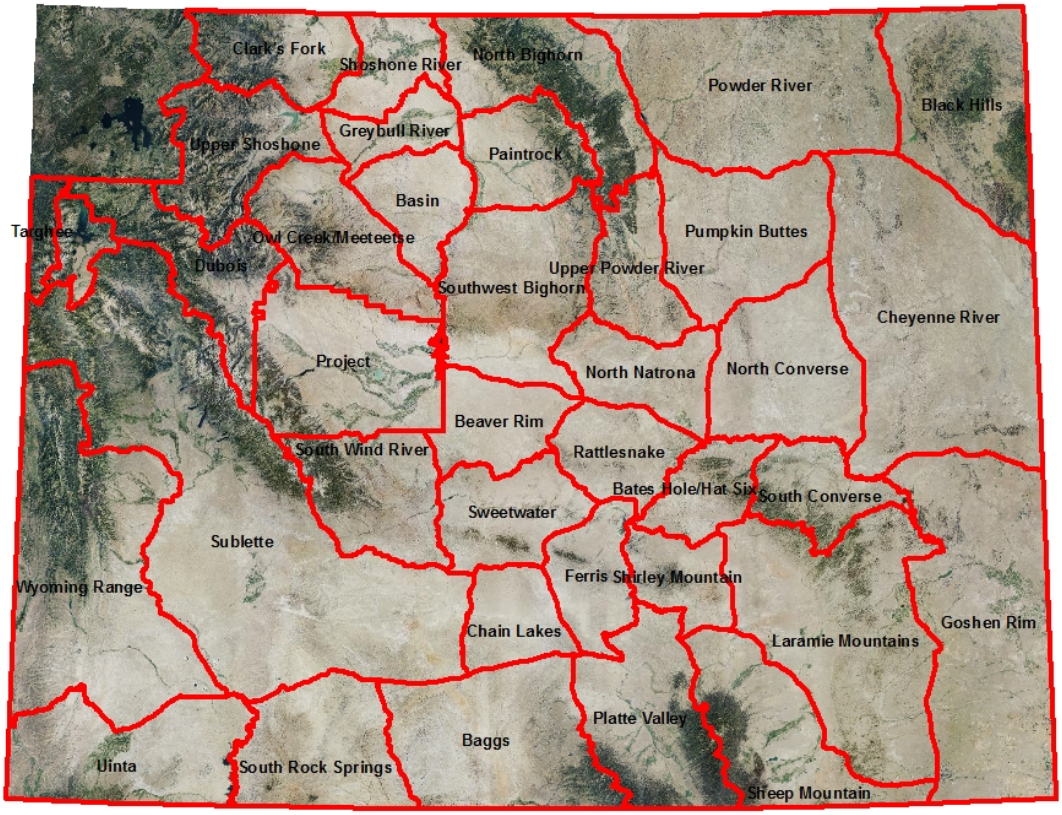

Fig. 1. Mule deer herd units.

All mule deer in Wyoming are "free-ranging" and depend predominantly on natural habitats. The most productive segments of mule deer herds evolved to migrate between seasonal habitats located within distinctly separate parts of the landscape. Consequently, activities disturbing even a small portion of a herd's seasonal ranges can have major population-level consequences. For example, many mule deer herds migrate to traditional winter ranges where they can move about more freely to find food and cover when deep snow accumulates on summer ranges. Winter ranges tend to be much more limited in area, forcing mule deer to congregate at much higher densities. Thus, a comparatively small loss of winter range can be as destructive as a much larger impact on summer range. Similarly, developments that disrupt a traditional migration route can also jeopardize a large segment of the herd.

Over thousands of years, mule deer have evolved physical adaptations to cope with Wyoming's harsh and variable climate. However, weather patterns can become severe enough at times to significantly increase overwinter mortality. The most extreme impacts happen when two or more stressful climatic events coincide, for example summer drought followed by a cold winter with prolonged, deep snow. Drought cycles reduce the amount and quality of forage and the availability of water sources. During these harsh conditions, mule deer are unable to accumulate sufficient fat reserves and thus enter the winter in poorer

condition. Inevitably, weakened mule deer suffer higher mortality rates, especially under normal to severe winter conditions. Recent research has also established that birth rates and fawn survival are significantly correlated with the health of adult females at the time they enter the previous winter. When female mule deer enter winter in poor body condition, they are less likely to produce offspring that will survive to adulthood.

Populations of mule deer have always fluctuated naturally in response to climate and other environmental variables. Historically, mule deer habitat was in much better condition and populations rebounded quickly after comparatively short-term declines. However, in recent years Wyoming's landscape has changed dramatically with many habitats altered in ways that are relatively permanent. New and upgraded highways, housing developments, ranchettes, oil/gas fields, reservoirs, and other large-scale developments are fragmenting mule deer ranges and diminishing habitat suitability over large areas. Invasive and noxious weeds such as cheatgrass have also compromised the integrity of many deer ranges throughout the West and in Wyoming. The Nation's increasing demand for domestically-produced energy has given rise to unprecedented resource development that is altering habitat at a much faster pace throughout Wyoming than can be offset by reclamation and mitigation. This impact is exacerbated by other long-term pressures on the land, including drought and heavy utilization by ungulates (both wild and domestic), causing a general decline in the condition and quality of remaining habitats.

Mule deer are predominantly browsers that rely on shrub communities to supply most of their food and cover. Unfortunately, the majority of shrub communities are in late seral stages (over mature) throughout Wyoming and the Intermountain West. For shrub communities to remain productive, succession must be periodically set back by natural disturbance events or managed treatments (e.g. fire). Key objectives of the WMDI are to increase the public's awareness of issues affecting mule deer, enlist public involvement, and promote conservation of the species and its habitat into the future.

THE MULE DEER INITIATIVE

The Wyoming Mule Deer Initiative (WMDI) identifies the most pressing issues affecting mule deer, establishes goals and objectives for management, and recommends strategies for implementation. The strategies include a broad range of program-level actions. While much is yet to be done, we provide examples of management actions being implemented to address many of the issues. These examples are not all inclusive. The intent ultimately is to continue improving the effectiveness of our mule deer management program and to better engage and involve the public in developing management recommendations. The overarching goals and objectives set forth in this initiative are intended to provide guidance for developing individual herd unit management plans and strategies. These herd unit plans will identify specific issues, opportunities, and management actions on local and regional scales.

The WMDI is intended to focus efforts and available resources by emphasizing the following strategies:

1. Conserve, enhance and restore mule deer habitat essential for population maintenance, reproduction and survival;
2. Through hunting frameworks, manage mule deer populations at sustainable levels that will maintain productive habitat conditions and provide recreation opportunity;
3. Apply the best available science, within budgetary constraints, to monitor mule deer populations and habitat condition;
4. Develop cooperative working relationships with universities and other institutions to conduct applied research needed to improve mule deer management;
5. Increase stakeholder awareness and involvement in the issues affecting conservation of mule deer, as well as opportunities to address those issues;
6. Enhance funding and public support for mule deer management; and
7. Collaborate with federal and state land management agencies to develop land use policies that will conserve and improve mule deer habitats.

Factors that impact or limit mule deer populations are described below:

1. Altered fire intervals, invasive plants, and historically heavy use by ungulates (both wild and domestic) are causing long-term declines in productivity and nutritional quality of many mule deer ranges.
2. Habitats are being converted and fragmented by expanding human populations, urbanization, increasing recreational activity, mineral and energy development, invasive plant species, and other intensive uses of the land.
3. Climatic extremes such as drought and severe winters impact quality and quantity of habitat, and lower recruitment of mule deer fawns to breeding age. Biologists and researchers are considering long-term implications of global climate change.

4. Competition with elk, white-tailed deer, feral horses, and domestic livestock can negatively affect mule deer. The relative impact of competition increases when condition and availability of habitats decline or where important habitats are limited.
5. Predation is a natural ecological process that acts in concert with habitat conditions and availability of alternate prey. In many ecosystems, mule deer coevolved with, and are preyed upon by multiple predator species such as mountain lions, coyotes, black bears, grizzly bears, and wolves. However, quantity and quality of habitat ultimately determine the number of mule deer that can be supported. Although predator control may be beneficial on a local scale, it can actually result in overuse of habitat by enabling mule deer to increase above the numbers the habitat can support at any given time. Conversely, when mule deer populations are depressed below carrying capacity, predator control can be beneficial and allow the mule deer population to recover more quickly.
6. Hunting frameworks can alter the size of a mule deer population and its age and sex structure. License allocation systems (e.g., general vs. limited quota) and season structures also affect hunting quality, hunting opportunity, and our ability to manage mule deer populations.
7. At times, diseases such as epizootic hemorrhagic disease (EHD) and chronic wasting disease (CWD) cause significant mortality. However, the impacts of such events are not fully understood. By monitoring disease outbreaks and prevalence, managers will improve their capability to predict changes in mule deer abundance and forewarn hunters and others about the prevalence of disease.
8. Popularity of off highway vehicles, including all terrain vehicles (ATVs) and snowmobiles, has increased markedly. This activity can displace mule deer from preferred habitats, increase stress, and cause mule deer to expend additional energy. In addition, ATV use detracts from the quality of hunting for some and reduces hunter success, thereby impacting management goals.
9. Access to private lands and landlocked public lands has become increasingly restricted in some portions of the state. This has reduced hunting opportunity and the ability to achieve harvest objectives in several predominantly private land herds. Hunting pressure displaced from private lands also increases crowding on accessible public lands.

Wildlife managers obviously cannot control weather or climate change. Our basic role is to prescribe hunting frameworks needed to manage mule deer populations within the existing capability of the habitat, in order to protect the habitat base, lessen the effects of weather, disease or other factors, and provide a range of recreation opportunities. In a majority of areas, we set season frameworks that emphasize the opportunity to hunt. In others, we emphasize higher success rates and harvest of mature bucks. We also collaborate with land management agencies and private landowners by promoting programs that will protect and improve existing habitats and avoid, minimize, or mitigate adverse impacts from mineral and energy production and other intensive land uses. Where predation and competition with

other wildlife are demonstrated to have an additive impact on mule deer survival, we will also consider cost-effective means to reduce those impacts.

This initiative strives to accomplish WMDI goals by addressing the following 10 major issues impacting mule deer and mule deer management:

1. Habitat Management;
2. Population Management (includes harvest and hunter management);
3. Predator Management;
4. Diseases;
5. Law Enforcement;
6. Weather;
7. Elk and Deer Interactions;
8. Public Outreach and Collaboration;
9. Research; and
10. Funding and Support.

WGFD is committed to reevaluate and improve the mule deer management program on a continuing basis. We will strive to enhance our management capabilities, ensure the long-term sustainability of mule deer populations, and provide quality hunting opportunities for present and future generations.

Habitat Management

In his book, Mule and Black-tailed Deer in North America, Wallmo (1981), stated:

> *"In my view, the only generalization needed to account for the mule deer decline throughout the West is that practically every identified trend in land use and plant succession on the deer ranges is detrimental to deer. Hunting pressure and predators might be controlled, and favorable weather conditions could permit temporary recovery, but deer numbers ultimately are limited by habitat quality and quantity."*

The Mule Deer Working Group of the Western Association of Fish and Wildlife Agencies (WAFWA) defines habitat as those resources and conditions present in an area that allow an animal or population to live, survive and successfully reproduce (deVos et al. 2003). Stakeholders often have an expectation that wildlife populations should be perpetually managed at maximum levels for aesthetic, recreation, and other interests. Habitat managers often find it difficult to convince wildlife enthusiasts that this is generally unsustainable. Unrealistic expectations commonly derive from what people recall historically based on high points during cyclical irruptive phases in the population. It can be difficult to recognize how the landscape has changed over time intervals spanning decades, or how those changes have negatively altered mule deer habitats.

Mule deer in Wyoming occupy diverse habitats that include riparian corridors, juniper/ponderosa pine breaks and ridges, sagebrush steppe, brushy foothills, high elevation timber and parks, agricultural lands, and at times, alpine tundra and talus slopes above timberline. The basic components of habitat include food, water, cover, and open space juxtaposed within the animal's mobility range. The maximum number of mule deer an area can support and sustain over time is commonly called "carrying capacity." Carrying capacity is determined by the amounts of food, cover, and water available in an area to support a given number of mule deer, and can vary with time. When a mule deer population outstrips the available food, the herd has exceeded the habitat's carrying capacity. Under these circumstances, mule deer body condition and productivity typically decline. Chronic overuse further diminishes the ability of the habitat to support mule deer and may alter the composition and productivity of vegetation for many years.

The nutritional condition of doe mule deer entering the winter determines their reproductive success and survival (Tollefson et al. 2010, 2011; Monteith et al. 2013). While WGFD continues to place a high priority on improving and maintaining winter ranges, habitat management is also emphasized on summer and transitional ranges, as well as migration corridors. The 2015 Strategic Habitat Plan and recently produced "Recommendations for Managing Mule Deer Habitat in Wyoming" prioritize these areas for habitat enhancement work (WGFD 2015).

Food is a key factor influencing how mule deer use their habitat. The characteristics that most influence the kinds of plants mule deer select seasonally are palatability, availability, and succulence. Mule deer forage mainly on shrub leaves, buds, and stem tips in the fall and winter. In spring and summer, they rely more on forbs (broad leafy plants) and grasses, which are green, succulent, and high in protein at that time of year.

Although mule deer require a certain quantity of forage to survive, low quality forage, even when available in large quantities, may be inadequate to support the herd. Mule deer must derive sufficient energy, protein, and nutrients from the plants they eat in order to maintain body condition and reproduce successfully. Nutrition influences overall body condition, ovulation, conception, gestation, lactation, survival, and home range size on a seasonal and annual basis. Nutrition also affects winter survival, size at birth, timing of birth, survival of fawns, and even sex composition of fawns. For example, does in good condition bear healthier fawns and more twins. The female fawns they bear have relatively higher survival rates compared to fawns of nutritionally-stressed does. On the other hand, low birth weight often predisposes fawns to higher mortality later in the season. Nutritional status also affects vulnerability to predation, as well as the ability to compete for food and survive when severe weather persists for extended periods. The primary cause of winter starvation is almost always poor habitat conditions throughout seasonal ranges and sometimes too many mule deer. History has demonstrated some winters are so severe significant mortality will happen regardless of habitat quality or availability.

Water is a critical element of mule deer habitat throughout Wyoming and is especially important in arid climates. Water intake varies depending on temperature, humidity, moisture content of forage, rate of forage consumption, and other factors. Mule deer generally obtain much of the water they need from succulent forage, however, availability of freestanding water is important when mule deer consume large amounts of cured vegetation and also when does are lactating. In winter, mule deer normally obtain sufficient water by eating snow.

Cover is the other major physical component of mule deer habitat. Types of cover include thermal cover used to minimize exposure and energy loss, and security or escape cover used to avoid detection, to evade predators, and even to avoid harvest by hunters. Mule deer are adept at using trees and shrubs as security cover. Topographic features such as canyons, rocks and river breaks also provide cover. Cryptic coloration greatly enhances the ability of mule deer to hide, making them difficult to detect even when they are standing in the open. Most features that will hide a mule deer also afford thermal protection from wind and cold weather.

Numerous factors have contributed to loss and fragmentation of mule deer habitats in Wyoming. Some of the more important include: energy and mineral exploration and extraction; urban growth and rural subdivision development; degradation of native rangelands due to invasive plants including cheatgrass; natural events such as drought and severe winters; construction of highways, railroads, fences, large reservoirs and other

impediments to seasonal movements. In addition, motorized recreation activities such as snowmobiling and off-highway vehicle use can also create additional stress and potentially displace mule deer from important habitats. Global climate change may exacerbate several of these effects (deVos and McKinney 2007). These types of disturbance impact the ability of mule deer to effectively use seasonally important habitats, leading to increased mortality, reduced reproductive success, and displacement onto less suitable areas.

Mule deer habitats are also altered by many land management practices including historic fire suppression, improper livestock grazing practices, shrub eradication projects, and activities that increase spread of cheatgrass and other invasive plants. Ungulate browsing pressure (both by wild and domestic animals) and loss of natural fire cycles have led to a decline in the quantity and condition of important habitats, particularly aspen and mixed-mountain shrub communities. These communities evolved with varying intervals of wildfire, and depend on fire as a periodical disturbance to rejuvenate plant productivity and nutritional content. Shrub eradication projects designed primarily to increase grass production have reduced availability of shrubs that provide essential food and cover, especially on mule deer winter ranges and in parturition habitats. Invasive plants such as cheatgrass, knapweed, thistle, and others out-compete native shrubs, forbs and grasses on important mule deer ranges. Some of these weeds, such as cheatgrass, are highly flammable and increase the frequency and intensity of damaging wildfires beyond natural fire regimes, which can ultimately eliminate native shrubs and other plants. Juniper and conifer stands can provide important mule deer cover, but also reduce sunlight and moisture reaching under-story vegetation. When these species expand into important shrub-dominated habitats and aspen communities they often out-compete and eliminate important native forage plants. Juniper and conifer invasion throughout the west is a direct consequence of long-term fire suppression. Depending upon the frequency and intensity of fire, along with a variety of other factors, fire can be either beneficial or detrimental to mule deer habitat. When fires occur too frequently due to invasive weed establishment, important shrub communities generally won't reestablish. However, when fires are suppressed for too long, as has been the case throughout much of Wyoming over the last century, many shrub communities become decadent, meaning they are less productive and far less nutritious.

Recurring and intensifying drought cycles have reduced the amount and quality of forage produced on many mule deer ranges, resulting in greater competition for the remaining food supply. Extended dry conditions also increase the frequency and intensity of wildfires to the point they become detrimental to some important plant communities. Most importantly, growth of herbaceous vegetation is greatly diminished and plants cure out more quickly during drought regimes. This can result in a lack of adequate nutrition for doe mule deer to accumulate adequate fat reserves entering the winter.

Vegetation manipulations, including mechanical and chemical treatments, prescribed fire, and re-seeding can be designed to improve and rehabilitate mule deer habitats. Some agricultural and livestock management practices can also be designed to benefit mule deer by increasing shrub productivity and vigor and by enhancing the herbaceous (forb and grass)

component in the understory. When planning treatments or agricultural practices to modify vegetation conditions, refer to the "Recommendations for Managing Mule Deer Habitat in Wyoming," (WGFD 2015).

Assessment and monitoring is essential to detect ecological trends and to effectively protect and manage mule deer habitats at risk. The Department recently employed Rapid Habitat Assessments (RHA) to document and quantify mule deer habitat conditions. Over time RHA data will inform herd objective reviews. It is also important to monitor effectiveness of habitat treatments and make adjustments where needed. Monitoring can be very costly and labor intensive to implement at a meaningful scale. However, evaluating habitat conditions and maintaining adequate amounts of high quality habitat are vital to sustain healthy mule deer herds. Managers continue to explore and refine cost-effective techniques to assess habitat condition in relation to mule deer densities.

Long-term research has established mule deer do not habituate to energy development and significant population declines associated with infrastructure avoidance can be very long-term if not permanent (Sawyer et al. 2017). The research also concluded mitigation efforts and best management practices associated with the Pinedale Anticline natural gas development did not prevent significant population declines. Few viable options exist to expand winter range or to effectively increase mule deer use of winter range offsite (Korfanta et al. 2015 as cited by Sawyer et al. 2017). These findings contradict prior NEPA document statements in which federal agencies speculated energy development would be a short-term impact to which ungulates can readily habituate. The research will have important implications for ongoing and future implementation of Council on Environmental Quality (CEQ) guidance because avoidance of crucial winter range appears to be the only truly effective mitigation approach to sustain mule deer populations. The research suggested offsite mitigation approaches such as biodiversity offsets or mitigation banks, while untested, may warrant further consideration where avoidance and minimization of impacts are not feasible. However, future impact assessments should disclose that the impacts to mule deer crucial winter range in the sagebrush-steppe environment of the West may well be a long-term and perhaps an irretrievable commitment of resources.

The above research is compelling evidence that further steps are warranted to reduce the footprint of oil and gas developments within mule deer crucial winter range in Wyoming. Directional drilling and drilling multiple wells from a single pad, remote monitoring to reduce traffic on roads, piping product to offsite centralized collection points rather than by trucking, and abatement of all noise produced by facilities and equipment may reduce impacts to wintering mule deer. Most importantly, however, pre-project planning should ensure facilities are installed at the lowest possible density and in the least sensitive areas. There is evidence site selection can be more effective in areas of topographic relief and less so in open, level terrain. The most assured mitigation strategy is to avoid drilling and infrastructure placement within mule deer crucial winter ranges.

The following management objectives and strategies are recommended to restore and sustain a quality habitat base for mule deer.

Objective: Integrate habitat needs of mule deer and other species when planning and implementing habitat management projects.

Strategy: When treatments intended primarily to benefit other species are planned in mule deer habitats such as shrub-dominated winter and transitional ranges and aspen communities, proponents should evaluate the anticipated short and long-term effects on mule deer before treatments are implemented.

Strategy: Where other herbivores contribute to excessive browse utilization, advocate appropriate management actions to ensure utilization levels are sustainable.

Strategy: Habitat management plans designed primarily to benefit mule deer should include a detailed analysis of the effects treatments may have on other species such as sage-grouse, lynx, pronghorn, raptors, and neo-tropical migratory birds. To the extent possible and permissible, habitat treatments should be beneficial or at least neutral in their effect on other species. Short-term, adverse effects may be permissible if they are of limited scope and will be reversed through vegetation response and succession.

What's been done:

- ✓ *To be consistent with the Sage-grouse Core Area Protection policy as delineated in the Wyoming Executive Order 2011-5, WGFD developed the "Wyoming Game and Fish Department Protocols for Treating Sagebrush" in 2011. This document is posted on WGFD's website.*
- ✓ *The Sage-Grouse Habitat Assessment Framework was produced by the BLM in 2015 and provides guidance on habitat suitability criteria for the different seasonal ranges used by sage-grouse. This document is also posted on WGFD's website.*
- ✓ *The Western Association of Fish and Wildlife Agencies published the draft Greater Sage-grouse Comprehensive Conservation Strategy in December, 2006.*
- ✓ *The State Wildlife Action Plan (SWAP) was approved by the Wyoming Game and Fish Commission in 2009 and is posted on WGFD's website. The Strategy lists species of greatest conservation need throughout Wyoming, including species inhabiting sagebrush and grassland ecosystems, and recommends conservation actions.*
- ✓ *Where excessive browse utilization levels have been documented, changes to hunting season structure have been implemented to bring wild ungulate populations in line with available resources.*

Objective: Implement vegetation management practices and treatments to enhance and or protect mule deer habitat on a landscape scale, while considering both the ecological and economic impacts.

Strategy: Conduct research and monitoring needed to better understand shrub ecology, the role of fire, and how vegetation responds to treatments intended to enhance wildlife habitat, mitigate impacts, or restore degraded communities. Focus research in sagebrush steppe, mountain shrub, aspen, conifer and riparian habitats. Continue to review current literature on these topics.

Strategy: Apply appropriate treatments to maintain health and productivity of mule deer seasonal ranges.

Strategy: Work cooperatively with land management agencies to implement monitoring programs that will detect and document potential decline or conversion of important habitats, migration habitats, and take appropriate action to avoid, minimize, or mitigate the impact.

Strategy: Ensure security cover requirements of mule deer are considered in all vegetation management plans.

Strategy: Provide for long-term protection of important mule deer habitats through land acquisitions, conservation easements, cooperative agreements and land-use management plans. Work with funding partners to implement habitat protection strategies.

Strategy: Work cooperatively with land management agencies to develop fire management plans and policies that, under appropriate conditions, allow natural ignition fires to burn when and where they will benefit mule deer.

Strategy: Encourage timber management activities designed to maintain and improve mule deer habitat, specifically including clear-cuts, stand thinning, and aspen and cottonwood enhancement.

Strategy: Work cooperatively with private landowners (ranchers/farmers) to obtain technical and financial assistance for enhancing mule deer habitat and to support agricultural practices that are beneficial to mule deer. Remain informed of Farm Bill programs that present opportunities to fund projects and coordinate with Natural Resource Conservation Service (NRCS) staff.

Strategy: Coordinate with wildlife agencies in neighboring states to cooperatively manage important habitats and share habitat management techniques and strategies.

What's been done:

✓ *Recent habitat improvement projects that have been implemented include:*

- *WGFD initiated the Wyoming Range Mule Deer Habitat Plan to treat over 30,000 acres on BLM, State and private land near Big Piney and LaBarge from 2014-2021.*
- *WGFD has initiated the Platte Valley Habitat Partnership (PHVP) and set aside $500,000 of seed money toward implementation of habitat treatments and other actions to benefit mule deer in the Platte Valley. The PVHP's Mule Deer Habitat Plan has identified a suite of silvicultural practices including clear-cuts to improve mule deer habitat.*
- *As a result of the success in the Wyoming Range and Platte Valley WGFD initiated a statewide Mule Deer Initiative in 2014, which will focus on actions to improve mule deer populations statewide. Key herds have been selected for this initiative in each WGFD region.*
- *WGFD routinely engages state and federal land management agencies to promote and implement habitat improvement projects designed to benefit mule deer.*
- *WGFD participates in all federal land use management plans and several Coordinated Resource Management planning and allotment management planning efforts.*

Objective: Identify areas at risk, where the cumulative effects of natural events and human activities have diminished, or threaten to diminish quantity and quality of mule deer habitats.

Strategy: Utilize and support the WISDOM (Wyoming Interagency Spatial Database and Online Management) Geographic Information System (GIS) to evaluate historic, ongoing, and future disturbances within important mule deer habitats to provide a basis for assessing cumulative impacts of proposed actions and to assist with planning mitigation and conservation.

Strategy: Develop GIS layers for mapping and updating quantity and condition of habitats within mule deer seasonal ranges, to serve as a basis for proposing management actions and habitat treatments designed to maintain mule deer populations.

What's been done:

- ✓ *WGFD has participated in developing several GIS systems including:*
  - *WISDOM to improve Wildlife Environmental Review (WER) analysis and comment preparation;*
  - *Remote sensing to delineate land cover types;*
  - *Sagebrush treatment database [in coordination with the Wyoming Geograpnic Information Science Center (WyGISC)] to aid in development of treatments in sage-grouse occupied habitat; and*
  - *Wildlife and Habitat Biologists continually evaluate and update seasonal*

range mapping and WGFD's Strategic Habitat Plan crucial and enhancement area polygons.

Objective: Avoid or minimize impacts to mule deer migration corridors, bottlenecks, and stopover sites.

Strategy: Work closely with the Wyoming Department of Transportation (WYDOT), irrigation districts, railroads, energy companies, and other entities to design projects that minimize barriers to migrating mule deer and to incorporate features (e.g., over- and underpasses, right-of-way (ROW) fences, project layout, etc.) that restore or improve migration over/through existing roads, highways, ditches, and other projects.

Strategy: Encourage WYDOT and county road departments to seed less palatable vegetation in highway rights-of-way to reduce vehicle/mule deer collisions.

Strategy: Recommend mule deer-compatible fence designs that minimize barriers and entanglements.

Strategy: Continue to identify and map migration corridors, bottlenecks, and stopover sites throughout the state, assess risks to these vital migration habitat features, and develop solutions to potential conflicts. The Wyoming Game and Fish Commission's Mitigation Policy recommends no significant loss of habitat function within vital habitats. Some modifications of habitat characteristics may occur, provided habitat function is maintained (i.e., the location, essential features, and species supported are unchanged).

What's been done:

- ✓ *The Trappers Point project was implemented near Pinedale by WYDOT and includes two overpasses, six underpasses and thirteen miles of fence to funnel wildlife;*
- ✓ *The Nugget Canyon project was implemented in cooperation with WYDOT and includes seven underpasses to funnel mule deer.*
- ✓ *The Baggs Underpass project was implemented in cooperation with WYDOT and includes two underpasses to funnel mule deer.*
- ✓ *Ongoing mule deer research with the University of Wyoming Cooperative Fish and Wildlife Research Unit (Coop Unit) and Western Ecosystems Technology Inc. (WEST) has identified stopover areas along identified migration routes;*
- ✓ *The Wyoming Migration Initiative is a cooperative project with many partners including Coop Unit and WGFD with objectives of advancing the understanding, appreciation, and conservation of Wyoming's migratory ungulates by conducting innovative research and sharing scientific information through public outreach such as the Red Desert to Hoback corridor*
- ✓ *WGFD, in cooperation with the WYDOT, has developed a statewide mule deer/vehicle collision database;*

- ✓ *Research on fence specifications, highway warning signs and detection systems, and under-passes has resulted in modifications to improve animal movement and reduce collisions;*
- ✓ *WGFD has developed wildlife-friendly fence specifications in cooperation with the BLM and WYDOT;*
- ✓ *WGFD has worked with various cooperators including land management agencies, private landowners and non-governmental organizations to identify and protect important migration corridors such as Trappers' Point, routes across Anadarko Corporation's properties, and those circumnavigating Fremont Lake; and*
- ✓ *WGFD has developed and the Commission approved definitions for "ungulate migration corridor" and associated features. Migration corridors are being delineated using GPS technology on big game seasonal range maps.*
- ✓ *WGFD and WYDOT coordinate annually to identify and mitigate known migration barriers and sections of highway where deer/vehicle collisions are a concern.*
- ✓ *A Wildlife and Roadways Summit was co-sponsored by WGFD and WYDOT in April, 2017 to discuss the collision problem and migration barriers, and to explore solutions. Many partners from conservation organizations, representatives from the WY legislature, and interested citizens attended. WYDOT has been very receptive to developing solutions that address both motorist safety and migration/movement barrier issues. As a result the "Road Map to Implementation" an action plan to implement identified projects was put into place.*

Objective: Maintain and improve programs and techniques to monitor the condition of mule deer habitats and mule deer response to vegetation treatments.

Strategy: Continue monitoring vegetation conditions in key mule deer habitats.

Strategy: Implement Rapid Habitat Assessments to evaluate mule deer habitats.

Strategy: Inform federal agencies when data indicate habitats are in poor condition. Encourage changes in land/habitat management to restore habitats that are in poor condition.

Strategy: Evaluate herd management objectives (i.e., population-based objectives). As appropriate, adjust objectives to maintain herds in balance with habitat condition and availability.

Strategy: Continue to evaluate all seasonal range delineations. As appropriate, adjust them to reflect changes in mule deer distribution and habitat use or based on improved data.

Strategy: Work with land management agencies and private landowners to incorporate mule deer habitat monitoring in their programs.

What's been done:

- ✓ *Cutting edge research in the Wyoming Range and Little Mountain areas, led by Coop Unit and WGFD is investigating relationships between habitat quality and nutritional condition of mule deer.*
- ✓ *WGFD updated the Strategic Habitat Plan in 2014. Following the plan's guidance, WGFD has identified priority mule deer transitional habitats statewide.*
- ✓ *Methodologies have been standardized statewide for monitoring winter range vegetation.*
- ✓ *Rapid Habitat Assessments have been developed to evaluate mule deer habitat.*
- ✓ *The Wyoming Range and Platte Valley Habitat Assessments were conducted in 2008-2010 to evaluate current habitat conditions and guide future management actions to improve habitat.*
- ✓ *WGFD personnel meet annually with BLM, USFS, NRCS, and other land management agencies to discuss habitat conditions, vegetation treatment projects, and recommend future management actions.*

Objective: Mitigate impacts of large-scale natural resource developments. Project development and operations plans should include avoidance as well as both onsite and offsite mitigation, as appropriate, to offset unavoidable habitat losses and maintain mule deer populations.

Strategy: Apply the Wyoming Game and Fish Commission's Mitigation Policy, WGFD's Ungulate Migration Corridor Strategy, and WGFD's "Recommendations for Development of Oil and Gas Resources within Crucial and Important Habitats" (WGFD 2010a) to develop mitigation plans for every oil/gas field impacting crucial or vital mule deer habitats.

Strategy: Become involved at the earliest possible stage in planning related to energy exploration and development, and other large-scale projects and land use plans. Emphasize alternatives that avoid impacts to important mule deer habitats. Formulate alternatives including operational practices that least impact mule deer and their habitats (e.g., "Best Management Practices"). Develop mitigation and reclamation plans to offset unavoidable habitat losses and other impacts. Before compensatory mitigation options are considered, request that developers provide rigorous documentation why it is not reasonably possible to avoid and minimize impacts.

Strategy: Engage individual energy companies and appropriate state and federal agencies to develop and implement effective reclamation and mitigation strategies.

Strategy: Advocate for continued improvements in technological capabilities to reduce and mitigate energy development impacts.

Strategy: As stipulated in WGFD's wind energy recommendations, insist that federal land management agencies, permitting agencies, and wind energy companies fund and conduct adequate research evaluating the extent to which commercial-scale wind farms impact mule deer and other wildlife (WGFD 2010b:49). This research needs to be completed before significant additional wind energy development takes place in Wyoming. Based on research findings, develop appropriate siting, design, and mitigation considerations to avoid and minimize impacts. Until the research is completed, wind farms should not be located in important mule deer habitats or migration corridors. Unpublished research in Oregon has documented both elk and mule deer displacement from wind facilities (ODFW 2010).

Strategy: Encourage the BLM to withdraw important mule deer habitats from consideration for oil/gas leasing and other industrial developments.

Strategy: In cases where important mule deer habitats have already been leased, work with the BLM and leaseholder to minimize the footprint of disturbance through directional drilling and other Best Management Practices which promote conservation of wildlife resources.

Strategy: Defer mineral leasing and development until appropriate technological capabilities have been developed to effectively avoid, minimize, and mitigate adverse impacts.

What's been done:

- ✓ *WGFD is actively working with industry, BLM, the Governor's Planning Office, and several interest groups to develop effective means of addressing energy impacts, including impacts that have affected mule deer herds.*
- ✓ *The Jonah, Pinedale Anticline and Atlantic Rim mitigation teams work to develop projects to enhance mule deer habitat to offset impacts on the populations resulting from energy development.*
- ✓ *Seeding trials have been conducted in partnership with energy companies, NRCS and BLM to improve seed mixes and reclamation techniques in low precipitation vegetation zones.*
- ✓ *WGFD coordinates closely with the BLM and USFS during the development and review of Resource Management Plans and Forest Management Plans, respectively.*
- ✓ *WGFD is actively exploring ways to resolve conflicts between wildlife and energy development. We participated in an Oil/Gas Mitigation Workshop held in spring 2006 and have developed innovative solutions such as yearlong drilling from a smaller number of multiple-well pads in order to reduce well pad densities and*

associated impacts in crucial wildlife habitat.

- ✓ *Industry has acquired and provided to WGFD specialized equipment (e.g., Lawson aerators and a tractor) needed for habitat improvements to mitigate development impacts.*
- ✓ *Industry has funded research to assess distribution shifts and survival of mule deer in the Pinedale Anticline and Baggs area oil and gas fields.*
- ✓ *WGFD continues to diligently review each proposed lease and oil and gas development plan. The State of Wyoming is a "cooperating agency" in the Resource Management and Forest Management planning processes of the BLM and USFS, respectively. WGFD serves its mission under this "cooperating agency" umbrella by recommending measures to maintain and improve habitat conditions for mule deer and other wildlife.*
- ✓ *WGFD is a cooperating partner in the Wyoming Landscape Conservation Initiative, an interagency, interdisciplinary coordination team tasked with a long-term, science-based effort to assess and enhance habitats at a landscape scale in southwestern Wyoming while facilitating responsible development through local collaboration and partnerships.*
- ✓ *WGFD developed mule deer winter habitat change thresholds to trigger an adaptive management response to mitigate oil and gas development impacts on Atlantic Rim.*

Objective: Manage recreational uses to reduce impacts on mule deer and mule deer habitat.

Strategy: Protect crucial winter ranges and other key areas on Commission owned lands by seasonally closing the areas to ORV use and where necessary, to all human access. Encourage similar closures on Federal and state lands.

Strategy: Identify areas where ORVs or other types of recreation (snow machines, skiing, antler hunting, etc.) are impacting mule deer or their habitats.

Strategy: Work with federal agencies to develop travel management plans that include seasonal and permanent road closures and area closures, as needed, to protect crucial winter ranges. Reduce excessive densities of open roads on transition and summer ranges. Encourage agencies to enforce their travel management plans.

What's been done:

- ✓ *WGFD considers its involvement with development and revision of travel management plans a high priority on Federal and State Lands.*
- ✓ *The Wyoming Game and Fish Commission recently revised its regulations (Chapter 23) pertaining to public uses of Commission-owned lands. The regulations address travel and ORV management on Wildlife Habitat Management Areas.*

- ✓ *Travel restrictions on WGFD's hunter management and walk-in access areas are specified by regulation.*
- ✓ *WGFD, through a cooperative MOU with the Office of State Lands and Investments, has accepted responsibility for enforcing vehicle travel restrictions on State lands.*
- ✓ *Several educational articles about ORV ethics and impacts to wildlife have been printed in Wyoming Wildlife Magazine, WGFD news releases, and other media.*
- ✓ *The Commission adopted Chapter 61, which prohibits collection of shed antlers and horns on public lands west of the Continental Divide (excluding the Great Divide Basin) from January 1 through April 30 each year. Antler hunting is also prohibited private lands without the landowner's permission. This provision reduces disturbance to big game caused by antler hunting on winter ranges.*

Objective: Limit the impacts of urban development and rural subdivision within mule deer habitat.

Strategy: Encourage land use planning statewide. Inform county and city planning and zoning boards where important mule deer habitats are located and encourage alternatives that avoid authorizing subdivisions and other developments within such areas. Encourage zoning that protects open space.

Strategy: During project design and permitting, work closely with private landowners and developers to minimize impacts to mule deer.

Strategy: Identify the key habitat areas that are most likely to be developed and attempt to protect them through conservation easements or other property interests.

Strategy: Continue to discourage feeding mule deer.

Strategy: Reduce mule deer vehicle collisions by recommending safety corridors, such as underpasses, in areas where busy highways and mule deer migration routes intersect. Review transportation plans to identify problem areas and recommend solutions.

What's been done:

- ✓ *WGFD continues its involvement with city and county planning and zoning boards, encouraging them to include wildlife considerations in their plans. We have obtained exceptional cooperation from Teton County.*
- ✓ *WGFD cooperates with agencies and various land trusts such as the NRCS, The Wyoming Wildlife and Natural Resource Trust (WWNRT), The Nature Conservancy, RMEF, Wyoming Stock Growers Agricultural Land Trust, Jackson Hole Land Trust, and Star Valley Land Trust to set aside open spaces for wildlife, including mule deer, through conservation easements. Landowner contacts frequently discuss conservation easements as a management tool and funding is*

frequently solicited by WGFD personnel to complete these projects.

- ✓ *WGFD routinely submits comments and suggestions to city and county governments during their public involvement processes. Many of our comments recommend considerations to protect and enhance mule deer habitats.*

Objective: Prevent the introduction or expansion of invasive plants in mule deer habitat and promote control and reduction of infestations.

Strategy: Map areas where non-native invasive plants threaten mule deer habitat.

Strategy: Promote aggressive treatment (using Early Detection Rapid Response (EDRR) methodologies) to eradicate non-native invasive plants.

Strategy: Evaluate the risk of invasive species establishment in mule deer habitats.

Strategy: Use multi-agency partnerships to develop coordinated approaches to identify and prioritize cheatgrass and other annual grass infestations and obtain funding to implement control programs.

Strategy: Seek legislation to designate cheatgrass as a noxious weed. This listing will provide statewide legal authority to regulate and manage cheatgrass.

Strategy: Encourage the legislature, NGOs, and other federal agencies to promote and secure sufficient funding to manage and control invasive species and assist private landowners.

Strategy: Support research to develop new and effective methods to control cheatgrass and other invasive species.

What's been done:

- ✓ *WGFD participates in a number of coordinated weed management groups.*
- ✓ *WGFD applies various integrated weed management practices on all Commission owned lands.*
- ✓ *WGFD personnel are active participants in a multi-agency group seeking to address cheatgrass expansion in many parts of the State. Extensive treatments have been completed by WGFD personnel through partnerships on federal, state and private lands across Wyoming.*
- ✓ *WGFD is currently evaluating trials using biological control measures.*

Population Management

WGFD manages the State's mule deer resource on behalf of diverse stakeholders who include hunters, guides and outfitters, farmers and ranchers, conservation organizations, local businesses, federal land management agencies, urban and rural property owners, and the general public. Stakeholders often hold differing viewpoints regarding alternative management philosophies and approaches. For this reason, mule deer population management can entail decisions that are socially and biologically complex. Attempting to meet the expectations of every group poses many challenges, so WGFD seeks to balance the diverse interests and expectations of Wyoming's citizens on a statewide basis.

Ultimately, the quality and condition of the habitat will determine the maximum number of mule deer that can be sustained in a healthy herd. Some hunters believe present-day management should replicate the higher mule deer densities they recall from the 1980s, and some even refer back to the much higher populations of the 1950s and 60s. Those eras coincided with precipitation regimes and stages of plant succession more optimal for supporting highly productive mule deer populations. Long-term intensive predator control was widespread at the time and may also have allowed some mule deer populations to increase beyond the carrying capacity of their habitat. In retrospect, many wildlife biologists believe mule deer were actually too abundant in the 1950s and 60s and that overabundance caused long-term damage to preferred forage plants. Since then, habitat conditions have declined as a consequence of fire suppression, invasive plant species, rangeland management practices, urban sprawl, energy development, long-term drought, and historically too many mule deer. Competition between deer, elk, pronghorn and livestock can also be a limiting factor in some areas. Excessive utilization of preferred shrubs and herbaceous species is an ongoing management concern, particularly where animals concentrate on limited winter ranges.

Chronically low fawn recruitment is a primary indicator mule deer density may have exceeded what the habitat can support, or that habitat quantity and quality have diminished. Attempting to manage mule deer at unsustainable numbers can further damage the habitat base resulting in a less productive herd that is susceptible to large-scale die-offs from disease, malnutrition and severe winters. On the other hand, maximum fawn productivity is achieved when the herd is held in check, and well within the habitat's carrying capacity. Responsible management seeks to protect the habitat base by maintaining mule deer populations at sustainable levels. A productive mule deer herd in good habitat is also more resilient and will recover sooner after stressful climatic events such as a severe winter.

Mule deer management in Wyoming is based on a system called "Management by Objective." Numerical population objectives were established for the majority of herds in the State and reevaluated every five years. Objectives are intended to be well within the carrying capacity of the habitat under normal climatic conditions. Objectives can also be adjusted based on social input received from sportsmen, landowners, and land management

agencies. However, unanticipated conditions including long-term drought, large-scale developments, habitat fragmentation, competition with other ungulates, shrub eradication programs, fire suppression, and intensive land management practices have reduced the capacity of several mule deer ranges in Wyoming. Consequently, some existing herd objectives may no longer be realistic or sustainable. In these circumstances, managers focus on identifying the specific issues limiting population growth and work with partners to correct them where possible. In cases where a population has been chronically depressed for many years, it may be necessary to adjust the population objective downward to a more realistic and sustainable level.

Hunting seasons are set to manage most mule deer herds within 20% of the respective population objectives. When a population is outside this range, more liberal or conservative seasons are recommended, as needed, to reduce or increase the herd toward its objective. However, mule deer populations may be managed at a lower level to protect the herd and its habitat when the carrying capacity is depressed as a consequence of protracted drought or other environmental factors. If the factors that depress carrying capacity persist, then managers should consider revising the objective downward.

Sometimes, we lack adequate data to reliably estimate a mule deer population. WGFD has adopted alternative management objectives to address situations (such as interstate herds) in which it is not possible to generate a reliable population estimate. We also apply alternative objectives to a few herds in which we are unable to manage deer numbers (through harvest) due to limited hunting access. Alternative objectives can be based on midwinter trend counts or landowner/hunter satisfaction surveys ($\geq$60% satisfaction level). Secondary objectives are sometimes used in conjunction with a population objective or alternative objective, and may include: habitat indices such as shrub utilization; male quality based on buck:doe ratios or antler class measurements; and harvest statistics such as hunter effort (average days required to harvest an animal) and success (percent of hunters who harvested a mule deer). Where adequate data are available, the preferred approach is always to manage harvest based on a numerical population objective.

Mule deer population size is managed primarily through harvesting female mule deer. It is generally accepted that a minimum ratio of 66 fawns per 100 does after the hunting season is required for a herd to maintain itself when there is minimal female harvest. To stabilize a productive mule deer herd (e.g., 70-80 fawns per 100 does) that is approaching its objective, an appropriate proportion of does must be harvested annually. Where mule deer are limited by their habitat, it is important to always harvest at least some females to maintain the herd at a sustainable level. Therefore, we may consider harvesting does to protect the habitat base during stressful environmental conditions (such as long term drought) even when a herd is below its population objective. When habitat conditions improve, a modest female harvest rate will not inhibit the population from rebounding. On the other hand, failing to harvest female mule deer when habitat is in poor condition may result in additional damage to the habitat base and a more protracted recovery. In circumstances where mule deer population

growth is inhibited by other factors such as predation, doe harvest may not be needed or desirable.

WGFD applies various harvest strategies depending on management needs. The most conservative strategy is an "antlered-only" season, irrespective whether licenses are limited (limited quota season) or unlimited (general season). This allows maximum population growth when habitat conditions are favorable. Seasons in which a license is valid for either sex can achieve a limited harvest of does, but comparatively few hunters are willing to harvest a doe on a license that allows them to harvest an antlered mule deer. A somewhat higher doe harvest can be realized by restricting an either-sex license to does and fawns only during the latter portion of the hunting season. Some hunters who were unsuccessful harvesting an antlered mule deer at the beginning of the season will opt to harvest a doe later on. Another variation is to allow harvest of either sex at the beginning of the season, and then restrict the license to antlered mule deer only during the later segment. However, WGFD has found issuing licenses valid only for doe/fawn mule deer is the most effective strategy when a significant number of female mule deer must be harvested. These licenses are always limited in quota, but are issued in sufficient numbers to achieve the necessary harvest. Doe/fawn deer licenses are sold at a reduced price and may be purchased in addition to a license allowing harvest of antlered deer.

Some stakeholders tenaciously oppose harvesting does and continue to believe this practice is detrimental to mule deer management in Wyoming. As a result, WGFD sometimes has difficulty implementing hunting seasons that will achieve a sufficient harvest of female mule deer to meet population management objectives and reduce potential for significant mortality events (i.e., "population crashes"). During the late 1980s, for example, many herds in Wyoming increased dramatically during an "irruptive" growth phase, vastly outstripping the capacity of available habitats. Although WGFD attempted to curb the undesirable population growth by harvesting additional does, those efforts often met with resistance and ultimately proved too little too late. After the moderately severe winter of 1992-93 mule deer populations declined abruptly, some by more than 50%. Although prescribed doe harvests were increased during the 1991 and 1992 hunting seasons to address deteriorating habitat conditions, the resulting harvest rates were not enough to have caused the observed population declines. Despite efforts to increase harvest and minimize over-winter mortality, significant overwinter mortality was documented in many areas. Those declines happened because there were simply too many mule deer trying to survive on depleted habitats in concert with extreme winter conditions. Competition for available resources was excessive and most mule deer did not accumulate sufficient fat reserves before entering the winter. In several herds, the lasting effect of long-term habitat degradation continues to manifest as chronically depressed fawn recruitment and elevated winter mortality. A sustained recovery has been difficult to attain in many of these populations despite minimal or no doe harvest since 1992.

Most mule deer herds in Wyoming are managed under a "recreation" concept. Harvest in these herds is regulated to sustain between 20 and 29 bucks per 100 does measured after the

hunting season has ended. In most areas, we are able to maintain buck:doe ratios within this range without limiting the numbers of hunting licenses available to resident hunters. These areas usually are open to hunting with a general license. "Recreational management" offers the maximum opportunity to hunt while providing a reasonably satisfying experience for the majority of hunters. A smaller number of mule deer herds designated as "special management" are managed to sustain between 30 and 45 bucks per 100 does after the hunting season. In order to maintain higher proportions of bucks, harvest pressure must often be reduced either by limiting the numbers of licenses (i.e., by setting limited quota seasons), or by setting conservative hunting seasons under a general license framework. Herds managed to sustain a larger proportion of bucks may not produce as many mule deer to harvest because the proportion of does in the population is lower. Fewer does mean fewer fawns and ultimately, fewer mule deer to harvest. Consequently, hunting opportunity must be reduced both to lessen harvest pressure on bucks and to harvest a smaller available surplus of mule deer. It is important to note that mature bucks are available for harvest in all mule deer herds in the state regardless whether they are managed under "special" or "recreation" management concepts.

Antler point restrictions (APRs) are another harvest strategy sometimes employed with the objective of improving depressed buck:doe ratios or, at times, to reduce hunter participation and harvest. APRs restrict harvest to bucks with at least 3 or 4 points on either antler. It may seem counterintuitive, but APRs do not necessarily produce more large bucks. When an antler point restriction is in place, all harvest pressure is redirected to the largest mule deer in the population, which reduces their number. Since yearlings and some 2-year old bucks are protected until they become small 3- or 4-point deer, the overall ratio of bucks to does may increase as a result of retaining more young bucks in the population. However, harvest is merely deferred until a buck grows its first set of 3- or 4-point antlers. The maximum benefit of an APR season is typically realized after 2 or 3 years. Thereafter, the buck:doe ratio does not continue to increase and fewer bucks actually survive to grow truly large antlers. If the objective is to produce more large mule deer, the antler point restriction needs to be lifted after 2 years so harvest is again spread across more age classes thereby reducing pressure on older age class bucks. Should the overall buck:doe ratio decline to an unacceptably low level, the antler point restriction can be reinstated for another 2-3 years to augment the number of bucks in the population, and the process is repeated. However, public perception often makes it difficult to discontinue APR seasons once they are in place. Over the long-term, persistently targeting mature bucks may also eliminate desirable genetics (the predisposition to grow large antlers) from the population.

Overall, mule deer hunters in Wyoming continue to be satisfied with existing management. In a 2017 survey, 58% of resident hunters indicated the Department is doing a good or excellent job managing mule deer (Responsive Management 2017:62). Responses to a similar question in the 2006 and 2012 surveys were 61% and 49% favorable, respectively (Responsive Management 2006:64, 2012:107). Survey participants tend to base their perspectives on their most recent experience. A relatively lower mule deer population (376,104) and resident hunter success (43.4%) in 2011 likely contributed to the lower

satisfaction rating in the 2012 survey. The mule deer population (409,100) and resident hunter success (54.3%) were improved in 2016, and hunter satisfaction also increased. The level of satisfaction with current management direction tends to vary regionally as well. Even where hunters are dissatisfied, opinions differ regarding how mule deer should be managed and this adds further complexity to the challenge of accommodating diverse public expectations. In addition to the periodic statewide attitude survey, local input is solicited and strongly considered in management decisions at the individual herd unit and hunt area levels. There is (and always will be) some interest in reducing hunter densities despite a 59% decline in the number of mule deer hunters statewide since the early 1980s. Contributing factors may include increasingly restricted access to private lands (displacing a higher *proportion* of hunters onto public lands), and a lower tolerance for other hunters when fewer mule deer are seen. Although there is support for limiting resident hunting opportunity to address perceptions of hunter crowding, it is noteworthy the level of support declined from 65% in the 2012 survey (Responsive Management 2012:137) to 55% in the 2017 survey (Responsive Management 2017:84). This again indicates the perception about hunter density was likely influenced by the higher deer population and hunter success during the 2016 hunting season. Strategies to limit the number of hunters conflict with an even stronger desire to hunt every year (Responsive Management 2017:80), a preference for general hunting seasons (Responsive Management 2017:70), and a 55% prevalence of hunters who hunt in multiple hunt areas each year (Responsive Management 2017:28). The outdoor and social media are also cultivating a growing interest in hunting large-antlered bucks. The 2006 survey had a question regarding opportunity tradeoffs needed to manage for larger bucks, but a similar question was not asked in the 2012 or 2017 surveys. The approach WGFD has taken is to maintain a diversity of management approaches that emphasize opportunity to hunt while providing, within reason, opportunities to hunt in special management areas where harvest of mature bucks and higher success rates are emphasized.

The following management objectives are recommended to sustain productive, resilient populations of mule deer over the long term.

Objective: Minimize the extent to which competition from other ungulates is impacting mule deer populations.

Strategy: Manage expanding elk and white-tailed deer populations within their established herd unit objectives.

Strategy: Improve our understanding of competitive interactions between mule deer and white-tailed deer, elk, pronghorn, feral horses, and domestic livestock. Develop management strategies to alleviate excessive competition and address conflicting wildlife management goals.

What's been done:

- ✓ *WGFD continues to liberalize elk hunting throughout the state by increasing license allocations, issuing additional cow/calf licenses sold at a reduced price, and extending hunting seasons in some areas as late as January 31. WGFD has also negotiated several hunter management areas to improve access in areas where it has been a challenge to achieve adequate harvests of cow elk.*
- ✓ *White-tailed deer management throughout the state is liberal and includes longer seasons with general license and/or limited quota license hunting through November and December, and doe/fawn white-tailed deer licenses available in many hunt areas. In selected hunt areas, hunters can obtain a second full-price license valid for white-tailed deer and an unlimited number of reduced-price doe/fawn licenses.*
- ✓ *WGFD funded two studies conducted by the Wyoming Cooperative Wildlife Research Unit, that examined competitive interactions between mule deer and white-tailed deer (Sawyer and Lindzey 2000), and between mule deer and elk (Porter, 1999).*

Objective: Manage mule deer populations on a sustainable basis, within the carrying capacity of the habitat.

Strategy: Monitor range conditions in key habitats within winter, summer and transition ranges.

Strategy: Implement habitat improvement projects to restore and increase habitat carrying capacity enabling managers to sustain mule deer numbers at established population objectives.

Strategy: Where long-term trends in habitat conditions are irreversible (i.e., due to permanent rangeland conversions, invasive plants, climate change, subdivisions, or large-scale energy development) and have been determined to cause mule deer population declines below established objectives, lower the objective to a sustainable level.

Strategy: Set hunting regulations to manage mule deer populations within the established herd unit objectives. Make further adjustments based on browse utilization readings and climatic conditions, to maintain herds within the existing capacity of the habitat.

Strategy: Reevaluate herd unit objectives every five years and adjust them as warranted to assure the habitat is protected from overuse.

Strategy: Evaluate the need to reduce mule deer populations when browse utilization readings on key shrub species exceed the thresholds identified in the

Mule Deer Habitat Management Guidelines (WGFD 2015) for three consecutive years based on representative sampling.

Strategy: Where other herbivores contribute to excessive browse utilization, advocate appropriate management actions to ensure sustainable utilization.

What's been done:

- ✓ *Rapid Habitat Assessments have been implemented to assess population objectives relative to habitat condition.*
- ✓ *Various strategies have been implemented in some areas to achieve harvest of female mule deer necessary to manage populations within herd objectives. These strategies include issuance of sufficient reduced price doe/fawn licenses, reduced license fees, allowance for hunters to obtain multiple doe/fawn licenses, and extended late antlerless mule deer seasons for full-price license holders. The extent to which these strategies are being implemented has decreased in recent years as many mule deer populations are currently below management objectives.*
- ✓ *The Access Yes and various hunter assistance programs have improved access to private lands, helping us to achieve desired harvest levels.*
- ✓ *WGFD has increased its emphasis on managing mule deer populations within herd objectives and within numbers the habitat can support on a sustainable basis.*
- ✓ *WGFD has increased public information and education efforts impressing the need to manage mule deer populations within the habitat's capacity and the need to harvest female mule deer to accomplish this. These efforts are accomplished through season setting meetings and publications.*
- ✓ *During the past five years, WGFD completed reviews of the herd unit objectives for all mule deer herd units. The reviews and subsequent recommendations were presented to the WGFC for final approval. This review process will continue on a five cycle for all mule deer herd units.*

Objective: In areas with limited access, improve hunting opportunities to realize harvest levels needed to manage populations within objective levels and to maintain productive habitat conditions.

Strategy: Evaluate landowner attitudes regarding hunting seasons and access.

Strategy: Encourage federal land trades that consolidate public and private parcels, or provide access to landlocked public lands.

Strategy: Increase public hunting opportunities through various landowner incentive programs, access easements, and additions/enlargements of Commission-owned lands, and by improving habitat management on private, federal, and Commission-owned lands.

Strategy: Increase landowner confidence and contacts by working through Wyoming Conservation Districts.

Strategy: Cooperate with the Wyoming State Land Board to facilitate hunting access on State lands and to enforce travel restrictions.

What's been done:

- ✓ *The Commission kicked off its "Private Lands/Public Wildlife" program (PLPW) in 2000, renamed "Access Yes" in 2016. The program compensates private landowners for providing public access to hunt on private lands or to access landlocked public lands. Access Yes is funded by voluntary contributions from sportsmen and from a portion of the Conservation Stamp revenue. Since the program began, tens of thousands of acres have been enrolled as "hunter management areas," or "walk-in areas." In 2015, the Access Yes program provided access to 2,809,153 acres (1,769,789 acres of enrolled private and state lands, and 1,039,364 acres of public lands).*
- ✓ *Several "hunter assistance" programs are operated in the state, usually by local Chambers of Commerce, to help hunters find a place to hunt. Some WGFD regional offices and game wardens also maintain lists of landowners who are willing to accept hunters.*
- ✓ *The Commission owns and manages numerous habitat units, winter ranges, and access easements that are open to public hunting throughout the state. As opportunities arise, additional priority lands and easements may be evaluated for acquisition pending adequate funding.*
- ✓ *WGFD's regional offices periodically conduct surveys to assess landowner preferences regarding hunting seasons and hunter access. Game wardens and biologists routinely contact landowners to obtain their perspectives on these issues as well.*
- ✓ *The Legislature has included a "landowner coupon" on deer, elk, and pronghorn licenses to compensate landowners for wildlife use of private lands since 1939. Hunters sign and detach the coupon upon harvesting an animal on private land and the landowner turns coupons in for payment after the hunting season.*
- ✓ *As the need arises, WGFD issues additional hunting licenses to address depredation concerns on private lands. These licenses are almost always limited to doe/fawn deer and pronghorn, or cow/calf elk only.*
- ✓ *WGFD comments on all proposals to acquire, exchange, or dispose federal and state lands. We encourage acquisitions and exchanges that consolidate isolated parcels of federal lands and provide access to landlocked blocks of federal lands. We also support retaining accessible public lands in federal ownership, especially lands containing important habitat.*
- ✓ *WGFD obtained a policy directive from the State Land Board in 1987 affirming the public's right to hunt and fish on all state lands under grazing leases. We also coordinated with the State Land Board to obtain clarification of rules*

pertaining to hunting and fishing access on state lands and a brochure on this topic was published in 2006.

- ✓ *In 2003, the Wyoming Legislature passed Enrolled Act 64, requiring the State to post signs on readily identifiable state lands that are legally accessible. The sign posting effort is ongoing.*

Objective: Provide diverse hunting opportunities to accommodate both recreational and trophy mule deer hunters.

Strategy: Evaluate and consider results of mule deer hunter attitude surveys conducted at both the statewide and local levels. Use survey results to identify and implement hunting season frameworks and licensing systems that provide a diversity of opportunity while maintaining or improving constituent satisfaction.

Strategy: Maintain general license hunting seasons while providing opportunities to hunt in areas that are managed to sustain a higher proportion of mature bucks or higher harvest success.

What's been done:

- ✓ *A Deer License Committee was established to evaluate problems and benefits associated with issuing separate hunting licenses for mule deer and white-tailed deer, and with potentially converting all deer hunt areas to limited quota licenses only (Sandrini et al. 2007). The report concluded, "The current system of deer license issuance adequately accommodates species-specific management of white-tailed deer and mule deer. It also provides flexibility for local big game managers to tailor seasons and opportunity for hunters to hunt both species in multiple areas on a single license."*
- ✓ *A second Deer License Committee has been established in 2017 to identify pros and cons of a region concept for resident general license seasons. A prior report on resident regions was completed by the Mule Deer Working Group in 2014 and is being consulted. Under this concept, resident general licenses would be valid within a defined region rather than statewide, similar to the system we use for nonresident general licenses.*
- ✓ *Hunter attitude surveys are conducted approximately every 5 years to assess satisfaction and gauge public understanding or acceptance of new ideas.*
- ✓ *In addition, level of hunter satisfaction is assessed annually through the Department's harvest survey.*

Objective: Identify and implement management actions to address agricultural damage problems.

Strategy: Adjust hunting regulations to alleviate agricultural damage caused by mule deer while balancing desires of hunters and landowners.

Strategy: Implement strategies in addition to hunting to alleviate damage.

What's been done:

- ✓ *Doe/fawn licenses are issued on a routine basis to alleviate damage.*
- ✓ *In special circumstances and where justified, kill permits are issued to alleviate damage.*
- ✓ *Special seasons (depredation seasons) are set to alleviate damage within specific geographic areas.*
- ✓ *WGFD supplies free exclosure fencing to landowners experiencing deer-caused damage to haystacks.*
- ✓ *WGFD has produced several extension bulletins providing landowners and homeowners information on how to prevent or reduce damage by deer. In addition, WGFD provides technical assistance to landowners experiencing damage.*
- ✓ *Since 1939, WGFD has compensated landowners for damage to private property caused by big or trophy game when WGFD personnel can verify the damage and a claim is filed in accordance with state laws and Commission regulations.*
- ✓ *In 1999, WGFD published the second edition of The Handbook of Wildlife Depredation Techniques:*

  Buhler, M.L., S.H. Anderson, F.G. Lindzey, and T. Cleveland. 1999. The Handbook of Wildlife Depredation Techniques: 2nd Edition. WY Game and Fish Department, Cheyenne. 680pp.

Objective: Use appropriate survey techniques, within budgetary considerations, to monitor mule deer populations at a level of precision needed to assess results of harvest strategies, climatic or disease events, habitat treatments and other management or conservation actions.

Strategy: Evaluate monitoring and population census techniques utilized by other Western states. If alternative techniques merit consideration, identify herd units in Wyoming in which the techniques can be experimentally applied and results compared against those obtained from WGFD's traditional survey techniques.

Strategy: Implement the most current, effective population estimation techniques to assess mule deer population status. Standardize survey techniques statewide.

Strategy: Support research to monitor mule deer response to habitat treatments and other management actions.

What's been done:

- ✓ *WGFD's Mule Deer Working Group (MDWG) periodically reviews current literature and contacts other state wildlife agencies to identify alternative techniques that may warrant consideration in Wyoming. Representatives from Colorado, Idaho, and Montana have attended MDWG meetings and given presentations on their states' monitoring and census procedures.*
- ✓ *Beginning in the mid 1990s, WGFD began measuring fat deposition in field-checked mule deer to assess body condition and provide an indirect means of assessing habitat quality and availability.*
- ✓ *Beginning in 1994 WGFD began conducting post hunting season change in ratio surveys and winter mortality surveys to gauge the impact of winter weather on mule deer populations in a few key mule deer herds.*
- ✓ *WGFD conducts aerial sightability surveys in key mule deer herds. These surveys provide an independent validation of estimates derived from population models. Sightability surveys are now scheduled on a 5-year rotation in key mule deer herds around the state. Funding for the surveys was obtained by re-allocating a portion of existing flight budgets.*
- ✓ *Continue to use quadrat sampling to estimate abundance in the Sublette Herd Unit (WEST Inc. is doing these).*

Strategy: Conduct annual herd composition surveys to assess population status after the hunting season has ended. Surveys should cover core winter range areas after the migration period and prior to onset of winter (November/December). A sufficient number of mule deer should be classified on the ground or from a helicopter to achieve statistically adequate sample sizes needed to reliably estimate age and sex ratios (i.e. buck:doe, fawn:doe ratios), and to provide a basis for estimating winter mortality.

What's been done:

- ✓ *Annual post-hunting season age/sex composition surveys are done in most herd units.*
- ✓ *WGFD routinely checks harvested mule deer in the field and collects age/sex data.*
- ✓ *WGFD has developed standardized antler classification measurements and now collects this data from harvested mule deer and during post-season classifications in several herd units throughout the state.*

Strategy: Continue to use spreadsheet population modeling to estimate the size of mule deer populations based on herd composition surveys, harvest and non-harvest mortality, and annual survival.

What's been done:

- ✓ *WGFD relied upon POP-II modeling software to estimate mule deer population sizes beginning in the early 1980s. Other methods have been reviewed and evaluated in selected herd units.*

- ✓ *Beginning in 2013, WGFD discontinued use of POP-II and replaced it with the spreadsheet model. Considerable effort was invested, in conjunction with the Coop Unit, to develop a modeling program suited to the needs of WGFD. The guidelines are referenced below:*

  White, G.C. and B.C. Lubow. 2002. Fitting population models to multiple sources of observed data. J. Wildl. Mgmt. 6(2):300-309.

  Morrison, T. 2012. User guide: spreadsheet model for ungulate population data. Appendix A-09b in S.A. Tessmann and J. Bohne (eds). Handbook of Biological Techniques: third edition. WY Game & Fish Department, Cheyenne.

Strategy: Continue to evaluate alternative methodologies and software for estimating populations.

- ✓ *The WGFD and WY COOP Unit have assessed utility and limitations of spreadsheet models. Spreadsheet models do not work well for smaller populations and where the closure assumption is violated. In addition, the method of estimating precision based on individuals classified (Czaplewski et al. 1983) produces unrealistically narrow confidence intervals which strongly drive the model's performance. Costs of obtaining monitoring data to improve spreadsheet model performance can be unrealistically high.*

  Morrison, T.A. and M.J. Kauffman. 2014. Mule Deer Modeling Report: A quantitative evaluation of survey efforts to model, monitor and manage Wyoming mule deer populations. WY COOP Unit Rept., University of Wyoming, Laramie. 29pp.

- ✓ *WGFD is currently investigating POPR Version 1.0 as an alternative modeling method for estimating big game populations.*

  J. J. Nowak, and P. M. Lukacs. 2014. PopR Version 1.0, Wildlie Biology Program, Univ. Montana, Missoula https://popr.cfc.umt.edu/

Strategy: Continue the big game harvest survey to estimate annual mule deer harvest, hunter success, effort, and other statistics. Continue requiring response sample sizes that are sufficient to estimate license success within a 90% confidence interval of ±10% for each hunt area license type. Determine whether non-response has a significant bias effect on harvest estimates.

What's been done:

- ✓ *The Statewide Wildlife and Habitat Management (SWaHM) Program and the harvest survey contractor refine and improve the harvest survey process on a continuing basis in order to achieve the contractually-specified level of precision.*
- ✓ *A non-response bias study was completed in 2004 and 2005. Results were comparable to those of an earlier study conducted in the late 1970s. The amount*

of bias detected at the statewide level was nominal (generally less than a few percent).

- ✓ *A sample size validation study was completed in conjunction with the 2010 harvest survey. The study validated that minimum sample size calculations by the Harvest Survey Contractor were sufficient to achieve the contractually-specified precision standard.*
- ✓ *During the harvest survey contract and bid process completed in 2014 considerable effort was made to evaluate and improve efficiency and data delivery.*

Strategy: Conduct post-winter mortality surveys and spring herd composition surveys to estimate fawn losses and the age and sex composition of winter mortality estimates each year. Monitor winter survival of fawns and adults in key areas to maintain accurate indices of recruitment and survival.

What's been done:

- ✓ *Winter mortality surveys and/or spring classifications are done in select herd units throughout the state.*
- ✓ *Research evaluating winter fawn survival was conducted by the Coop Unit. It was determined that due to the high cost of this work, the money is better spent on improved population estimation techniques. See above implementation of sightability surveys on key herd units.*
- ✓ *Fawns are being fitted with radio collars and tracked as part of the WY Range Mule Deer Study. Seventy fawns were fitted with radio collars in 2016. None survived the exceptionally severe winter of 2016-2017. In a recent Idaho study, overwinter survival of radio-collared mule deer fawns ranged from 56%-63% (Hurley and Zager 2007).*

Strategy: Obtain data from field-checked mule deer to monitor ages and gender of harvested mule deer, body condition, antler classification, and geographic distribution of the harvest. Collect incisor teeth to accurately age mule deer based on laboratory analysis of cementum annular deposits.

What's been done:

- ✓ *For many years, WGFD collected incisors from harvested mule deer to estimate the age composition of the harvest and to provide an estimate of the age structure of adult female mule deer in the population. Where such data are important to construct reliable population models, an adequate budget should be restored to collect tooth samples for laboratory aging.*
- ✓ *WGFD continues to collect tooth-age data in a few select herd units.*
- ✓ *WGFD routinely checks harvested mule deer in the field and collects age/sex data.*
- ✓ *In 2013, WGFD expanded efforts statewide to collect antler classification data from both harvested mule deer and mule deer observed during classification surveys.*

Strategy: Identify and implement mitigation practices to reduce the incidence of vehicles and trains colliding with mule deer, especially at important migration crossings.

What's been done:

- ✓ *WGFD helped fund the Nugget Canyon Deer Study completed in 2003.*
- ✓ *Underpass structures, deterrent devices, and motorist warning systems have been installed at Nugget Canyon, the Pinedale and Baggs areas, and other key locations around the State.*
- ✓ *In 2012, WYDOT completed 2 earthen overpass structures and 6 underpasses along a section of U.S. Highway 191 west of Pinedale to facilitate mule deer and pronghorn migrations. The deterrent devices and motorist warning systems previously in place were determined ineffective and removed. The WYDOT also constructed high woven-wire fences to keep mule deer and pronghorn off the referenced section of U.S. Highway 191, and to guide them toward the underpasses and overpasses for safe crossings.*
- ✓ *WYDOT maintains a deer collision database to identify problem locations along the State's highways.*
- ✓ *WGFD and WYDOT have developed educational materials and signs that advise motorists about dangers of wildlife collisions and encourage safe driving practices when mule deer are present.*
- ✓ *WGFD has continued to communicate with WYDOT and advocate mule deer crossing structures at key highway crossings.*
- ✓ *A Wildlife and Roadways Summit was co-sponsored by WGFD and WYDOT in April, 2017 to discuss the collision problem and migration barriers, and to explore solutions. Many partners from conservation organizations, representatives from the WY legislature, and interested citizens attended. WYDOT has been very receptive to developing solutions that address both motorist safety and migration/movement barrier issues. As a result the "Road Map to Implementation," an action plan to implement identified projects, was put into place.*

Strategy: Continue to increase our knowledge of mule deer distribution, migration, and habitat use throughout Wyoming. Apply this information to manage mule deer more effectively, document potential impacts, justify the need for mitigation, and design more effective mitigation and habitat treatments.

What's been done:

- ✓ *For many years, WGFD has mapped seasonal ranges utilized by mule deer throughout the State. The maps (geographic overlays) are often consulted to assess impacts of proposed developments. These maps have also been digitized and are available in a GIS format.*
- ✓ *Big game migration corridors are classified as "Vital" habitats by WY Game and Fish Commission Mitigation Policy VI H, revised January 28, 2016. The*

Department recommends no significant decline in species distribution or abundance, or decline in habitat function.

- ✓ *The Wyoming Ungulate Migration Corridor Strategy" was approved by the Wyoming Game and Fish Commission on January 27, 2016. The final version is dated Febryary 4, 2016 and can be downloaded at:*
  https://wgfd.wyo.gov/WGFD/media/content/PDF/Habitat/Habitat%20Information/Ungulate-Migration-Corridor-Strategy_Final_020416.pdf
- ✓ *To be officially recognized under the Mitigation Policy, migration corridors must now be formally identified by the Department based on a "Brownian Bridge" analysis or other defensible data.*
- ✓ *WGFD developed a Decision Support System (DSS) that became operational in 2005. The DSS is a geographic data system that includes distributional data, seasonal ranges, migration corridors and other critical information. The system was devised to assist WGFD personnel, companies and consultants with analyzing potential impacts of proposed developments and to help identify mitigation opportunities. All spatial data formerly associated with DSS, along with other geo-referenced data platforms, are now incorporated into WISDOM, managed by the Wyoming Geographic Information Science Center (WyGISC). WISDOM serves the same purposes as DSS, but with expanded tools and capabilities.*
- ✓ *WGFD has maintained a Wildlife Observation System (WOS) database since the late 1970s. This is WGFD's longest standing geo-referenced database containing seasonal distribution, herd composition, and mortality records for mule deer. The WOS is currently being migrated over to the Wyoming Natural Diversity Database (WYNDD), administered by the University of Wyoming, Biodiversity Institute. WYNDD is affiliated with NatureServe, a global network of natural heritage programs to collect and manage data about the status and distribution of species and ecosystems of conservation concern.*
- ✓ *In September, 2004 WGFD compiled "Recommendations for Development of Oil and Gas Resources within Important and Crucial Wildlife Habitats" (WGFD 2010a). This document provides management and mitigation recommendations applicable to energy developments within important habitats of several wildlife species including mule deer. It is available on WGFD's public web site. Version 6.0, relsased in April, 2010, incorporates results of recent research and updated impact assessment and mitigation procedures. The document will continue to be updated periodically, as new data and information warrant.*
- ✓ *In September, 2010 the Wyoming Game and Fish Commission approved, "Wildlife Protection Recommendations for Wind Energy Development in Wyoming" (WGFD 2010b). This document includes a brief section on big game, noting the paucity of research specific to wind energy impacts on big game. The wind energy recommendations are available on WGFD's public web site. Since the document was released, limited additional studies have been completed to assess wind energy impacts on mule deer. WEST Inc. completed an unpublished monitoring study in Oregon entitled "Elkhorn Valley Wind Project Big Game*

Monitoring Study," which showed displacement of elk and mule deer from a wind energy facility.

- ✓ *WGFD has collaborated with the Wyoming Migration Initiative orchestrated through the University of Wyoming Wildlife Research Unit. The initiative's mission statement is: "Advancing the understanding, appreciation, and conservation of Wyoming's migratory ungulates by conducting innovative research and sharing scientific information through public outreach." (http://migrationinitiative.org).*
- ✓ *The WGFD has initiated research and partnered with the University of Wyoming Wildlife Research Unit and other investigators regarding several mule deer migration and distribution studies. These include: Uinta Herd Unit Study, Platte Valley Mule Deer Project, Wyoming Range Mule Deer Project, Sublette Mule Deer Project, Atlantic Rim Mule Deer Study, Steamboat Mule Deer Study, Baggs work, Wyoming Migration Viewer, DEER Project, Eastern Greater Yellowstone Ecosystem (EGYE) Mule Deer Project, Sheep Mountain, Bates Hole/Hat Six, etc.*

The following studies and baseline assessments have been recently completed in Wyoming:

Sawyer, H., N.M. Korfanta, R.M. Nielson, K.L. Monteith, and D. Strickland. 2017. Mule deer and energy development – long-term trends of habituation and abundance. Global Change Biology. 2017:1-9. http://onlinelibrary.wiley.com/doi/10.1111/gcb.13711/full

Sawyer, H., M. J. Kauffman, A. D. Middleton, T. A. Morrison, R. M. Nielson, and T. B. Wyckoff. 2013. A framework for understanding semi-permeable barrier effects on migratory ungulates. Journal of Applied Ecology. 50:68-78.

Sawyer, H. 2007. Final Report for the Atlantic Rim Mule Deer Study. Western Ecosystems Technology, Inc., Cheyenne, WY

Sawyer, H., C. LeBeau, and T. Hart. 2012. Mitigating roadway impacts to migratory mule deer – a case study with underpasses and continuous fencing. Wildlife Society Bulletin 36:492-498.

Sawyer, H., F. Lindzey, and D. McWhirter.2005. Mule deer and pronghorn migration in western Wyoming. Wildlife Society Bulletin 33:1266-1273

Sawyer, H. and M. Kauffman. 2011. Stopover ecology of a migratory ungulate. Journal of Animal Ecology 80:1078-1087.

Sawyer, H., M. J. Kauffman, and R. M. Nielson. 2009. Influence of well pad activity on the winter habitat selection patterns of mule deer. Journal of Wildlife Management 73: 1052-1061.

Sawyer, H., R. Nielson, and D. Strickland. 2009. Sublette Mule Deer Study (Phase II): Final Report 2007. Western Ecosystems Technology, Inc. Cheyenne, Wyoming, USA.

Sawyer, H., R. Nielson, F. Lindzey, and L. McDonald. 2006. Winter habitat selection of mule deer before and during development of a natural gas field. Journal of Wildlife Management 70:396-403

Webb, S.L., M.R. Dzialak, K.L. Kosciuch, and J.B. Winstead. 2013. Winter resource selection by mule deer on the Wyoming-Colorado border prior to wind energy development. Rangeland Ecology & Management. 66(4):419-427.

Webb, S.L. and M.R. Dzialak, D. Houchen, K.L. Kosciuch, and J.B. Winstead. Spatial ecology of female mule deer in an area proposed for wind energy development. Western North American Naturalist 73(3):347-356.

Young, D., and H. Sawyer. 2006. Wildlife Crossing Study: US Highway 287/26, Moran Junction – Dubois. Western Ecosystems Technology, Inc., Cheyenne, WY

Kauffman, M., H. Sawyer, W. Schultz, and M. Hayes. 2015. Seasonal Ranges, Migration, and Habitat Use of the Platte Valley Mule Deer Herd. Wyoming Cooperative Fish and Wildlife Research Unit, University of Wyoming, Laramie. USA. 21 pp.

- ✓ *In 2011, the MDWG of the WAFWA published, "Energy Development Guidelines for Mule Deer." This document addresses issues and concerns related to energy development in the West, and provides guidelines for project planning, design, and mitigation to avoid and reduce impacts to mule deer. The document can be downloaded online at: http://www.muledeerworkinggroup.com/Docs/Energy_Development_Guidelines_for_Mule_Deer_2013.pdf*

Lutz, D.W., J.R. Heffelfinger, S.A. Tessmann, R.S. Gamo, S. Siegel. 2011. Energy development guidelines for mule deer. Mule Deer Working Group, Western Association of Fish and Wildlife Agencies. 27pp.

Objective: Continue to refine and improve herd unit boundaries and concepts for managing populations of mule deer.

Strategy: Conduct studies of mule deer distribution and movements to refine seasonal range type delineations and herd unit boundaries. Revise herd unit boundaries and combine herd units as needed to meet the criterion of not more than 10% interchange between adjoining herd units.

Strategy: For those herds shared with adjacent states, continue to improve coordination and data collection in order to attain better population and harvest estimates, and more reliable trend monitoring.

Strategy: Coordinate with wildlife agencies in neighboring states to cooperatively manage mule deer populations and to share management techniques and strategies.

What's been done:

- ✓ *WGFD continues to conduct population movement studies where existing herd unit boundaries are questionable. Most recently, the Steamboat Herd was incorporated into the Sublette Herd due to migration and interchange between the two former herds.*
- ✓ *WGFD conducts surveys during critical periods to document seasonal habitat use and distribution.*
- ✓ *WGFD coordinates data collection with adjoining states.*
- ✓ *Local wildlife managers commonly work with their counterparts in adjacent states on many issues affecting mule deer management.*
- ✓ *WGFD entered into a "good neighbor" agreement to cooperatively manage interstate wildlife populations (Memorandum of Agreement on the Management of the Multi-state Wildlife Resources in Boundary Habitats of Colorado, Idaho, Montana, Utah and Wyoming).*

Objective: Assess the effect of hunting on the various age and sex classes of mule deer.

Strategy: Determine age and sex-specific mortality rates during hunting seasons.

Strategy: Compare data obtained from harvest field checks and the harvest survey to determine prevalence of age or sex reporting biases in the harvest survey and to estimate their importance.

What's been done:

- ✓ *WGFD collects incisors from hunter-harvested mule deer to determine age structure of antlered and/or antlerless mule deer harvested in selected herd units.*
- ✓ *Mortality surveys are done each spring in western Wyoming to gauge overwinter mortality of mule deer and collect incisors to determine age structure of winter mortality.*

Predator Management

Ballard et al. (2001) wrote a synthesis of research on deer-predator relationships, which formed the basis for deer-predator relationships in "Mule Deer Conservation: Issues and Management Stategies" (deVos et al. 2003), and the context for the discussion on predation in the "North American Mule Deer Conservation Plan" (Mule Deer Working Group 2004). Hurley et al. (2011) published a comprehensive evaluation of mule deer population response to coyote and mountain lion control efforts in Idaho. These publications were instrumental in synthesizing this Predator Management section of the WMDI.

Mule deer are preyed upon by many predators including coyotes, mountain lions, wolves, bobcats, bears, and eagles among others. However, relationships between predator and prey populations are complex and dynamic. The extent to which predators affect mule deer populations varies to a large degree depending on the size of a mule deer population in relation to the habitat's carrying capacity. Mule deer are also impacted by such variables as change in habitat quality and quantity, weather patterns (prolonged drought or severe winters), competition with other ungulates, species and densities of predators, effects of hunting season strategies, and abundance of alternate prey. Managers must take all these factors into consideration when determining whether a mule deer population is likely to respond to predator management, and in prescribing effective predator management strategies.

Predator management may or may not increase a mule deer population. For example, a mule deer population near the habitat's carrying capacity will not respond, in a sustainable manner, to predator management. Habitat carrying capacity is difficult to assess and varies season to season and year to year. However, several indices may indirectly indicate when carrying capacity has been exceeded. For example, adults in poor body condition, low birth rates, low fawn production, high utilization of available forage, and high population densities are all indicative of a mule deer population that has surpassed the capacity of the habitat to support further growth. In these circumstances, management to reduce predation on mule deer is neither desirable nor effective.

A mule deer population that is chronically depressed may respond to predator management when fawn production and adult mule deer body condition are good, but recruitment and adult survival are low in otherwise favorable habitat (i.e., a "predation sink") (Jenks 2011). To be effective, control actions must target the predator species limiting the mule deer population, and must be both sufficient and sustained. Hurley et al. (2011) demonstrated decreasing mountain lion populations resulted in increased doe:fawn ratios, adult doe survival, and a slight increase in the mule deer population, but only temporarily. They also found that although a reduction in coyotes increased fawn survival through summer, fawn recruitment into the population was not increased. Hurley et al. (2011) concluded neither mountain lion nor coyote reductions altered a mule deer population's overall trajectory. Similarly, Pierce (2012) concluded mountain lion reductions did not change mule deer

population trend. Under specific circumstances, a reduction of predator populations may be warranted to attain management goals within an individual herd unit. However, it is imperative to assess whether predator reduction is attaining the desired ungulate population response in each situation.

It has been shown predator management may be beneficial to mule deer when:

1. Predation is a documented factor limiting growth of a mule deer population;
2. The mule deer population is well below the habitat's carrying capacity;
3. Populations of alternate prey species (for example rodents and rabbits) are at low levels;
4. Management actions target the predator species actually limiting the population;
5. Management efforts can realize a sufficient reduction in predator densities to yield results;
6. Predator management is conducted at a time of year when it is most effective;
7. Predator management is focused in small areas of important mule deer habitat; and
8. Management efforts can be sustained over several years to keep the predator population sufficiently in check.

The Wyoming Animal Damage Management Program created by the Wyoming Legislature in 1999 is administered by a 15 member Animal Damage Management Board (ADMB). The ADMB was established for the purpose of mitigating damage caused to livestock, wildlife and crops by predatory animals, predacious birds and depredating animals or for the protection of human health and safety. The ADMB distributes revenues to fund county Predator Management Districts and approved projects that implement predator management strategies in conformance with the ADMB's mission.

Commission Policy VIIR (September 8, 2006) stipulates predator (coyote) control may be considered to increase mule deer recruitment and/or survival if post-hunting season fawn:doe ratios are less than 65:100, or after sudden population losses (winter die-off) greater than 25%. Control actions may also be considered when productivity and fawn survival data are not available, and the population is more than 15% below the objective level. The need for predator management should be objectively evaluated and should consider whether mule deer productivity and population trends are being affected by natural factors other than predation.

The strategies outlined below are intended to address situations in which predators, including trophy game animals, may be having a significant impact on mule deer. Trophy game animals (mountain lions and black bears) are managed under separate plans approved by the Wyoming Game and Fish Commission. If predation by trophy game animals is documented to have a population level impact on mule deer, trophy game management objectives and hunting seasons can be reevaluated.

Objective: Implement predator management to maintain or increase mule deer populations when predation is determined the cause of a population decline or is suppressing population recovery.

Strategy: Predator management intended to increase mule deer recruitment and survival should be considered only if it is determined predation is suppressing population growth <u>and</u> if habitat conditions are sufficient to support a higher mule deer population.

Strategy: In herds that are below carrying capacity, identify important parturition areas for mule deer. Annually direct Wildlife Services and county Predator Management Districts to focus coyote control actions from February through July within those areas.

Strategy: If herds are depressed below objective and the habitat's carrying capacity, and if predation is the primary factor limiting population growth (i.e., fawn production and adult mule deer body condition are good but fawn recruitment and adult survival is low), undertake actions to reduce predator or trophy game populations.

Strategy: Predator management is not recommended to support additional growth of any mule deer herd that is over the Commission's approved population objective, or within any hunt area that is over the desired population level.

Strategy: Predator management is not recommended in areas with chronic damage caused by mule deer.

Strategy: Predator management is not recommended in areas where WGFD has limited opportunity to control the mule deer population through hunting.

<u>What's been done:</u>

- ✓ *The Wyoming Game and Fish Commission contributes $100,000 annually to the Animal Damage Management Board for predator control in areas where predation is thought to limit the desired size of wildlife populations. In recent years coyote control, primarily through aerial gunning, fumigating dens, and trapping, has been undertaken in areas of exceptionally depressed fawn recruitment. As a general rule, habitat conditions rather than predation limit fawn survival. In light of this reality, WGFD has not undertaken broad scale predator control. To make the most effective use of available funding, WGFD focuses control actions in localized areas where actions may have some beneficial effect.*
- ✓ *Mountain lion management throughout most of the state is driven by public perception and by increasing lion densities. Harvest mortality limits have been liberalized in most lion hunt areas over the past 15 years. In most situations it is*

unclear if the higher lion harvests have actually decreased predation on mule deer or whether mule deer populations have responded. WGFD is currently evaluating relationships between increased harvest of mountain lions and mule deer populations in many areas of the state. Increased surveillance and possibly more detailed studies will be necessary to understand the relationship between lion harvest and mule deer population response. Lion harvest quotas have been increased specifically to address depressed mule deer numbers in hunt areas such as the Black Hills and Platte Valley.

- ✓ *In response to public concerns about mule deer populations in the Wyoming Range, black bear mortality limits in the Greys River hunt areas were increased significantly for the 2014 – 2016 harvest cycle. The increase coincides with an ongoing study of mule deer neonate mortality beginning in the spring of 2015. The study will provide invaluable information regarding effects of black bear predation on mule deer.*
- ✓ *WGFD has coordinated with the Coop Unit to conduct research addressing mule deer habitat, nutrition, productivity, and survival in the Wyoming Range. Results documenting cause-specific mortality of ungulates will greatly enhance our knowledge of the potential impacts of predation on herds of interest.*

Objective: Maintain a dialogue and ongoing information exchange between WGFD, the ADMB, county Predator Management Districts, and the public with regard to predator management issues.

Strategy: Coordinate with the ADMB and county Predator Management Districts to implement predator management where appropriate and in accordance with Wyoming Game and Fish Commission Policy VIIR.

Strategy: Disseminate information through public forums, reports, research findings, and peer-reviewed publications to explain and support WGFD's decisions and actions regarding predator management strategies.

Strategy: Clearly convey the Commission's rationale for its Policy on Predatory Animal and Predacious Bird Management Recommendations for the Benefit of Wildlife.

What's been done:

- ✓ *Through legislative appropriation to the ADMB, money has been made available to qualifying predator management districts for the purpose of addressing predatory animal impacts to wildlife including mule deer. WGFD coordinates with the ADMB and Predator Management Districts to guide their predator management efforts to maximize benefits for mule deer.*
- ✓ *WGFD has coordinated with the ADMB regarding projects to assess population dynamics and identify seasonal ranges in several herd units.*

Objective: Address gaps in our understanding of the interactions between mule deer, other ungulates, and predators.

Strategy: Conduct research to determine if predation is limiting mule deer populations under differing environmental and ecological conditions. Studies should include herds exhibiting a range of vital rates (i.e., fawn recruitment and mortality rates) and occupying different habitat types to determine if predator control is an appropriate and effective management tool. Effects of climatic factors, habitat quality, and competition should also be considered.

Strategy: Evaluate the effectiveness of predator control actions for increasing recruitment and survival, taking into account environmental influences on fawn ratios and populations.

What's been done:

- ✓ *WGFD has coordinated with the Coop Unit to conduct research projects addressing mule deer habitat, nutrition, productivity, and survival in the Wyoming Range and South Rock Springs herd units. Results documenting cause-specific mortality of ungulates will greatly enhance our knowledge of the potential impacts of predation on herds of interest.*

Diseases

Diseases serve essential functions in the ecology of all wildlife. Disease is one factor that can naturally regulate mule deer populations and assure the fittest animals survive. The ultimate influence on a population depends on a variety of factors related to the host (mule deer), the specific pathogen, and other environmental factors. Host factors can include population density, age structure, overall health status, degree of interchange between herds, and level of immunity a herd has to the pathogen. Disease factors include; the specific pathogen and how virulent it is, mode of transmission, and abundance of vectors. Important environmental factors influencing susceptibility to diseases can include habitat condition, various nutritional aspects, distribution of water sources, and stressors such as drought and extreme cold or snow.

In general, most diseases of mule deer are thought to have little long-term impact on populations. The exception may be Chronic Wasting Disease (CWD) where negative population-level impacts could manifest in cases of high prevalence. The true impact of most wildlife diseases on mule deer populations can be difficult to determine because diseased mule deer are not easily detected unless they die in large numbers or in areas where the carcasses are easily observed. Sick animals tend to seek seclusion, are more prone to predation, and are eaten by scavengers or decompose rapidly after death. Some of the more important diseases affecting mule deer populations in Wyoming are described below.

Epizootic Hemorrhagic Disease (EHD) and bluetongue are closely related viral diseases that can cause periodic large-scale die-offs. Significant die-offs are cyclical and populations usually recover rapidly. Arthropod vectors, particularly biting midges in the genus *Culicoides*, transmit both diseases. The two diseases produce indistinguishable symptoms in deer and pronghorn. Outbreaks typically happen in late summer or early fall when arthropod vectors are most abundant and tend to occur in 4-7 year cycles with smaller disease events in between. Outbreaks are most severe in wet years when the first frost is delayed, and in dry years when animals concentrate around stagnant water sources. These conditions enable biting midges to become more prevalent and live later into the fall. There are multiple strains of the virus, and two forms of the disease. The acute form kills or sickens large numbers of deer over a comparatively short period. Symptoms include edema (swollen tissues) and hemorrhages throughout the body. Infected deer are commonly found sick or dead at water sources, often exhibiting respiratory distress, excessive salivation or drooling, loss of awareness of their surroundings, and sometimes swollen tongues or eyelids. The chronic form does not result in large-scale die-offs; however, emaciated deer with lesions in their mouths, rumen, and on their hoofs are found (or sometimes shot) during hunting season. A confirmed diagnosis requires laboratory analysis of tissue samples to identify the virus.

Adenovirus Hemorrhagic Disease (AHD) is another viral hemorrhagic disease often grouped with EHD and blue tongue. There are a variety of adenoviruses that can infect different species, both wild and domestic. AHD of deer, caused by *Odocoileus* adenovirus (OdAdV),

was first discovered when it caused the death of over 1,000 black-tailed deer in central and northern California in 1993. Unlike EHD and blue tongue, AHD can be spread through direct contact with bodily fluids (saliva, feces, urine). Transmission through airborne routes, contaminated water, and contaminated equipment may also occur. As a result, an increase in adenovirus cases can happen when deer are densely concentrated such as on winter range or if they are artificially fed. Adenovirus can manifest in both an acute systemic form and a chronic localized form. Acute clinical signs of AHD include difficulty breathing, foaming/drooling from the mouth, diarrhea (sometimes bloody), and seizures. This disease course is often rapid and fatal. Chronic signs include ulcers and abscesses in the mouth/throat, which can eventually lead to weight loss and death. Fawns are more susceptible and experience higher mortality than adults. This disease was first documented in Wyoming in 1999. Since the initial discovery, the Wildlife Health Laboratory documented a few cases most years, with a spike in 2015. Little is known about the larger scale impact of AHD on deer populations; however, AHD has been known to cause small-scale localized losses in some areas of Wyoming.

Chronic wasting disease is a fatal disease caused by an abnormal protein, called a prion. All members of the deer family in Wyoming (mule deer, white-tailed deer, elk, and moose) are susceptible, but it is most prevalent in mule deer and white-tailed deer. CWD affects the central nervous system, eventually leading to abnormal behavior, weight loss or emaciation, excessive salivation, droopy ears, hair-loss, and ultimately death in all infected animals. Deer can be infected by chronic wasting disease for months to years before demonstrating any noticeable clinical signs of disease. Deer in the end stage of disease are often found near water sources and are usually unaware of their surroundings, leaving them more susceptible to predation and vehicle collision. CWD has been present at least four decades in southeast Wyoming and continues to slowly spread northwest across the State There is currently no vaccine or treatment for CWD; however, research has identified polymorphisms in the prion protein gene that result in a slower disease progression (Jewell et al. 2005). Deer with these select genetics may be infected at the same rate as others, but can live longer before succumbing to clinical CWD. The increased survival times infer some potential for long-term genetic selection that may reduce the population-level impact of CWD infection. However, the implications of this phenomenon are unknown as animals that live longer with CWD may also shed greater volumes of infectious prion over their lifespan. The disease remains ultimately fatal to all cervid species once infected and recent research and theoretical modeling have suggested endemic CWD at high prevalence levels may have population-level impacts in mule deer (DeVivo 2015, Miller 2008). CWD-related surveillance, research and management actions are directed by the Department's CWD Management Plan, which was revised in April 2016 and formally adopted by the Wyoming Game and Fish Commission (WGFD 2016).

Pinkeye (keratoconjunctivitis) is an inflammation of the conjunctiva and cornea of one or both eyes. Symptoms include reddened, swollen eyes or eyelids, often with mucoid or pus-like discharge, and sometimes cloudiness of the cornea. Pinkeye is fairly common, often recurs in the same locations winter after winter, and can be caused by numerous different

bacteria and viruses. This disease tends to be more prevalent in bucks and in areas of high deer concentration. One potential cause of pinkeye that warrants special mention is plague or infection with the bacterium *Yersinia pestis*, which has been identified in a few cases over the past several years. In most of these cases, the deer also had plague bacteria in other tissues (lung, liver, and lymph nodes) and were very sick or dead when found. This type of pinkeye poses a serious risk to human health and appropriate precautions should be taken to prevent infection from handling sick or dead deer. The impact of pinkeye at the population level is unknown, but over the past decade, multiple mule deer mortalities have been documented in various locations around the state.

Exotic chewing lice (*Bovicola tibialis, Damalina (Cervicola*) sp.) have been identified in mule deer from several locations across Wyoming. These old world lice of European and Asian deer were likely introduced through translocation of these deer into North America. *Bovicola tibialis* was first discovered in Carbon County in 2009, and has since been detected in many areas across the state. Exotic chewing lice have significantly affected deer in Washington and Oregon. The lice cause a hypersensitivity reaction resulting in excessive grooming and skin irritation leading to significant hair loss. The impact of these lice to Wyoming mule deer populations is unknown; however, they have been implicated as a contributing factor to mule deer declines in Washington State. Surveillance for exotic chewing lice should continue in Wyoming to the extent feasible.

Mule deer co-evolved with many endemic diseases that are generally not considered a substantial threat at the population level. The exception may be chronic wasting disease. The threat of introducing new diseases also has serious implications. As game ranching, private ownership, transportation and trade of wildlife continue to grow around the world, new and emerging diseases potentially pose significant jeopardy to mule deer and other wildlife. Adequate enforcement of current regulations controlling the transportation and importation of deer and elk carcasses is critically important to reduce risk of disease transmission into new areas. Feeding mule deer also poses a particular risk, as it artificially concentrates animals and elevates risk of disease transmission. Our priorities should include effective surveillance as well as support for research to fully understand how disease influences populations and how to manage disease incidence and distribution.

Objective: Monitor the distribution and effects of known diseases affecting mule deer (i.e., CWD, EHD, Adenovirus, exotic lice).

Strategy: Continue to monitor and manage CWD in accordance with WGFD's CWD plan.

What's been done:

- ✓ *WGFD revised the Chronic Wasting Disease Management Plan, which was formally adopted by the Wyoming Game and Fish Commission in April 2016.*

Refer to this plan for specific information regarding the Department efforts related to disease management, applied research, public information and funding.

- ✓ *WGFD has sampled and tested ~57,000 deer, elk and moose from 1997 to 2016.*
- ✓ *WGFD maintains a GIS database depicting the distribution and prevalence of CWD positive deer.*

Strategy: Continue routine monitoring of other diseases and parasites, collect specimens and samples for analysis.

What's been done:

- ✓ *WGFD routinely collects tissue samples from deer that appear sick or are suspected to have died from disease. Samples are sent to the WGFD's Wildlife Health Laboratory for analysis. An extensive database on diseases in Wyoming wildlife is maintained by the laboratory.*
- ✓ *The WGFD Wildlife Health Laboratory maintains a serum and tissue bank from Wyoming wildlife species to facilitate research on wildlife diseases.*

Strategy: As appropriate, adjust hunting seasons in response to large-scale disease outbreaks and die-offs.

What's been done:

- ✓ *When WGFD becomes aware of large-scale mortality events, we consider adjusting hunting season frameworks in order to account for the loss of animals to disease and other factors.*

Strategy: Provide training to assist field personnel with disease identification, necropsy and tissue sampling, surveillance, and disease management.

What's been done:

- ✓ *WGFD provides appropriate training when specific needs arise to monitor diseases. For example, the collection and handling of tissue samples for CWD testing. Training has also been provided on brucellosis and EHD surveillance.*
- ✓ *WGFD provides periodic training on wildlife diseases and field necropsy techniques to agency personnel.*
- ✓ *WGFD has produced the following publications on identification and pathology of wildlife diseases in Wyoming:*

Kreeger, T.J., T. Cornish, T.E. Creekmore, W.H. Edwards, and C. Tate. 2011. Field Guide to Diseases of Wyoming Wildlife. Wyoming Game and Fish Department, Cheyenne. 218pp.

Thorne, E.T., N. Kingston, W.R. Jolley, and R.C. Bergstrom (eds). 1982. Diseases of Wildlife in Wyoming. Wyoming Game and Fish Department, Cheyenne. 353pp.

- ✓ *WGFD has also provided personnel with copies of the following publication:*
  Friend, M., J. Christian, and E.A. Ciganovich (eds). 1999. Field Manual of Wildlife Diseases. U.S. Geological Survey Information and Technology Report 1999-001. Washington, D.C. 426pp.

Objective: Reduce the risk and incidence of non-endemic parasites and diseases.

Strategy: Regulate the import, export, and transportation of deer and elk carcasses from known CWD areas.

What's been done:

- ✓ *The Commission adopted regulations restricting transportation of big game carcasses within and from known CWD areas both inside and outside Wyoming.*

Strategy: Regulate wildlife transportation and prohibit game ranching

What's been done:

- ✓ *Transportation and possession of wildlife are strictly regulated under Chapter 10 of the Wyoming Game and Fish Commission's regulations.*
- ✓ *Private ownership of big game has been prohibited in Wyoming since 1973. Game ranching is also prohibited. WGFD will steadfastly oppose efforts to legalize game ranching due to the grave and irreversible risks to the State's native wildlife.*

Strategy: Discourage feeding of mule deer.

What's been done:

- ✓ *WGFD has published several popular articles and press releases informing the public about the problems and disease risks created by feeding big game. These articles are periodically re-released.*
- ✓ *A discussion of the circumstances under which feeding or baiting big game may be considered, as well as the risks associated with feeding, has been included in this Mule Deer Initiative (next section).*

Strategy: Manage mule deer populations at healthy levels that can be sustained by existing habitat conditions.

What's been done:

- ✓ *WGFD strives to manage mule deer herds within established population objectives. The objectives account for the habitat's carrying capacity and are adjusted when necessary.*

Mule Deer Winter Feeding and Baiting

Over the past century, wildlife agencies in western North America have attempted to increase mule deer survival by providing supplemental feed during harsh winter conditions. Some western wildlife agencies continue this practice, primarily in response to pressure from well-meaning members of the public. Most agencies acknowledge the practice has little effect on mule deer survival. However agencies recognize feeding, especially during severe winters, fosters public support for the agency and for mule deer management. Recent efforts to feed mule deer in Colorado, Utah and Idaho reaffirmed feeding is a popular program with the public, but has limited nutritional benefit for mule deer.

The biology and ecology of the animals must be considered to ensure management actions achieve a net benefit. This is often a point of debate in decisions whether to initialize a winter feeding program. The collective experience of wildlife agencies throughout the West is clear – feeding mule deer is largely ineffective. The goal of winter feeding also opposes the fundamental processes by which populations are regulated within sustainable levels in natural systems. At best, winter feeding mule deer gives people who are truly concerned and compassionate about wildlife, a sense that something is being done to help starving deer. However, actual benefits are seldom realized.

Despite broad social appeal, winter feeding is simply not an effective tool to save deer from severe winter conditions and resulting mortality. Over the past several decades, this has been repeatedly demonstrated and re-affirmed. Peterson (2008) studied the efficacy of feeding mule deer during four winters in Utah, and also provided a comprehensive review of associated literature. Feeding mule deer high quality supplements resulted in a slight, though non-significant increase in annual survival of does (Peterson 2008:45). However, feeding did not decrease mortalities attributed to malnourishment during the most severe winters. Moreover, any increase in survival of fed deer was offset by mortality from other sources, including vehicle collisions. Mid-winter fawn recruitment rates of fed versus unfed does also did not differ statistically (Peterson 2008:30). Peterson cautioned that to have any benefit, winter feeding must be initialized before deer become nutritionally stressed. To ensure this, feeding would need to start earlier in winter, and instituted annually on a herd unit or statewide basis. This is economically infeasible. The prevailing practice among western wildlife agencies, of emergency feeding when deer are nutritionally stressed, is largely ineffective. Thus, winter feeding is an expensive and complex undertaking that produces marginal benefit and often negatively affects mule deer biology and behavior, resulting in long-term shifts in their habits, distribution, migration, and habitat use. Winter-feeding can also artificially concentrate animals at feeding sites, thereby providing ideal opportunities for transmission of diseases such as Chronic Wasting Disease (CWD) and adenovirus.

Mule deer, unlike elk, are highly selective foragers due in part to their specialized digestive system (Wallmo 1981, Mule Deer Working Group 2003). Mule deer have a complex digestive system that depends on bacteria to aid in food digestion. Specific bacterial flora is required to adequately digest specific types of food, and this bacterial composition must

adapt seasonally to changing availability of forage items. When a sudden change in diet occurs by artificial feeding, the bacteria in the rumen often cannot adapt quickly enough to allow proper digestion. As a consequence, fed mule deer often die with full stomachs (Mule Deer Working Group 2013). This situation is especially common when starving mule deer are fed alfalfa hay, corn, or other traditional livestock feeds.

Winter feeding can also cause mule deer to alter their natural behavior. Learned behaviors, such as foraging and migration, are critical to the long-term sustainability of a mule deer population. Any alteration of these behaviors stemming from winter-feeding can have prolonged consequences at the population level.

In summary, proponents and opponents of feeding mule deer are genuinely concerned about the species' welfare. However, even well designed and executed feeding programs do not significantly increase survival of mule deer. Long-term biological consequences need to be weighed. Winter feeding is not only ineffective, it may lead to increased disease transmission, habitat degradation, and long-term behavior alterations (Mule Deer Working Group 2003 and Mule Deer Working Group 2013). The primary consideration should be long-term sustainability of the mule deer population and not the effect of a single winter.

Objective: Maintain Wyoming's wild mule deer populations.

Strategy: WGFD will continue to assess winter feeding programs undertaken by other states' wildlife agencies, as well as further research on this topic. WGFD will make appropriate adjustments in its winter feeding decisions and practices based on new information.

Strategy: When overwinter survival is consistently below average, alternative management actions such as habitat improvements to increase population carrying capacity, or actions to reduce the deer population to a sustainable level, should be considered.

Objective: Mitigate short-term, site-specific problems or issues.

Strategy: Use formulated feed or rations to bait deer in appropriate circumstances and as a last resort when:

1. Winter conditions create extraordinary public safety concerns and deer mortality due to vehicle/deer collisions. Baiting may be appropriate in localized circumstances to lure mule deer away from roadways and railroads or urban areas to decrease mule deer mortality and address public safety.

2. Winter conditions concentrate mule deer in areas where they cause extraordinary agricultural damage and traditional preventive measures are ineffective or impractical. When deciding whether or not to bait, the cost of baiting relative to

the cost of the damage shall be considered. This analysis shall address manpower, equipment, damage prevention materials, and actual damage compensation.

Strategy: Use formulated feed or rations to mitigate unforeseen short-term emergencies (e.g. unusual weather/snow conditions temporarily strand groups of deer away from winter range). This short-term feeding should only provide food for deer until conditions moderate and deer are able to reach suitable habitat.

Strategy: Prior to feeding or baiting, WGFD regions will submit a written proposal and justification to the Wildlife Division Chief. The decision to feed or bait will be made by the Division Chief in consultation with the Director. The proposal and justification will include:

1. A statement of purpose that describes the need and intended outcome of the baiting operation.
2. The estimated number of mule deer (and other ungulates) to be fed/baited.
3. The estimated duration of feeding/baiting.
4. The estimated cost.
5. The number of Department or other agency personnel, volunteers and equipment (i.e., snow machines, ATVs, 4-wheel drive pickups, etc.) needed.
6. The type and availability of feed to be used.
7. The level of coordination that needs to take place with other agencies and organizations (i.e. NGOs).
8. A map(s) showing the land status and locations where the feeding/baiting operation will likely occur.
9. If baiting on private land, approval from the landowner or his agent.
10. A monitoring plan to determine when baiting shall continue or cease.
11. An evaluation of the efficacy of the baiting operation upon conclusion.
12. A description of planned outreach efforts to inform the public.
13. An assessment of the impacts to habitats and migration behavior.
14. An assessment of the threat of CWD and other diseases shall include whether the proposed feeding/baiting sites are within the known or adjacent distribution of any deer or elk populations where CWD has been detected or other diseases are of concern. Any feeding/baiting operation will follow the Department's CWD Management Plan (WGFD 2016).

Any action to feed or bait mule deer or other ungulates for the reasons described in this document is not intended to violate or conflict with W.S. 23-1-302, W.S. 23-3-304 and the Commission's Regulation Governing Baiting of Big Game Animals (Chapter 63).

Law Enforcement

Wildlife laws and regulations serve three fundamental purposes: 1) protect the resource; 2) protect the public; and 3) assure equitable opportunity to enjoy the resource. A strong majority of the hunting and non-hunting publics support effective wildlife laws that are firmly and fairly enforced. Due to the rapid evolution of outdoor technology, increasing numbers of users, and increasing trophy values, wildlife law enforcement remains as important today as it was during early years of the conservation movement.

Several important functions of law enforcement related to mule deer management and conservation include:

1) Maintain an effective system of mule deer management. Perhaps the most important role of law enforcement is to secure our ability to regulate harvest within prescribed biological and social limits. The institution of law enforcement and its field presence assure the majority of hunters comply with statutes and regulations designed to manage harvests within sustainable levels.
2) Detect and reduce illegal harvest of mule deer. Mule deer are especially vulnerable during the rut and in winter when they congregate on traditional wintering areas. While illegal hunting impacts both does and bucks of all age classes it generally targets mature bucks and removes genetically superior animals from the population. This loss can impact the quality of bucks in future generations of mule deer. Significant illegal activity could reduce the number and quality of bucks available for harvest by law-abiding sportsmen in subsequent years.
3) Enforce laws and regulations on Commission-owned and State lands to minimize disturbances to mule deer. Coordinate with federal land management agencies to regulate and enforce off-road vehicle (ORV) use and recreational activity within sensitive habitats (e.g. crucial winter ranges). Mule deer are negatively impacted by heavy ORV use and high levels of dispersed recreation on winter ranges. Impacts can include added stress to mule deer and displacement from preferred habitats, resource damage, and illegal access to designated wilderness areas or to areas seasonally closed to recreational activity to protect wildlife and other resources. Many hunters are concerned about the problems ORV abuse cause and increasingly urging WGFD to establish and enforce ORV travel restrictions during deer hunting seasons.
4) Enhance public support and recognition of wildlife laws. Support for WGFD originates at the local level. Through their contacts and presence in local communities, enforcement personnel foster greater understanding of wildlife laws and the public's support in enforcing them.
5) Regulate possession and transportation of wildlife to avoid or limit disease transmission and potential for hybridization with native wildlife. WGFD also regulates disposal of harvested deer and elk from CWD areas.

Objective: Increase compliance with wildlife laws designed to protect mule deer populations and habitats.

Strategy: Work with federal land management agencies to enforce travel management and seasonal closures on federal lands.

Strategy: Enforce laws and regulations on Commission-owned and State lands.

Strategy: Make educational materials, including ORV rules and regulations, more accessible to the public via brochure dissemination and on the WGFD website.

What's been done:

- ✓ *WGFD enforces travel management rules and seasonal closures on Commission-owned lands to minimize disturbances to mule deer.*
- ✓ *On some USFS and BLM lands, WGFD has entered cooperative agreements closing important winter ranges to human and vehicular access.*
- ✓ *Through periodic consultation and coordination, WGFD encourages the USFS and BLM to implement travel management plans and increase enforcement of existing travel restrictions on public lands.*
- ✓ *WGFD has entered into a memorandum of understanding with the State Land Board, enabling WGFD to enforce restrictions on off-road travel, camping, and fires on all State lands, and antler hunting on State lands west of the Continental Divide (per state statute and regulation).*

Strategy: Implement programs to protect mule deer when they are most vulnerable to harassment and illegal take, especially on winter ranges. Publicize high profile enforcement cases that are successfully prosecuted.

What's been done:

- ✓ *WGFD has implemented travel and access management plans, road closures, winter range closures, and motorized travel limitations on Commission owned lands. We encourage federal agencies to institute similar closures and restrictions within important habitats on federal lands to protect mule deer during critical times of year.*
- ✓ *WGFD worked with the Legislature to promulgate a law regulating the collection of shed antlers on all public lands west of the Continental Divide.*
- ✓ *The **Stop Poaching** program is a joint effort between WGFD and the Wyoming Wildlife Protectors' Association. The program pays a reward to persons who report information leading to the arrest and conviction of wildlife violators. The **Stop Poaching** enhancement program procures billboards, hats, knives, bumper stickers, calendars and brochures used to inform the public. A **Stop Poaching** slide show is presented at hunter safety classes to illustrate the cost of ignoring poaching activities. "Wildlife Crime: Stories from Wyoming's wildlife officers" was published in 2013 and is a sought after publication depicting true life*

accounts from the files of game wardens and wildlife investigators statewide. The series, based on investigations and prosecutions of resource abusers, encourages the public to support wildlife law enforcement and assist WGFD through the ***Stop Poaching*** *program.*

- ✓ *WGFD developed a computerized licensing system to more easily detect license fraud. This system is used frequently within Wyoming and is shared with investigators from other states.*

Strategy: Conduct and improve operations to apprehend poachers and continue to develop more sophisticated enforcement technologies.

Strategy: Maintain a sufficient enforcement presence to attain a high level of compliance with wildlife laws and to deter illegal activity.

What's been done:

- ✓ *WGFD utilizes task forces to detect poaching activities. Officers from warden districts around the state are assembled to serve on these task forces. Although catching violators often requires substantial time in the field, the public strongly supports these types of operations because they resolve high profile cases involving illegal take of trophy mule deer. Perhaps the greatest benefit is the publicity value, which serves as a strong deterrent to others who may contemplate similar crimes.*
- ✓ *WGFD's Forensics and Fish Health Laboratory at the University of Wyoming analyzes forensic evidence such as hair, blood, bone, feathers, meat, tracks, saw marks, ballistics, or photographs. This essential service assists WGFD in resolving many wildlife crimes each year. One noteworthy development in recent years is the use of DNA evidence to link the perpetrator to a crime scene. Wildlife forensic science pioneered the application of DNA technology for this purpose.*
- ✓ *WGFD created a Wildlife Investigative Unit in 1996. These officers primarily focus on complex and long-term investigations. They assist regional wardens by taking on more time-consuming, in-depth investigations necessary to successfully prosecute cases involving multiple offenders, illegal commercial activities, multiple jurisdictions, or other complex circumstances.*
- ✓ *The Investigative Unit coordinates with USFWS to address interstate movement of illegally taken wildlife including mule deer.*

Strategy: Work with the public, prosecutors, judges, and legislators to build support for adequate fines and penalties and for stronger laws to provide an effective deterrent.

What's been done:

- ✓ *The Wyoming legislature promulgated a law commonly known as the "winter range statute." This law substantially increased the penalties for illegal take of antlered or horned big game animals without a proper license or during a closed*

season. Those found in violation may be fined up to $10,000, imprisoned up to one year, or both.

- ✓ *A forfeiture statute was also promulgated enabling the court to seize devices and equipment including firearms, ammunition, traps, snares, vessels, motorized vehicles, and aircraft used in cases prosecuted under the winter range statute.*
- ✓ *Wyoming statute was amended to make it illegal for anyone to possess wildlife taken illegally in another state, as well as to possess any part from a big game animal that was allowed to needlessly go to waste.*
- ✓ *Wyoming statutes grant the Commission authority to establish by rule and regulation restitution values of wildlife, which the courts consider in assessing fines and penalties. The restitution value of a mule deer is currently $4,000.*
- ✓ *The legislature promulgated a statute allowing wildlife officers to deploy decoys that simulate wildlife and to charge persons who attempt to take simulated wildlife in violation of game and fish laws. Mule deer decoys are frequently used to detect violations such as shooting from a road, hunting without the proper license, hunting in the wrong area, and hunting in closed areas.*
- ✓ *Wyoming, along with 47 other states, is a member of the Wildlife Violator Compact. Signatory states recognize and enforce court-ordered revocations of hunting, fishing and trapping privileges regardless which member state prosecuted the violation(s).*

Weather

Weather events and long-term climatic trends can affect mule deer both directly and indirectly. During severe winters, deep or crusted snow restricts mule deer movements and access to forage. Exceptionally cold weather also increases metabolic stress. Drought compromises the ability of mule deer to recover or maintain satisfactory body condition. Drought preceding a severe winter exacerbates the negative effect of adverse weather. These conditions can exhaust fat reserves, leading to malnutrition and higher mortality. Fawns are especially vulnerable to high mortality rates in winter and adults can be susceptible when they are in poor condition. In addition, fawn survival is often lower following a severe winter because nutritionally stressed does give birth to fawns in poor condition and have a reduced ability to provide adequate nutrition (milk) for newborns. Some exceptional winters are so severe that significant mortality will occur regardless of the condition of mule deer or their habitat.

Seasonal precipitation patterns strongly influence the quantity and quality of forage available to mule deer, which in turn affects the overall health and productivity of a herd. Precipitation received during April, May and June directly influences shrub annual leader production and overall forage quantity on many winter ranges. During years of favorable moisture, forage quantity and quality improve. Under these conditions, mule deer are able to recover more quickly from the prior winter and accumulate ample fat reserves through the summer and fall. Mule deer in good quality habitat typically have higher reproductive and survival rates, and their fawns grow more quickly. Does also tend to bear twins and produce sufficient milk to raise healthy fawns that are less susceptible to predation and disease. Fawns that grow to a larger size by fall also have a better chance of surviving their first winter.

Mule deer have adapted to a variety of rangeland, forest, and agricultural environments ranging from low to high elevations and southerly to northerly latitudes, including regions heavily modified by land use changes. The effects of weather and climate can vary markedly among these environments. For example, drought tends to have a more pronounced impact on mule deer inhabiting rangelands and agricultural regions at lower elevations. On the other hand, severe winters can be a more significant factor in mountainous environments where mule deer have more dependable access to succulent forage in the summer, but are exposed to harsher winter conditions.

We have an incomplete understanding how mule deer populations are affected by the complex interactions among weather, habitat and other environmental factors. The number of mule deer that die during winter can be influenced by their nutritional status in the fall, the sequence and timing of winter storms, depth and duration of snow cover, crust formation, duration of cold temperatures, and quality of forage on winter ranges. Impact of weather can be modified by combinations of these environmental conditions. For example, mule deer in good nutritional status at the beginning of the winter can withstand more severe conditions, whereas mule deer in poor health during a drought may succumb even in a mild or normal

winter. It is important to develop a better understanding of weather-related effects in order to improve how we manage mule deer and their habitat.

Global climate change will potentially have a much longer-term effect on mule deer and their habitats (deVos and McKinney 2007). Warmer temperatures may result in a northward shift of the ranges of plant and animal species, reduced plant vigor and productivity, changes in plant community composition, and increased prevalence of invasive plant species. These factors could ultimately affect mule deer distribution, density and productivity in Wyoming. Sustaining Wyoming's mule deer herds within the capacity of habitat that is less productive and more limited in availability would require managing populations at lower levels.

Changing climatic trends can be assessed using tools such as the Palmer Hydrologic Drought Severity Index (PHDSI), which measures the long-term cumulative effect of drought. Drought has been common in Wyoming since the mid-1980's, and especially since 2000 when a much more severe and longer duration drought persisted (Fig. 2). The past 15 years in particular correspond to notable decreases in mule deer populations and fawn ratios. While the PHDSI well illustrates the long-term trend toward increasingly frequent and severe drought on a statewide scale, other indices such as the Palmer "Z-Index" or the Palmer Drought Severity Index (PDSI) are likely better suited for evaluating shorter-term response in habitat conditions on a local scale.

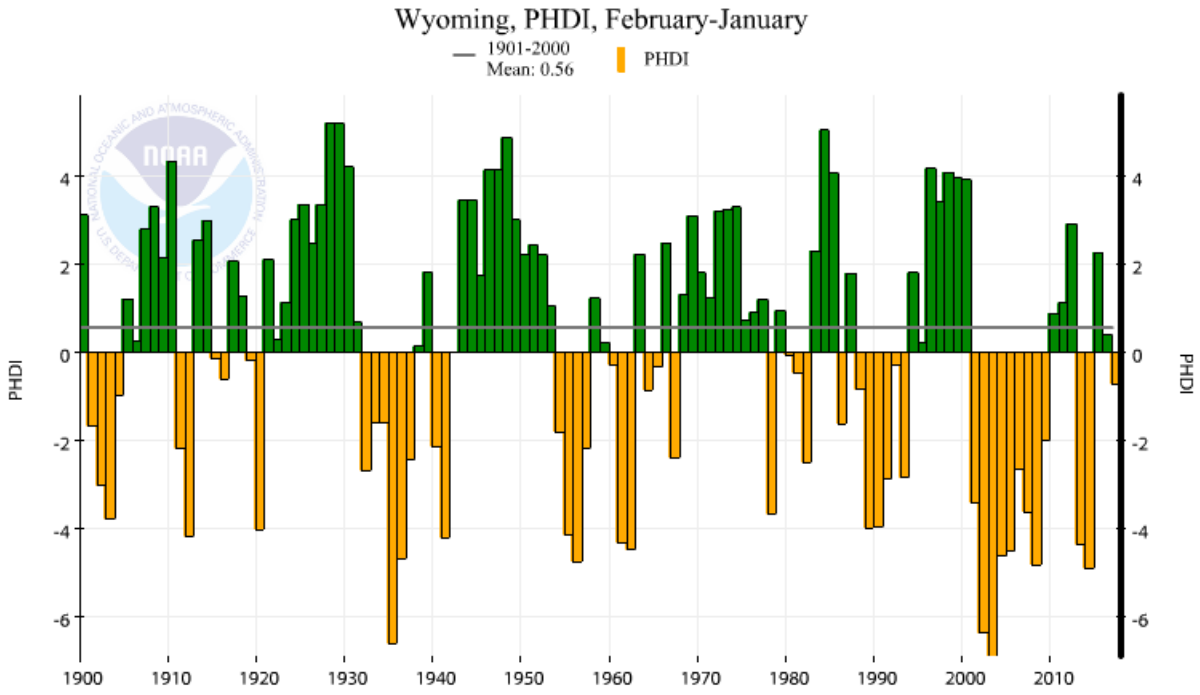

Fig. 2. Wyoming Palmer Hydrologic Drought Severity Index, 1895-2016 (source NOAA - http://www.ncdc.noaa.gov/cag/time-series/us/48/0/phdi/12/1/1900-2016?base_prd=true&firstbaseyear=1901&lastbaseyear=2000)

Objective: Improve methods used to estimate winter survival of mule deer.

Strategy: Analyze available data on climatic trends within mule deer ranges.

Strategy: Study the relationships among seasonal precipitation, forage availability and quality, and trends of mule deer populations.

What's been done:

- ✓ *WGFD incorporates annual survival data into population models where applicable.*
- ✓ *WGFD will continue to analyze weather data in relation to shrub production measured on established transects and will correlate these data with mule deer survival.*
- ✓ *Field personnel are directed to utilize PRISM weather data in concert with Rapid Habitat Assessment data within WMDI key herds.*
- ✓ *WGFD consults available weather data to better plan and implement prescriptive habitat treatments.*
- ✓ *WGFD conducts mortality surveys and change in ratio surveys in selected herds each spring to document the magnitude of overwinter mortality and the age and sex composition of animals that died.*

Objective: Implement management practices that moderate the extent to which mule deer may be adversely impacted by weather.

Strategy: Enhance summer and transitional habitats to improve body condition of mule deer entering the winter.

Strategy: Maintain habitat connectivity and migration corridors to ensure mule deer have unimpeded access to important seasonal habitats.

Strategy: Maintain mule deer herds within the habitat's carrying capacity and maintain habitats in optimal condition. Restore and improve habitats that are in suboptimal condition.

What's been done:

- ✓ *WGFD has developed technical definitions of "migration corridor," "stopover site," and "migration bottleneck."*
- ✓ *WGFD has identified important migration corridors, stopover sites and migration bottlenecks, and advocates for their protection.*
- ✓ *WGFD has implemented numerous habitat treatment and improvement projects that enable mule deer to better cope with weather extremes.*

- ✓ *WGFD manages mule deer populations within established objectives to prevent habitat overuse, which in turn helps moderate the impact of unfavorable weather patterns.*
- ✓ *WGFD adaptively manages mule deer populations in response to climatic fluctuations and severe weather events.*

Elk and Deer Interactions

Mule deer, white-tailed deer and elk potentially compete for resources where the three species' ranges overlap. Elk are predominantly grazers (eating grasses and forbs) whereas mule deer and white-tailed deer are predominantly browsers (eating shrub leaves, stems and buds). However, diets of these species change seasonally and at times, they compete directly for the same food sources. For example, newly growing forbs and grasses are important to all three species in spring and early summer. During winter, elk browse on a variety of shrubs and willows that are also eaten by mule deer. In addition, these species may compete for space at certain times of year. The degree of competition and its impact to mule deer continue to be debated among biologists. Several aspects of this question are currently being examined:

1. Dietary overlap – Although these species may consume the same types of plants or occupy the same areas at specific times of year, this does not necessarily mean they are competing. Mule deer have a higher metabolic rate than elk and their internal system is smaller and less efficient. Thus, mule deer require higher quality forage than elk during critical periods. For example, elk can subsist on cured grasses, whereas mule deer generally cannot. The two species may also avoid direct competition through ecological mechanisms such as spatial or behavioral separation, or they may simply select different plants or plant parts. In some areas of overlap (e.g., riparian areas and associated habitats and crop lands), high numbers of white-tailed deer utilize the highest quality forage available before mule deer migrate from higher elevations. In spring, elk migrate to higher elevations sooner than mule deer and they can successfully forage in deeper snow. The actual degree of dietary overlap between mule deer and elk is generally thought to be limited; however, some researchers believe competition for food can have significant impacts in specific situations.

2. Effects of Development – Ranges occupied by mule deer are being physically altered and developed at unprecedented rates across the West. Energy extraction, range conversions, rural subdivisions, and other intensive land uses are displacing mule deer and elk from preferred habitats and altering their distribution and patterns of use. Mule deer may be more dependent on specific, traditional winter ranges and habitat conditions to survive. Elk and white-tailed deer, on the other hand, are more adaptable to change and are more capable of finding adequate habitat. While development and intensive land uses adversely affect all three species, mule deer may be impacted to the greatest degree.

3. Winter conditions – Elk are better adapted to survive in severe winter conditions. They are much larger and metabolically more efficient; they are more mobile and can forage successfully in deep snow; they can subsist on lower quality forage; and they can withstand more extreme temperatures over longer periods of time. Thus, elk populations are more likely than mule deer to remain at stable levels during sequences of normal to severe winters, especially as the suitability of winter habitats continues to be degraded by

human activities. Though white-tailed deer are similar in body size and metabolic rate, they are adapted to utilize a wider variety of habitats and forage types, enabling them to persist through severe conditions and changes in their environment. In contrast, most summer ranges are usually sufficiently large and diverse that elk and mule deer are able to disperse and find adequate conditions to meet their physiological needs.

4. Biological attributes – Several inherent characteristics of mule deer and elk populations may affect the outcome of competitive interactions between the species. Elk are longer lived and, although they produce fewer young, their survival rates are high. Elk populations are more stable and less affected by weather patterns. Elk in Wyoming also tend to occupy forested mountainous environments that are currently less impacted by development. In contrast, mule deer have shorter life spans. They produce significantly more offspring, but survival of mule deer fawns is substantially lower. Mule deer populations fluctuate to a much greater degree than elk populations. White-tailed deer populations also fluctuate to a large degree, as they have very high reproductive rates and are capable of rapid population growth and expansion when conditions are favorable. Recruitment and survival rates in particular can be extremely variable from year to year depending upon weather conditions and forage availability. Mule deer tend to occupy shrubland basins, foothills and forest edges, which are changing more rapidly as developments and subdivisions encroach. And, mule deer are much more sensitive and less adaptable to changing conditions than are elk or white-tailed deer. Although hybridization between mule deer and white-tailed deer does occur, it is very rare and is not considered a threat to mule deer (Heffelfinger 2000).

Researchers continue to study the extent and potential significance of competition between mule deer, elk and white-tailed deer. In recent decades, elk populations seem to have benefited from changing habitat conditions. Conversely, unfavorable changes in habitat have been the dominant cause of declining mule deer populations. What's less clear is whether competition with elk and white-tailed deer has been a contributing factor in mule deer declines. Mule deer have also declined in regions where there is little or no potential for competition with elk or white-tailed deer. WGFD considers the potential for competition between elk and deer in setting management objectives and in designing habitat improvement projects. However, additional research is needed to better understand whether competition has a significant impact on these species, and to identify specifically how, when, and where competition takes place. The following objectives address the potential impact of competition between mule deer, elk and white-tailed deer:

Objective: Integrate other species' habitat needs with those of mule deer when developing and implementing habitat management plans within mule deer habitats.

Strategy: Coordinate species management programs when developing habitat management plans that will be implemented in important mule deer habitats.

Strategy: Minimize the impacts other species' management plans may have on mule deer populations and habitat.

Objective: Minimize potential impacts competition with other wildlife may have on mule deer populations.

Strategy: Identify and prioritize mule deer herd units where elk or white-tailed deer populations may be negatively impacting mule deer numbers and distribution.

Strategy: Where significant competition by elk or white-tailed deer is documented or believed to impact mule deer, develop harvest management strategies to reduce negative interactions with mule deer.

What's been done:

- ✓ *Concerns about elk and mule deer interactions are discussed in "Mule Deer: Changing Landscapes, Changing Perspectives (MDWG 2003).*
- ✓ *WGFD attempts to manage mule deer, elk and white-tailed deer herds at or near population objectives to limit potential for competition.*
- ✓ *Elk and white-tailed deer hunting seasons have been liberalized over the past decade in an attempt to stabilize or decrease elk and white-tailed deer populations and to reduce populations that are over objective.*
- ✓ *Organizations including the Mule Deer Foundation, The Rocky Mountain Elk Foundation and The Wild Sheep Foundation have cooperatively purchased grazing AUMs (animal unit months) from willing sellers to reduce livestock stocking rates and to retire some key allotments that include important mule deer habitat.*
- ✓ *A cooperative endeavor among WGFD, the University of Wyoming. and the Muley Fanatics Foundation, the Deer Elk Ecology Research (D.E.E.R.) Project in southwest Wyoming isl assessnig mule deer and elk interactions.*
- ✓ *WGFD assisted with research to assess the effects of mule deer and white-tailed deer competition in Converse County (Sawyer and Lindzey 2000).*

Public Outreach and Collaboration

By any measure (social, cultural, economic, or ecological), mule deer are among the most valued of Wyoming's natural resources. To many, the species is emblematic of the open western landscape. Mule deer are also among the most popular big game species sought by resident and nonresident hunters alike. Historically, WGFD sold far more deer hunting licenses than licenses to hunt any other species. As a result, the sale of deer licenses brought more revenue to WGFD than was generated by any other species.

Managing mule deer entails a myriad of biological considerations. We also factor social expectations into our management strategies and decisions. Integrating social preferences with biological considerations is a foundational premise of the North American Model of Wildlife Conservation. The most effective management strategies are both consistent with the species' biology and supported by society.

It is often difficult to gauge social preferences because at any given time, managers are more likely to hear from constituents who are dissatisfied and want some aspect of management changed, whereas those who are satisfied with current management tend to be less vigorous in expressing their support. Some of the more common issues include: hunter densities; numbers of mule deer; numbers of bucks; availability of large bucks; harvest success; hunting access; habitat conditions; and excessive off-road vehicle use. To objectively evaluate our constituents' viewpoints on these and other issues, WGFD periodically conducts a survey of licensed deer hunters' attitudes and opinions toward deer management in Wyoming (Responsive Management 2006, 2012).

WGFD's public involvement program is focused on collaboration between managers and anyone interested in mule deer management. Collaborative Learning (CL) is the opportunity to share information among a diverse group of stakeholders. CL has been the WMDI's primary medium to increase public interaction and active participation. The CL process has been successful and is ongoing in the Wyoming Range and the Platte Valley where it has resulted in stakeholder buy-in and ownership of herd management plans and has given rise to other partnerships (i.e., the Platte Valley Habitat Partnership). CL is based on the following principles (Clements, 2007):

1. *Interdependent parties work together to affect the future of an issue of shared interests;*
2. *Improvement rather than solution is the goal;*
3. *The situation and progress rather than problem and conflict are the focus.*
4. *Learning and benefits are owned by all stakeholders. The creation, maintenance and progress of a collaborative learning process are collectively owned by WGFD and all stakeholders.*
5. *Concerns and interests rather than positions are emphasized.*
6. *Interrelated rather than linear thinking is emphasized.*

7. *Through shared learning and transparency, collaborative learning creates equal access to information, allowing solutions to emerge that otherwise could not.*

CL has been a positive experience for everyone involved whether supporter or critic. Everyone has the opportunity and expectation of actively participating and being heard. People with similar or opposing points of view learn from one another when they gather around a table and feel safe expressing their opinions, thoughts, and ideas. Often they begin to understand there is a lot of complexity in wildlife management. When we hear acknowledgement of that complexity from one another, our thinking becomes interrelated and less self-focused. This is powerful! In the end, this learning provides the capacity, or "social license" to effect change – or not.

Public participation through collaborative learning ensures all stakeholders obtain an understanding of the art and science of wildlife management. That includes the science and biology of mule deer and a better appreciation of diverse stakeholder expectations. Through CL and the WMDI, all biological and sociological data and information are brought to the table. Through the CL process we have successfully married the biological constraints or opportunities with society's expectations and desires.

WGFD has successfully applied CL to engage the public statewide in identified "key" mule deer herd units including: Wyoming Range, Sublette, Baggs, Platte Valley, Sheep Mountain, Bates Hole/Hat Six, Upper Powder River, Owl Creek/Meeteetse, South Wind River, and Sweetwater (Fig. 3). In addition to the extensive CL process instituted in the Wyoming Range and Platte Valley herd units, public engagement has included appointing local mule deer working groups (Baggs, Sheep Mountain, Bates Hole/Hat Six, and South Wind River/Sweetwater herd units) and conducting a series of public meetings in the Sublette, Upper Powder River and Owl Creek/Meeteetse herd units. In further support of these collaborative efforts, a recent Wildlife Management Institute audit of the WGFD concluded that "task forces" or focus groups are a more effective means than public meetings for gathering input from a cross-section of our constituents.

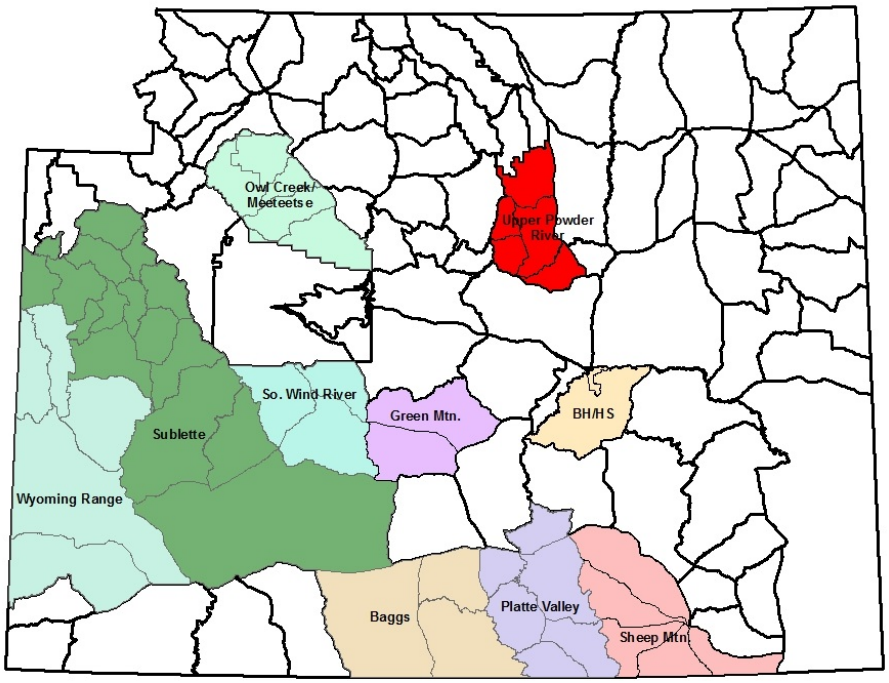

Fig. 3. Statewide Mule Deer Initiative herd units.

Objective: Ascertain the public's current knowledge and awareness of important issues affecting mule deer management in Wyoming. Understand the public's opinions and expectations regarding mule deer management and hunting.

Strategy: Conduct public opinion studies to gauge the overall [statewide] preferences of affected interests as management plans are developed. Develop regional surveys to assess hunter knowledge and awareness, opinions, and desires relating to mule deer management at the local level.

What's been done:

- ✓ *Since 2005, WGFD has compiled data from three surveys regarding deer management in Wyoming: Deer and Elk Hunters' Response to Chronic Wasting Disease (2005) and Licensed Deer Hunters' Opinions and Attitudes toward Deer Management in Wyoming (2006 and 2012). These statewide reports provide a broad overview of resident and nonresident hunters' attitudes and values regarding a variety of issues and are often consulted to guide management planning.*
- ✓ *WGFD has also conducted herd-specific attitude surveys in the Wyoming Range, Platte Valley, Bates Hole/Hat Six, Upper Powder River, Owl Creek /Meeteetse, Sweetwater, Sheep Mountain and South Wind River mule deer herds.*

Objective: Actively involve the public in management decisions.

Strategy: Utilize the Collaborative Learning method to involve stakeholders when addressing issues related to mule deer management and when developing formal management plans for specific herd units.

What's been done:

- ✓ *Since 2007 WGFD has utilized CL to address mule deer management in the Wyoming Range and the Platte Valley. Both efforts produced herd unit and habitat management plans, and a "Platte Valley Habitat Partnership" was also formed.*
- ✓ *Most recently, the WMDI was "rolled out" statewide with a decision to engage stakeholders through the CL process in at least one mule deer herd in each region.*
- ✓ *WGFD hosts a series of meetings and workshops throughout the year to engage the public on a range of management issues including season recommendations.*

Research

Wildlife research can be broadly categorized as "pure research" and "applied research." Pure research is unrestricted in the sense it can address subjects ranging from highly theoretical aspects to basic characteristics of an organism or its environment. Applied research, on the other hand, seeks to answer specific questions needed to resolve a problem or improve our ability to manage a resource. Pure research has produced a great deal of information useful to the science of wildlife management and often serves as a foundation for applied research. However, most investigations conducted or supported by WGFD will address applied management questions.

Many of the issues affecting mule deer are not understood beyond a conceptual level. Natural succession, invasive plants, human developments, energy extraction, land management practices, weather and climate change, disease, predation, competition with other wildlife, and perhaps additional factors have contributed to the general decline in mule deer across the West. Through monitoring and field studies, managers are improving their understanding of how various environmental and anthropogenic stressors interact to affect mule deer and their habitat. This knowledge will help us design more effective management and mitigation solutions, and will provide essential documentation justifying the need for mitigation to offset development impacts. Managers also need to be sure management practices we recommend, and those considered in the future, are effective. Applied research is being done throughout the range of mule deer to assess whether management practices are producing desired results. Practices that do not attain desired results should be discontinued so available resources can be directed at strategies more likely to succeed.

We study mule deer distribution, habitat use, and movement patterns in order to focus management actions where they are most needed. Related research seeks to identify the specific environmental factors that limit the size and health of a mule deer population. This type of information enables us to better predict whether a proposed development is likely to have a significant impact at the population level, and provides a basis to select the most effective locations for habitat treatments or mitigation projects. The emergence of diseases such as adenovirus poses additional management challenges. Research is being done to examine how deer diseases are transmitted, the extent to which they may impact populations, and how such diseases can be controlled or eliminated. Finally, investigating cost efficient means to more reliably estimate population size, mortality, and other vital factors is a priority. Improved survey techniques will ultimately increase confidence in harvest management decisions and will improve our ability to monitor populations.

Ultimately, sound management decisions must be founded in good science. Research is an essential component of any progressive management program.

Objective: Improve our understanding of mule deer ecology and management.

Strategy: Periodically update WGFD's research priorities.

Strategy: Maintain a cooperative working relationship with the WY Coop Unit, other departments at the University of Wyoming, and other research institutions. Support adequate staffing and funding for the Coop Unit.

Strategy: Secure an adequate budget including external funding sources to support WGFD's highest research priorities.

Strategy: Continue to pursue and support the creation of a WGFD position that would assist personnel with monitoring, survey and study designs, population estimation methods, and statistical analyses.

What's been done:

- ✓ *WGFD is the principal agency cooperator working with the University of Wyoming Cooperative Wildlife Research Unit. We provide funding, technical and logistic assistance, and we identify and prioritize the Department's research needs.*
- ✓ *WGFD also conducts research on a limited basis.*
- ✓ *WGFD seeks involvement by NGOs, conservation groups, sportsmen and outfitter groups to help fund research, provide logistical support, and participate in management and research programs.*

Objective: Identify the most important factors affecting mule deer survival and recruitment, and estimate the extent they affect populations.

Strategy: Monitor and assess annual survival of mule deer.

Strategy: Assess pre and post winter nutritional condition (i.e. fat reserves) of adult females.

Strategy: Determine late winter fetal rates based on ultrasonography. Determine fall recruitment rates based on annual herd composition surveys.

Strategy: Compare survival of mule deer fawns among herd units throughout the State to quantify productivity of different herds.

Strategy: Evaluate shifts in distribution and habitat use resulting from competition with elk, white-tailed deer and pronghorn.

Strategy: Evaluate the degree to which competition with elk and white-tailed deer on summer and transition ranges affects mule deer productivity and habitat use.

Strategy: Evaluate the degree to which competition with elk, white-tailed deer and pronghorn on winter ranges affects mule deer habitat use and survival.

Strategy: Evaluate predation impacts on survival of mule deer fawns and more importantly, recruitment to adult age classes.

Strategy: In areas where predators may be having a significant impact on mule deer populations, assess how predation may influence mule deer survival and age/sex composition of the population.

What's been done:

- ✓ *WGFD has participated in several investigations to identify factors affecting annual and seasonal movements of mule deer.*
- ✓ *WGFD is cooperating with research consultants, Federal agencies, and energy companies to assess distribution shifts and survival of mule deer throughout Wyoming.*
- ✓ *WGFD has initiated a multi-faceted research project to determine nutritional carrying capacity, adult survival, productivity, nutritional condition and movements and distribution of mule deer in the Wyoming Range. This project is a cooperative effort with the Coop Unit.*
- ✓ *In June, 2015 WGFD initiated fawn survival studies. Fawns were captured and radio-collared to determine survival rates and identify mortality factors.*
- ✓ *WGFD has partnered with the ADMB to identify parturition areas that may benefit from predator control efforts.*

Objective: Investigate the impacts of human development.

Strategy: Conduct research on both a statewide and regional scale to evaluate impacts of: 1) energy development, 2) vehicle and train collisions, 3) highway construction, 4) fence construction, 5) reservoir construction, and 6) large-scale shrub control projects and rangeland conversions.

Strategy: Assess impacts of housing and subdivision construction, and human-caused habitat fragmentation within mule deer migration corridors and habitats.

What's been done:

- ✓ *WGFD is cooperating with research consultants, Federal agencies, and energy development companies to study mule deer impacted by the Pinedale Anticline, Atlantic Rim and Baggs area oil and gas fields. These studies will document the impact that intensive natural gas field developments have on survival and distribution of adult mule deer that winter in these areas.*
- ✓ *The Pinedale Anticline and Atlantic Rim oil and gas development projects were*

designed to help identify impacts on local mule deer populations and to determine appropriate mitigation.

- ✓ *WGFD personnel worked with the Wyoming Department of Transportation (WYDOT) and local conservation groups to develop plans for minimizing vehicle collisions with mule deer. These plans have resulted in construction of under- and over-passes in the Pinedale, Nugget Canyon, and Baggs areas.*
- ✓ *WGFD is actively engaged with the Wyoming Department of Transportation to develop strategies that will minimize vehicle collisions statewide.*
- ✓ *WGFD and BLM are funding preconstruction monitoring of mule deer at the Chokecherry/Sierra Madre Wind Farm site south of Rawlins. This massive project consisting of 1,000 wind turbines will be the largest onshore wind farm in North America upon completion.*

Objective: Improve survey methods and other techniques used to estimate size and trends of mule deer populations.

Strategy: Determine the levels of adult female survival and recruitment (post-hunt fawn:doe ratios) that result in population changes in representative areas. Apply this information to improve WGFD's population simulation models.

Strategy: Continue examining how weather data may be applied to adjust survival estimates used in model simulations of annual mule deer population size and trend.

What's been done:

- ✓ *WGFD and Western Ecosystems Technology, Inc. have applied the quadrat sampling procedure to census mule deer populations on winter ranges occupied by the Sublette mule deer herd.*
- ✓ *WGFD has implemented sightability surveys for estimating mule deer abundance.*
- ✓ *On an ongoing basis, WGFD evaluates techniques used by other wildlife agencies to estimate mule deer abundance.*
- ✓ *WGFD, in conjunction with the University of Wyoming, has evaluated the reliability of computer simulation models for estimating sizes of mule deer populations and for tracking population trends.*

Objective: Study habitat selection by mule deer.

Strategy: Evaluate how adult bucks (age 2+) utilize hiding and security cover in relation to its availability during the hunting season.

Strategy: Evaluate whether there is significant overlap in the habitats selected by female mule deer and elk during and after the parturition period. Determine if competition for reproductive habitat impacts productivity of mule deer.

Strategy: Identify stopover areas mule deer use during annual spring and fall migrations and assess plant phenology and key plant selection by mule deer.

Strategy: Identify habitat characteristics at parturition sites in relation to fawn survival and recruitment.

What's been done:

- ✓ *Key stopover points have been identified through radio-marked animal movements in the Wyoming Range, Sublette, Platte Valley and Baggs herd units.*
- ✓ *Work progresses on these key habitats statewide with recent or upcoming radio-collar studies in the Clarks Fork, Owl Creek/Meeteetse, Dubois, South Wind River, Bates Hole/Hat Six, and Sheep Mountain herd unit.*

Objective: Improve our knowledge of how various vegetation management techniques affect mule deer and their habitat.

Strategy: Evaluate vegetation and mule deer response to wildfires and various applications of prescribed fire and other treatment techniques in sagebrush steppe, mountain shrub, aspen, conifer and riparian habitats.

Strategy: Include pre- and post-treatment monitoring in habitat treatment projects to assess mule deer response.

Objective: Investigate susceptibility of mule deer populations to diseases.

Strategy: Evaluate the prevalence, transmission, and spread of diseases such as CWD, EHD, and adenovirus, and the potential for an effective vaccine.

Strategy: Investigate methods to reduce population-wide effects of these diseases.

What's been done:

- ✓ *WGFD has participated in a large mule deer CWD epidemiology study.*
- ✓ *WGFD has assessed the efficacy of a CWD vaccine on elk which indicated no increase in elk survival rates.*
- ✓ *WGFD conducts surveillance statewide to assess prevalence of CWD in mule deer. Hunter-provided samples are collected at check stations, warden stations, and WGFD offices.*

Funding and Support

WGFD expended more than $8.9 million to fund mule deer management in fiscal year 2016. Data collection and enforcement constitute the largest expenditures in each of the 37 mule deer herds. WGFD foresees three critical needs that will require significant additional funding in the future: 1) Landscape-scale habitat management; 2) Energy impact analysis and mitigation; and 3) Research and management.

Much of WGFD's current emphasis is directed at conserving and enhancing mule deer habitat. This effort involves monitoring habitat conditions throughout the state, participating in land use planning, overseeing collaborative projects to protect and improve mule deer habitats, and implementation of habitat treatment and management actions.

Habitat must be managed on a landscape basis if mule deer herds are to be sustained at levels desired by the public and in balance with available habitat. To achieve this, land use plans must address the ecological requirements of all species including mule deer. Cumulative implementation of habitat treatments must also be at a scale sufficient to realize population-level responses by mule deer. These efforts will require significant new sources of funding as well as cooperative partnerships with industry, private landowners, federal agencies, and non-governmental organizations (NGOs). Collaborative partnerships are the most effective means to secure funding from novel and traditional sources. Numerous conservation organizations, federal and local governments, industry partners, agricultural entities, charitable foundations, etc. have contributed to date. Their cooperative efforts and contributions are sincerely appreciated!

Wyoming is the leading energy exporter among all states and expansive energy development continues to be a major focus. It is imperative we understand the extent to which these developments affect mule deer populations and find ways to effectively mitigate the impacts. This need is especially urgent given recent findings by Sawyer et al. (2017) that concluded existing mitigation approaches did not prevent a significant population level decline caused by behavioral avoidance of natural gas field infrastructure. Energy companies are the most appropriate source of funding needed to study and mitigate impacts.

WGFD continues to identify research and monitoring studies needed to better understand mule deer population dynamics and seasonal habitat use throughout Wyoming, and to improve population estimation methods. Substantial gaps in knowledge continue to exist at the herd unit level regarding seasonal movements and migration corridors, herd-specific survival rates, causes of mortality, effects of disease, and carrying capacity of the habitat. Knowledge about the nutritional carrying capacity of landscapes is becoming increasingly important. Managers are now recognizing the nutritional condition of does when they enter winter is perhaps the most important factor affecting the subsequent year's production and survival of fawns. However, this is very difficult to ascertain in the absence of expensive, herd-specific research. Budgetary constraints also impact our ability to collect data and lack

of data renders population estimation more difficult in many herds. For example, WGFD simply does not have funds or staffing to radio-collar a sample of mule deer in most herds in order to estimate annual survival, monitor movements, or conduct sightability surveys similar to the work recently completed in the Platte Valley. These facets of research and management are necessary to better understand mule deer population dynamics in each herd. Such work is often cost-prohibitive, however increased funding and support for research and management will ultimately improve the capability of wildlife and land managers to conserve and manage Wyoming's mule deer.

Objective: Fund WGFD's mule deer management program at a sufficient level.

Strategy: Increase funding to conduct priority research on mule deer and their habitat.

Strategy: Increase funding and staffing levels needed to conduct priority habitat work.

Strategy: Increase funding for population monitoring such as radio-marking mule deer to obtain annual survival estimates, conducting more intensive classification and abundance surveys, and better defining seasonal movements and migration corridors.

Strategy: Continue to monitor and develop new technologies, such as aerial drones or satellite imagery, that may accomplish population monitoring more efficiently and at reduced cost.

Strategy: Determine appropriate levels of funding and an implementation schedule to reasonably accomplish the above tasks.

What's been done:

- ✓ *During Fiscal Year 2016, WGFD's mule deer management program cost $8,884,624. Over the preceding 5 years, the average annual cost was $7,715,350.*
- ✓ *The Commission has annually appropriated funding to support research by the UW Coop Unit. This research addresses a myriad of wildlife topics throughout the state, including priority research needed to support mule deer management.*
- ✓ *Starting in FY '16, the Commission appropriated $500,000/year for five years as seed money to support research and management projects in WMDI key herd units.*

Objective: Seek new sources of funding to implement landscape scale habitat treatments, better understand impacts of energy development, and identify mitigation corridors. Adequately fund priority research.

Strategy: Develop collaborative partnerships with NGO's, government agencies, and private companies to address the funding needs.

Strategy: In compliance with the Commission's Mitigation Policy (VII H, March 22, 2012), consider creating mitigation accounts to accept money from natural resource developers to mitigate their impacts to mule deer. This is normally the last option in the mitigation sequence to be considered when avoiding and minimizing the impact, and repairing, restoring or rehabilitating the affected environment are not feasible. As a condition for participation in any mitigation accounts, project proponents should be required to provide rigorous documentation justifying why preferred mitigation alternatives are not feasible.

What's been done:

- ✓ *The Jonah Interagency Office and Pinedale Anticline Project Office in Pinedale were created in partnership with the Federal Government and Industry to implement mitigation programs that will address wildlife habitat impacts arising from large-scale energy development. Recent research has concluded the efforts to mitigate impacts on wintering mule deer did not prevent significant herd-level population declines attributed to avoidance behavior (Sawyer et al 2017).*
- ✓ *Several WGFD personnel serve on NGO Project Advisory Committees (i.e. MFF, RMEF, WSF, etc.) that leverage funding for habitat improvement projects in Wyoming.*
- ✓ *WGFD has also assigned personnel to serve as liaisons to numerous NGOs*
- ✓ *General fund money has been appropriated by the legislature for WGFD's Veterinary Services program and the Wildlife/Livestock Disease Partnership. This has enabled WGFD to increase our surveillance of wildlife diseases and related research.*
- ✓ *The Commission is partnering with Federal land management agencies, landowners, and NGOs to leverage federal, state, and private funding sources to implement the Wyoming Landscape Conservation Initiative. This Initiative will develop a science-based program to strategically conserve, restore, and enhance wildlife habitat throughout the southwest Wyoming landscape.*

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