WOLF REPORT

Contract No. 136039

September 2016

BGF

BIGGAME FOREVER

WOLF REPORT

Contract No. 136039

September 2016

BIGGAME FOREVER

Executive Summary

The focus of Big Game Forever's efforts pursuant to its contract with the State of Utah has been to restore state management authority over wolves in the state. This is consistent with our contractual obligations with the state of Utah and pursuant to Utah statute that states, "It is the policy of the state of Utah to legally advocate and facilitate the delisting of wolves in Utah under the Endangered Species Act and the return management authority to the state." See Utah Code 23-29-101-(10).

The decline of key elk, moose, deer and other wildlife populations and the rapid growth of Canadian Gray Wolf populations in the Northern Rockies has been an issue of growing concern in the Western States. In particular, important elk and moose herds in Idaho, Montana, and Wyoming are showing dramatic declines. Some wildlife herds, such as the Northern Yellowstone elk herd, have lost as much as 80% of its population. Moose in Jackson Hole, Wyoming have declined by 90%. Dramatic declines of 50% have been documented in many of the largest wilderness herds of elk and moose in America. Family ranchers are also feeling the impacts of livestock depredation and economic loss from unmanaged wolves.

The influx of Canadian Gray Wolves into Utah is inevitable. Documented wolf sightings in Utah are becoming more common. In 2014, a wolf was confirmed in central Utah when a coyote hunter accidentally killed the animal. Adjacent states are also beginning to document wolves moving into their states. The purpose of this contract is to ensure that the state of Utah will have management authority of wolves when it is needed. Wolf delisting for the state of Utah is not only about restoring state wildlife management authority. More importantly, it is about conservation of elk, moose and deer in the state. Wolf-delisting and restoring state management authority will allow Utah to protect its wildlife, livestock, outdoor recreation, and rural economies from the impacts that have been documented in Idaho, Montana, and Wyoming.

There is a growing recognition that many of the unintended consequences on wildlife and livestock can be mitigated by timely and responsible wolf management efforts. When Canadian Gray Wolves were introduced into Yellowstone and Central Idaho, assurances were given that wildlife and livestock would be protected from excessive wolf predation. In many instance, these commitments have not been kept. Failure to manage Canadian Gray Wolves has hurt wildlife populations and hard working livestock producers. Local communities bear much of the economic burden of unsustainable wolf predation. After years of decline, recovery of moose, elk, and deer in Idaho, Montana, and Wyoming will be a long and expensive undertaking. Wolf-delisting and responsible wolf management are needed to protect and conserve key wildlife populations of elk, moose, and mule deer in Utah and across the West.

Big Game Forever's Efforts

Purpose of Report

This report is submitted in compliance with State of Utah Contract 136039. The contract requires Big Game Forever (BGF) to provide a "summary report of accomplishments to DWR." It is important to note that in addition to the funding provided by the Utah Legislature during the 2015-2016 contract period to conduct wolf-delisting efforts, we have raised substantial funds from private donors and local fundraisers. Big Game Forever is a 501(c)4 social welfare organization that was organized for the purpose of protecting elk, moose, deer, and other wild game populations in America. Ryan Benson is the attorney for Big Game Forever who works on the wolf-delisting effort.

This year's report is provided as an addition to the June 30, 2013 and June 30, 2014 reports which outlined accomplishments, science, and policy related to Big Game Forever's efforts in previous years. This report will focus largely on progress toward delisting during the 2013-2014 contract period.

Figure 1 - Conservation of America's Shiras moose depends reducing predation on calf moose during the first year of life.

Big Game Forever's Work

The research, educational, legal, and legislative efforts conducted by BGF to restore state authority to manage wolves has been a significant undertaking. BGF's wolf delisting efforts are directed in the following categories:

Education and Science

Big Game Forever has conducted extensive research on the scientific, biological, and policy considerations surrounding wolf delisting. Understanding the science, data, and impacts of unmanaged wolves in states with significant wolf populations has been an important part of Big Game Forever's wolf-delisting efforts. The impacts of unmanaged wolves in many states continues to be profound. Dramatic impacts to elk, deer, and especially moose are concerning. Through our research, Big Game Forever has been able to educate decision makers and the public on the importance of protecting native wildlife species and the need for responsible management of Canadian Gray Wolves.

Public Outreach

Big Game Forever's public outreach efforts are also an important part of building support for and implementing lasting wolf-delisting solutions. Big Game Forever works extensively across Utah, Washington D.C., and in other states around the country. Building cohesive science-based support for responsible wolf management and protection is the foundation of these efforts. These public outreach efforts typically involve working with concerned individuals and organizations on ways they can get more involved to support solutions to restore wolf management authority to the states and to protect wildlife.

Direct Action

Grassroots support is also one of the tools utilized by Big Game Forever. Big Game Forever's online petition at http://biggameforever.org allows individuals to voice their concern while joining Big Game Forever's education and response network. Big Game Forever utilizes one of the most robust political action systems available. This system makes it easy for the average citizen to send a message to our leaders in Congress. Big Game Forever's approach is to be simple, concise, respectful, but also clear regarding the desire to ensure that all states have authority to manage wolf populations. Big Game Forever's members have sent hundreds of thousands of messages in support of state management of wolf populations.

Legal and Legislative

Big Game Forever has been a significant driving force of legislative efforts to delist wolves in Congress starting in 2010. Ryan Benson's expertise on wolves and wolf delisting has been sought in many of the legislative proposals presented before Congress. Tim Rupli and Bill Simmons have worked in support of these wolf delisting efforts in Washington D.C. Mr. Rupli represented the state of Utah in the 1993 and 1995 Base Realignment & Closure Process (BRAC's), an effort funded by the state of Utah and private sector partners. Mr. Rupli, an avid outdoorsman, is regularly listed as one of the most successful lobbyists in Washington D.C. Bill Simmons, a former staffer of Congressman Jim Hansen, has also been instrumental in these efforts. Bill Simmons is the managing partner of Grayling, U.S.A. and has extensive experience with natural resource issues. The guidance, professionalism, and expertise of Mr. Rupli and Mr. Simmons have been instrumental in working with many members of Congress from around the country. A map showing members of Congress who have supported wolf delisting by signing "Dear Colleague" letters or cosponsoring wolf-delisting legislation is attached. Through these efforts we have been able to facilitate a more complete understanding of why wolf management is so important to long-term conservation efforts in Utah and other states.

Progress During the 2013-2014 Contract Period

Background

The focus of Big Game Forever's efforts pursuant to its contract with the State of Utah has been to restore state management authority over wolves in the state. This is consistent with our contractual obligations with the State of Utah and pursuant to Utah statute that states, "It is the policy of the state of Utah to legally advocate and facilitate the delisting of wolves in Utah under the Endangered Species Act and the return management authority to the state." See Utah Code 23-29-101-(10)

The decline of key elk, moose, deer and other wildlife populations and the rapid growth of Canadian Gray Wolf populations in the Northern Rockies has been an issue of growing concern in the Western States. In particular, important elk and moose herds in Idaho, Montana, and Wyoming are showing dramatic declines. Some wildlife herds, such as the Northern Yellowstone elk herd, have lost as much as 80% of its population. Family ranchers are also feeling the impacts of livestock depredation and economic loss from unmanaged wolves.

The influx of Canadian Gray Wolves into Utah is inevitable. In 2014, a wolf was confirmed in central Utah when a coyote hunter accidentally killed the animal. Adjacent states are also beginning to document wolves moving into their states. The purpose of our efforts is to ensure that the state of Utah will have management authority of wolves when it is needed. Wolf delisting for the state of Utah is not only about restoring state wildlife management authority. More importantly, it is about conservation of elk, moose and deer in the state. Wolf delisting and restoring state management authority will allow Utah to protect its wildlife, livestock, outdoor recreation, and rural economies from the impacts that have been documented in Idaho, Montana, and Wyoming.

Figure 2 - as one of the world's most efficient predators, wolf packs can quickly reduce calf recruitment below levels needed to sustain healthy elk and moose populations.

Proposed Administrative Delisting

On June 7, 2013, the U.S. Fish and Wildlife Service announced its intention to delist Western Gray Wolves nationwide. In its press release U.S. Fish and Wildlife Service explained its decision:

> *The U.S. Fish and Wildlife Service today proposed to remove the gray wolf (Canis lupus) from the list of threatened and endangered species. The proposal comes after a comprehensive review confirmed its successful recovery following management actions undertaken by federal, state and local partners following the wolf 's listing under the Endangered Species Act over three decades ago. The Service also proposed to maintain protection and expand recovery efforts for the Mexican wolf (Canis lupus baileyi) in the Southwest, where it remains endangered."*
> See http://www.fws.gov/home/newsroom/serviceproposes- graywolvesNR06072013.html

U.S. Fish and Wildlife Service Director Dan Ashe further explained the basis for the decision, "From the moment a species requires the protection of the Endangered Species Act, our goal is to work with our partners to address the threats it faces and ensure its recovery . . .An exhaustive review of the latest scientific and taxonomic information shows that we have accomplished that goal with the gray wolf, allowing us to focus our work under the ESA on recovery of the Mexican wolf subspecies in the Southwest." See id.

The following testimony from U.S. Fish and Wildlife Service Deputy Director Gary Frazier presents a cogent and instructive explanation of the fact that Western Gray Wolves (excluding subspecies Canis lupus Baileyi) are no longer endangered:

> *We looked at Gray Wolves as a species, Canis Lupus, range-wide, and we found no evidence to suggest that Gray Wolves, Canis Lupus, are at risk of extinction. So we concluded that listing at the species levels is not warranted.*
>
> *We also looked at the three subspecies of Gray Wolves that historically existed within the lower 48 and found that there's no basis to conclude that Nubilus or Occidentalis are in danger of extinction, but we did find that Baileyi, the Mexican wolf in the southwest, is currently at risk of extinction throughout its range.*
>
> *Finally, we looked in the Pacific Northwest. We found that there are wolf packs now in Western Washington. Wolves are expanding into Western Oregon. There was one wolf that wandered into Northern California, and we've concluded these don't constitute a population at this time. They may*

constitute a population in the future, if it's consistently reproducing and that carries over recruiting into the population.

But, more significantly, we found that these wolves are not discrete. They're not separate. They are, in fact, on the advancing edge of the recovering wolf population Northern Rockies and Wolves in Canada. So we've concluded that this would not valid distinct population segment.

So this table summarizes our and it's all laid out in our proposed rule. We found that the current listed entity is not a valid listable entity, that Canis Lupus, range-wide, listing is not warranted. The same for Nubilus and Occidentalis. That Baileyi, the Mexican wolf, is endangered and should be listed, and that wolves in the Pacific Northwest are not a valid DPS.

So on that basis, we came to our proposal, which was to focus Endangered Species Act protection for the Mexican wolf by listing the subspecies Baileyi as endangered wherever found, and remove the current Gray Wolf listing from the list of endangered and threatened wildlife, and also to improve the operation of the experimental rule for Mexican wolves in the Southwest.

So again, in conclusion, our goal is to administer the Endangered Species Act, to prevent extinction and to secure a species from the threat of extinction now and into the foreseeable future.

We believe that the Gray Wolf has recovered in the Western Great Lakes and the Northern Rockies, and that we now need to focus the Endangered Species protections on the Mexican wolf in the Southwest.

Public Comment Reopened

On February 7, 2014, U.S. Fish and Wildlife Service announced it was reopening the public comment period following the receipt of the independent scientific peer review. The public comment period reopened February 10, 2013 for a period of 45 days. "Peer review is an important step in our efforts to assure that the final decision on our proposal to delist the wolf is based on the best available scientific and technical information," indicated U.S. Fish and Wildlife Service Director Dan Ashe. "… We are incorporating the peer review report into the public record for the proposed rulemaking, reopening the public comment period to provide the public with the opportunity for input."

Final Rule Never Published

In February 2014, U.S. Fish and Wildlife Service indicated they would finalize the delisting rule by the end of 2014. While the initial projections indicated that a delisting was likely to occur much sooner in 2014, public comment period extensions and the 2013 "government shutdown" resulted in moving the finalization date to later in 2014. U.S. Fish and Wildlife Service subsequently indicated a final delisting rule would be published by December 2014. Months passed after the expected final rule publication date without publication of the final rule. Subsequently, officials from U.S. Fish and Wildlife Service have signaled that an administrative delisting rule is unlikely to be finalized.

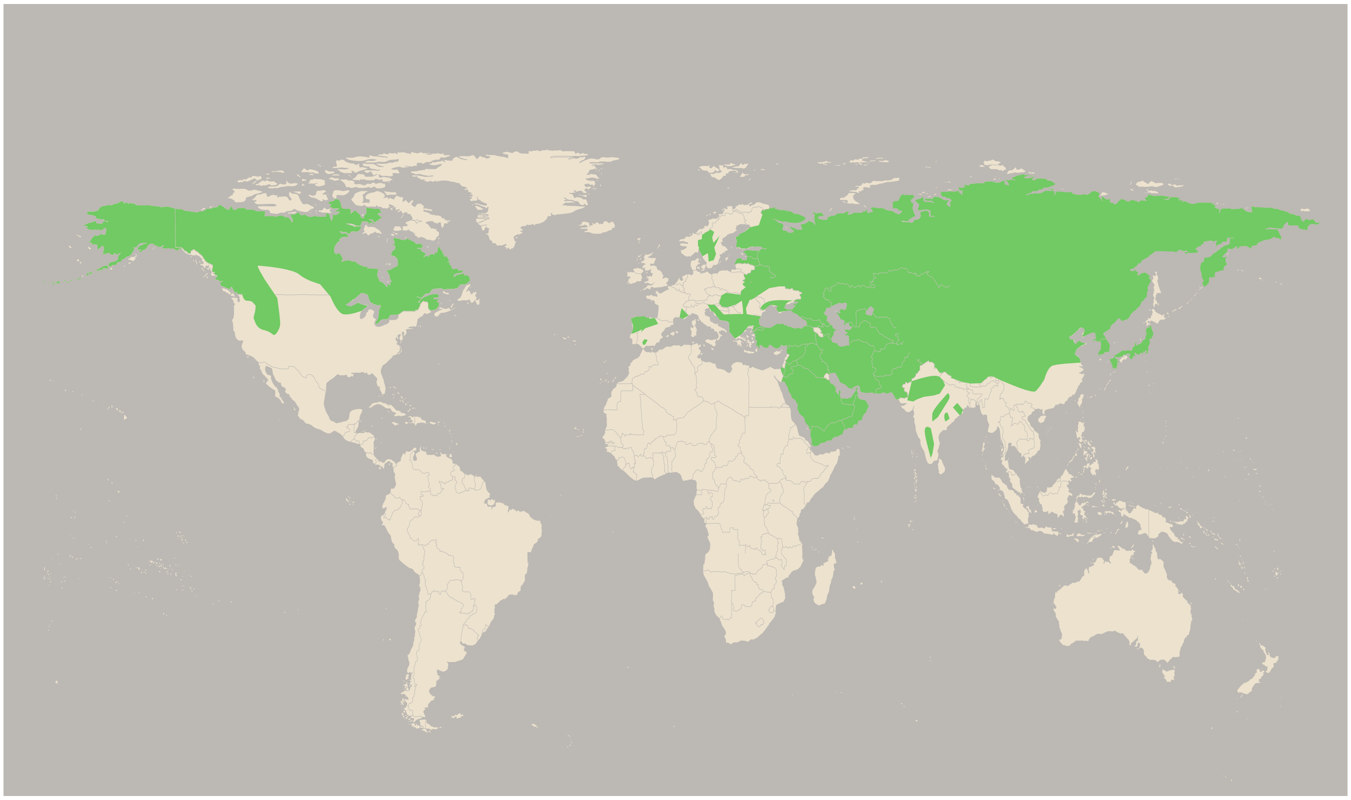


Figure 3 - Map showing the worldwide distribution of the Northern Gray Wolf.

New Contract Period

Recognizing that the Congressional action will again be needed to restore state management authority in the rest of the state, the Utah legislature appropriated $500,000 to fund Utah Contract 136039 during the 2015 legislative session. Pursuant to this contract, Big Game Forever has undertaken substantial research, educational, legal, and legislative efforts to restore state authority to manage wolves.

Relisting of Wolves

Since wolves were delisted in Idaho, Montana, Wyoming, Wisconsin, Michigan, and Minnesota, lawsuits have once again been filed challenging wolf delisting in several states. While wolf delisting for Idaho and Montana were provided protections by congressional action, such protections have not been made available for Wyoming, Wisconsin, Michigan, or Minnesota. As a result, courts have relisted wolves in each of these states. Despite carefully regulated wolf management plans and hunting seasons, once again the states of Wyoming, Wisconsin, Michigan, and Minnesota do not have the authority to undertake wolf or wild game conservation efforts.

Further Decline of Wild Game

Despite the worldwide abundance of Northern Gray Wolves, lawsuits filed by wolf advocates exploiting a variety of technicalities have been used to stop all wolf management in these states. Unfortunately, these “protections” have further exacerbated the declines of much more fragile populations of wild game in states which have substantial wolf numbers. One of the most important indicator species is the Shiras Moose. Shiras Moose are the largest deer species in the Western United States. In fact, almost the entire worldwide population for Shiras Moose is found in Idaho, Montana, Wyoming, Washington State, Utah, and Colorado. The following provides a more detailed overview of impacts to Shiras Moose in America.

Moose in Yellowstone

America's moose are in serious trouble. Nowhere is this decline more pronounced than in Yellowstone. Yellowstone National Park and the Yellowstone Ecosystem were the heart of America's moose population 20 years ago. There were literally thousands of moose. People traveled from all over the world to Yellowstone to view and photograph moose populations.

This past winter, efforts to count moose in Yellowstone show just how dire the situation has become. Reportedly, biologists flew over 350 miles of prime winter range in Yellowstone over 7 hours, under prime viewing conditions. This is the best time of year to count moose. But only 6 total moose were located. Even the most optimistic population calculations project that there are less than 100-300 moose left in Yellowstone National Park. Most who have been watching the issue more closely indicate that the real number is likely much lower. The near extirpation of moose from Yellowstone National Park is a tragedy of modern conservation. It is also a cautionary tale for states like Utah and Colorado that still have stable or growing moose populations. While these states have many times the moose in Yellowstone, Jackson Hole, and Wyoming's Bighorn Basin, total moose numbers in Utah and Colorado are approximately 7,000 moose. What this means is that if, or when, wolves move into these states, America's remaining Shiras moose could be decimated in just a few short years.

Moose in Montana

Research of first source material conducted by Big Game Forever shows that moose decline extends far beyond Yellowstone. Since wolves were introduced into Montana 20 years ago, survival of young moose has plummeted. In fact, calf moose survival has declined from 50 calves per hundred cows to approximately 20 calves per hundred cows just 20 years later. This level of calf recruitment is not enough to maintain or protect moose populations in the state. See Figure 4 below.

Predation by wolves is a major concern to moose biologists. Here is a very telling quote from this report on moose populations in Montana:

> *While predation was not considered a concern 40 years ago (Schladweiler 1974), the expanded composition and abundance of predator species may have the potential to limit local moose populations. Predation was the most common concern of regional biologists relative to moose population dynamics.*

Figure 4 - Calves per 100 Adult Moose in Montana. See Appendix A, page 41

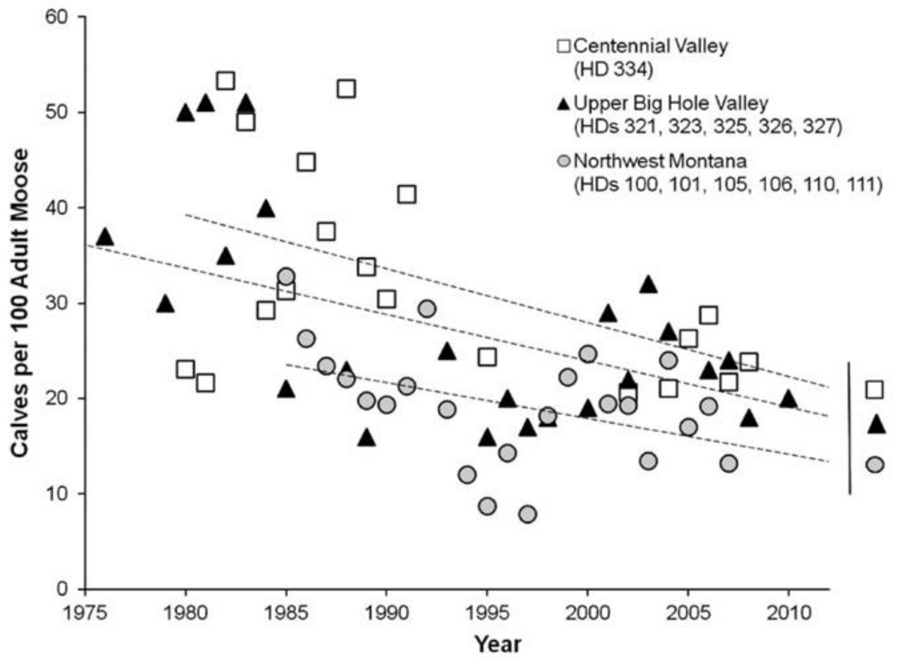
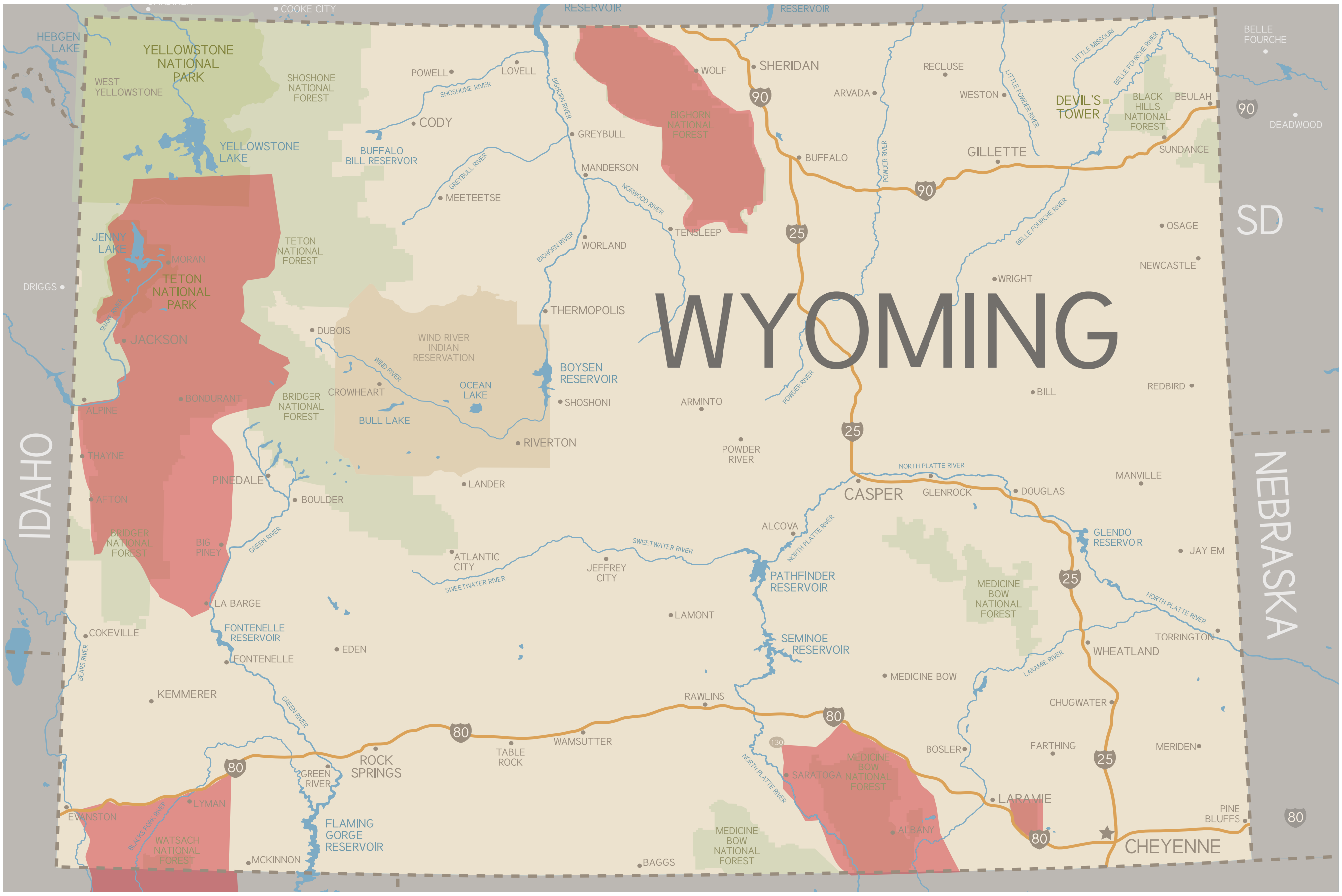


Fig. 5. Annual moose calves per 100 adult recruitment data and associated linear regression trend lines calculated from fixed-wing and helicopter late winter aerial surveys in 3 regions of Montana, 1976–2010.



Moose distribution in Wyoming

Research on winter prey selection by recolonizing wolves in the North Fork of the Flathead River drainage from 1986-1996 indicated that while wolves disproportionately used areas where deer were concentrated, they preferentially killed larger moose and elk over more abundant deer. Moose, particularly calves and cows, comprised a greater proportion of wolf kills as winter progressed (Kunkel et al. 2004). See Appendix A, page 43.

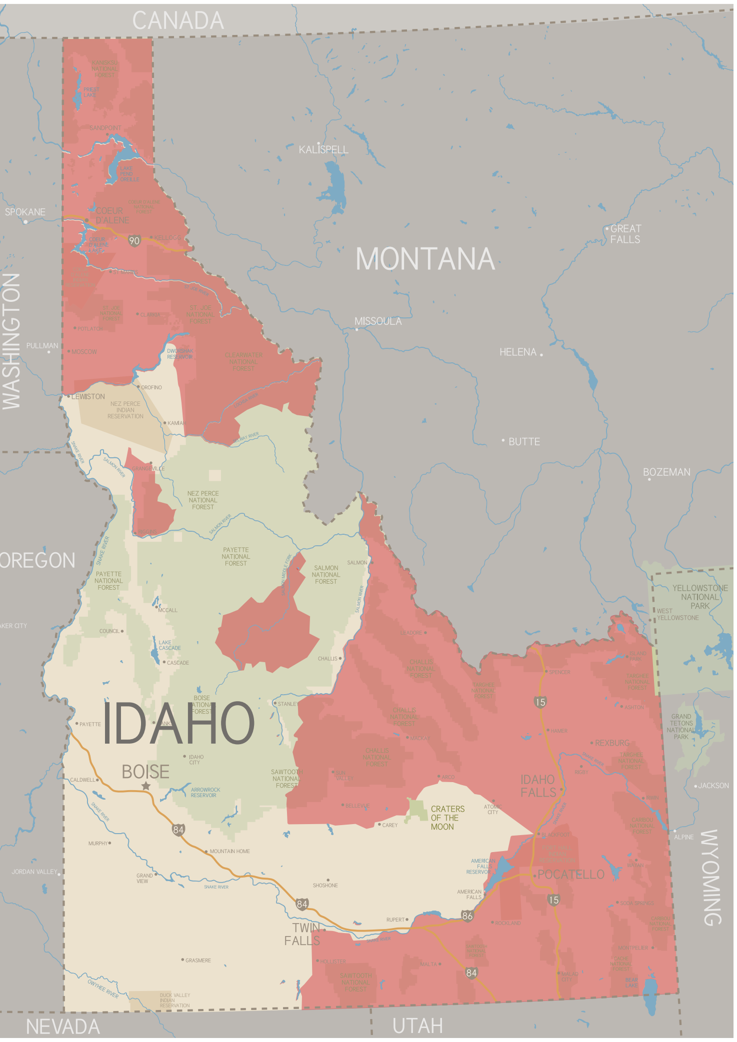
Moose in Jackson Hole, Wyoming

Before Canadian wolves were introduced into Northern Wyoming, moose in Jackson Hole, Wyoming numbered 3,000 to 5,000 moose. Today, less than 20 years after the experimental wolf introduction, there are less than 450 moose left in Jackson Hole. This is a 90% reduction in moose in Jackson since Canadian wolves were introduced into Northern Wyoming.

Here is a quote from one scientific study showing just how dire the situation is for wolves in Jackson Hole, Wyoming:

This [moose] population is 88% below its postseason management objective. Native moose populations naturally expanded and colonized the Jackson area in the late 19th century. The species arrival was followed by a classic exponential population increase, peaking at approximately 3,000-5,000 animals (depending on the modeling techniques.) For many years, the Jackson moose herd served as a source for moose transplants in multiple states and supported nearly 500 hunting licenses. However, the population underwent a dramatic population crash beginning in the early 1990's. Despite drastic reductions in hunting licenses, the population has failed to recover and continues to declines." (Houseon 1968, Berger 2004, Becker 2008, Vartanian 2011)

In 2010, when Congress delisted wolves in Montana and Idaho, there were still 1,000 moose left in Jackson Hole, Wyoming. In this five year period since wolf delisting in 2010 for the Northern Rockies DPS (excluding Wyoming), over 50% of the remaining moose in Jackson Hole have disappeared. In total, since introduction of the Canadian wolf 20 years ago, 90% of moose in Jackson Hole have disappeared. Wolves were delisted in Wyoming temporarily in 2012, however a judge in Washington D.C. almost immediately overturned the listing decision for Wyoming after one or two wolf seasons had been completed.



Moose distribution in Idaho

Moose in Idaho

Moose populations in three of Idaho's four moose regions have been in steady decline since wolves were introduced in central Idaho in 1995. In talking with senior wildlife biologists, outfitters, and sportsmen in the state of Idaho, indications suggest that moose populations have declined by as much as 50% or more. Perhaps this is why the state of Idaho has cut 50% of moose permits since wolves were introduced.

Just like in Montana and Wyoming, a major culprit of moose decline in Idaho appears to be predation of calf moose by wolves. The results of a recent collar study of calf moose which was conducted to better understand high calf mortality in Idaho are instructive. What the study found was startling-50% of collared calves were killed by wolves:

> *Harvest records, field staff and hunter reports indicated however, that moose populations in central Idaho Wilderness and other areas of Clearwater and Southeast Idaho continue to decline…In February 2011, an additional 22 moose were captured and radio-collared (2 bulls, 8 cows, and 12 calves). Since January 2012, wolves had killed one adult cow moose and 6 calves in addition to 2 unknown cow and 1 non-predation bull mortalities…if early trends in wolf-caused calf mortality continue, calf survival and recruitment could be a serious issue. See Idaho Department of Fish and Game, FY 2014 Statewide Report, Moose (Study 1, Job 6) (page 3, 20)*

The Challenge of Wolf Management

Idaho and Montana are finding that managing and reducing wolf populations to protect and conserve species like Shiras Moose is very difficult. In fact, in Montana, wolf populations have remained stable or increasing since wolf-delisting. In Idaho, a combination of hunting, trapping, and professional removal has reduced wolf populations only modestly. Both states remain many times above their wolf population objectives.

Wyoming, Wisconsin, Minnesota, and Michigan remain tied up in lawsuits. Much like the West, moose populations in the Western Great Lakes are also in serious decline. Without responsible wolf and predator management, preservation of species like Shiras Moose is not possible. Considering that Utah, Colorado, and Southern Wyoming remain the last populations of healthy Shiras Moose, protection of these vital wildlife populations is critical.

Shiras Moose Protection Act

On Wednesday, July 13, 2016 Congressman Jason Chaffetz introduced H.R. 5751, The Shiras Moose Protection and Recovery Act of 2016. The bill allows state wildlife agencies the full authority to begin the process of protecting and recovering Shiras Moose Populations. The bill also recognizes the importance of finalizing the draft wolf-delisting rule published by the U.S. Fish and Wildlife Service June 7, 2013. The bill also provides a congressional backstop to prevent further lawsuits from interfering with wolf conservation and management. A copy of the bill can be found in Appendix B. A copy of Congressman Chaffetz press release can be found in Appendix C.

We appreciate the leadership of Congressman Chaffetz and other members of Congress from Wyoming and Colorado for sponsoring this important legislation. Twenty years of Canadian wolves in the Northern Rockies has demonstrated one important fact: Delayed wolf management is harmful to moose, elk, and other wildlife species. Western states are well-equipped to protect moose populations from the declines experienced in Yellowstone, Jackson Hole, and across wolf habitat in Idaho, Montana, and Wyoming. Protecting moose herds in Utah, Colorado, and Southern Wyoming is an important step for ensuring long-term Shiras Moose survival worldwide. We look forward to working with Congressman Chaffetz, members of Congress across the country, and America's sportsmen conservationists to protect and recover moose in America.

APPENDIX A

Moose Status and Management
Montana 2014

BGF
BIGGAME FOREVER

MOOSE STATUS AND MANAGEMENT IN MONTANA

Nicholas J. DeCesare[1], Ty D. Smucker[2], Robert A. Garrott[3], and Justin A. Gude[4]

[1]Montana Fish, Wildlife and Parks, 3201 Spurgin Road, Missoula, Montana, USA 59804; [2]Montana Fish, Wildlife and Parks, 4600 Giant Springs Road, Great Falls, Montana, USA 59405; [3]Fish and Wildlife Ecology and Management Program, Department of Ecology, Montana State University, 310 Lewis Hall, Bozeman, Montana, USA 59717; [4]Montana Fish, Wildlife and Parks, 1420 East Sixth Avenue, Helena, Montana, USA 59620.

ABSTRACT: Moose (*Alces alces*) are currently widespread across Montana where regulated moose hunting has occurred since 1872, >140 years ago. The number of annual moose hunting permits has averaged 652 over the past 50 years. The popular permits are allocated via a random drawing, with an annual average of ~23,000 applicants in 2008–2012 who faced a 1.9% chance of success. Monitoring of moose largely occurs through annual harvest statistics collected via post-season phone surveys. Recent harvest statistics indicate lower hunter success, increased effort, and lower kill per unit effort, concurrent with >50% reduction in available permits since the 1990s. Aerial surveys also show decline in calf:adult ratios. In combination, these data suggest a declining trend in the statewide population, despite some ambiguity of certain data. Potential limiting factors include harvest, predation, vegetative succession and degradation, parasites, and climatic conditions, which were all identified as concerns in surveys of state biologists. Accordingly, Montana Fish, Wildlife and Parks will direct funds derived from moose permit auctions toward calibrating and refining statewide monitoring methods and research of population dynamics and potential limiting factors of Montana moose.

ALCES VOL. 50: 35–51 (2014)

Key words: *Alces alces shirasi*, *Elaeophora schneideri*, harvest statistics, hunter success rates, KPUE, Montana, Shiras moose, subspecies.

Moose (*Alces alces*) colonized North America roughly 14,000 years ago and have since occupied much of Alaska, Canada, and northern portions of the contiguous United States (Hundertmark et al. 2002, Hundertmark and Bowyer 2004). Considered rare throughout the U.S. Rocky Mountains until the mid-1800s (Karns 2007), their earlier presence in several regions of Montana were documented by the Lewis and Clark expedition in 1805–1806, Alexander Ross in 1824, and others (reviewed by Schladweiler 1974). Widespread prevalence of moose in Montana during early settlement is supported to some extent by a review of place names throughout the state, including at least 22 creeks and 6 lakes bearing "moose" in their names (Schladweiler 1974).

Regulation of moose hunting in Montana began in 1872, yet after subsequent decline brought near extirpation, hunting was closed statewide for almost 50 years from 1897–1945 (Stevens 1971). In 1910, the state warden estimated a rebounding population of 300 moose as the result of "ten years of careful protection" (State of Montana 1910). Allowable harvest began again in 1945 with 90 permits issued. Subsequently, annual permit numbers rose quickly to a maximum of 836 in 1962, and thereafter averaged 652 until 2012 (Fig. 1a). The limited number of permits have been allocated via a random drawing process. In 2008–2012, an average of ~23,000 hunters applied annually for <600 permits, with a 1.9% chance of success. Beginning in 1988, one

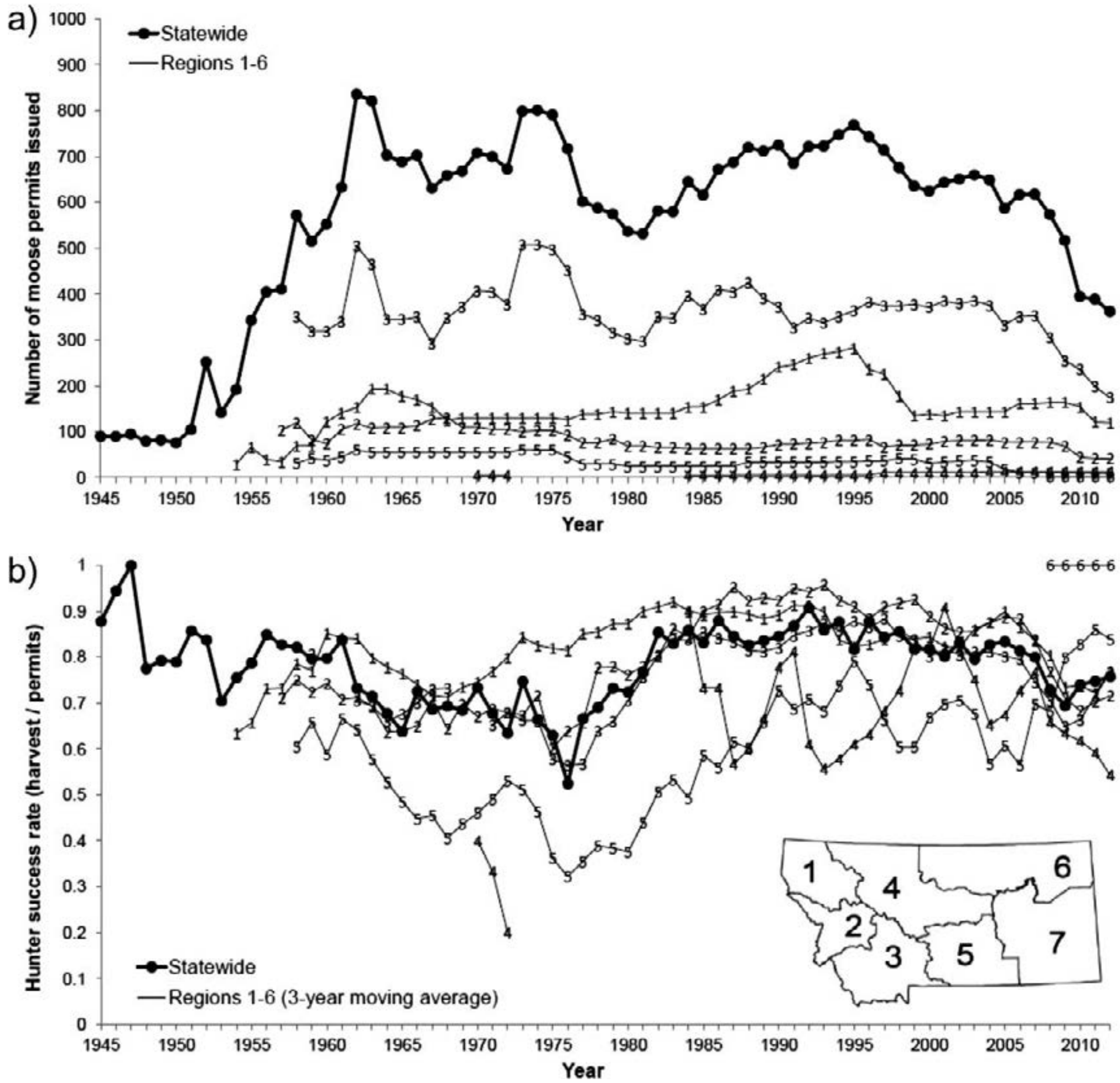


Fig. 1. Statewide and regional trends of a) number of permits issued and b) hunter success rates (number harvested/number of permits issued) for moose in Montana, 1945–2012.

additional permit has been auctioned to the highest bidder, with revenue directly earmarked for moose management or research. Additionally, since 2006 applicants can purchase unlimited numbers of chances at drawing one available moose "super-tag," valid in any permitted hunting district. Along with super-tag chances for other species, revenue from these sales is earmarked for hunting access programs and wildlife habitat conservation.

Moose in Montana typically occur at relatively low density and are vastly outnumbered by seasonally sympatric elk (*Cervus elaphus*), white-tailed deer (*Odocoileus virginianus*), and mule deer (*O. hemionus*) populations. Relative ungulate densities are reflected in their harvest level; in 2012 hunters harvested ~274 moose versus >20,000 elk, 37,000 mule deer, and 49,000 white-tailed deer. Rigorous statewide abundance estimates of moose are lacking, but based on professional opinion among regional management biologists in 2006, the estimated statewide population was 4,500–5,500, albeit without estimable accuracy or precision

(Smucker et al. 2011). Moose are distributed widely across western portions of the state, with lower density extending to the east, as reflected by the current distribution of allowable harvest (Fig. 2). The majority of annual permits are offered in the southwest (56% in Region 3) and northwest (25% in Region 1). In recent decades moose have continued to colonize, or re-colonize, portions of central and eastern Montana allowing for added harvest opportunity.

Moose occupy forested landscapes throughout western Montana ranging from regenerating areas within dense mesic forest, such as the Cabinet Mountains in the northwest, to areas with extensive willow fen habitat, as found within the Centennial and Big Hole Valleys in the southwest. Moose in the prairie landscapes of the east inhabit wetlands, particularly along the Missouri river, other riparian corridors, and areas supporting healthy willow communities.

TAXONOMY

Moose within the Rocky Mountains of the United States have historically been classified as Shiras moose (*A. a. shirasi*). The subspecies was first described in Wyoming (Nelson 1914), and subsequent morphological sampling by Peterson (1952) suggested its range to extend northward through Montana and into a zone of intergradation with the northwestern subspecies (*A. a. andersoni*) in western Alberta and eastern British Columbia. While genetic evaluation of subspecies designations using mitochondrial haplotypes generally upheld some level of differentiation between Shiras moose in Colorado and representative samples from other subspecies (Hundertmark et al. 2003), such methods have not been applied to evaluate moose in Montana. Particular interest in subspecies distinctions has arisen recently with anecdotal evidence of immigration of moose in northern and northeastern Montana from expanding populations in southern Alberta and Saskatchewan. For example, the Boone and Crockett Club has traditionally used the Canadian border to distinguish Shiras from "Canada" moose (a designation that essentially lumps northwestern and eastern [*A. a. americana*] subspecies into a

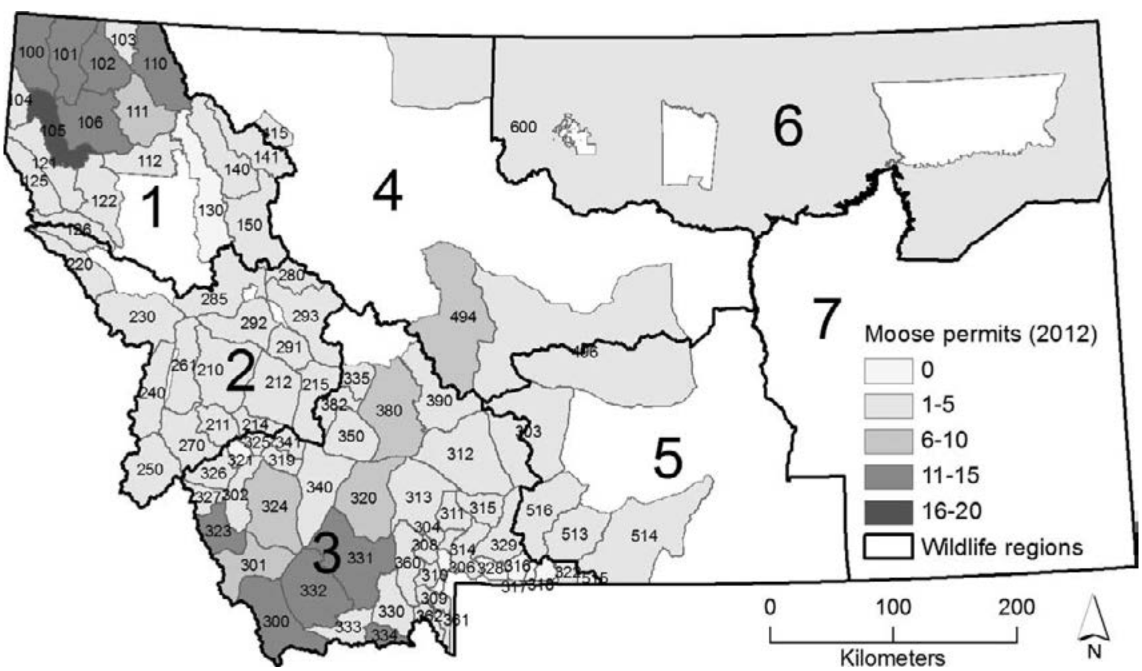


Fig. 2. Number of moose permits issued by moose hunting district in Montana, 2012.

single category) in scoring and record keeping of trophy animals. The advent of hunting in northeastern Montana's hunting district 600 has prompted informal discussion of classifying moose harvested within northern Montana and east of interstate highway I-15 as Canada moose, though none have been submitted for scoring to date (personal communication, J. Spring, Boone and Crockett Club, Missoula, Montana). Further sampling and analysis of population genetic structure of moose within and surrounding Montana may be needed to evaluate and update the subspecies range extents in the region.

MONITORING METHODS AND DATA

Resources have been limited for monitoring moose given their relatively low abundance and hunting opportunity compared to other Montana ungulates. Post-season surveys of permit holders have been used to estimate wildlife harvest since 1941 (Cada 1983, Lukacs et al. 2011), and in recent years phone surveys are used to collect annual harvest data. Montana Fish, Wildlife & Parks (MFWP) attempts to survey every permit holder to measure hunter success and effort, and adjusts harvest estimates according to annual hunter responses and rates. During 2005–2012, surveys yielded hunter response rates of 81–96% and statewide harvest estimates with coefficients of variation of 0.6–2.3%. These are the most consistent monitoring data through time and across the state, and are estimated distinctly for each district and permit type. Though potentially less precise than more intensive aerial survey methods, hunter statistics provide a cost-effective means for monitoring moose population trend (Boyce et al. 2012). Generally, there are 4 statistics computed annually that provide insight into potential moose population trends: 1) number of permits issued, 2) hunter success rate, 3) days of moose hunter effort, and 4) kills per unit effort (KPUE).

Beyond harvest statistics, MFWP biologists in most regions have made at least intermittent efforts to conduct aerial surveys, but sustained survey efforts are limited to the few areas with historically higher density. In the northwest (Region 1), December helicopter surveys have been conducted annually since 1985 in a subset of moose hunting districts centered around the Cabinet, Purcell, Salish, and Whitefish Mountains. Moose in this densely forested region selectively use and are more visible in regenerating (15–30 years old) stands during early winter, but move into mature, closed-canopy forest as winter progresses (Matchett 1985). While an explicit model with sightability covariates has not been developed for the area, an early 1990s mark-resight study with 81 neck-banded individuals produced average sightability estimates of 0.53–0.55 (Brown 2006). In the southwest (Region 3), fixed-wing aerial surveys have been conducted during most years since the 1960s in the hunting districts of the Big Hole and Centennial Valleys. These surveys typically yield calf:adult ratios and uncorrected minimum counts, and their timing (September–May) has varied considerably by year and district. Sporadic helicopter and fixed-wing aircraft surveys have occurred in other lower-density regions of the state including Regions 2, 4, and 5. The MFWP is currently exploring the utility and cost-effectiveness of standardizing and coordinating survey efforts.

The MFWP is also exploring the utility of cheaper monitoring methods including hunter sighting surveys at voluntary hunter check stations, and post-season phone surveys used to measure deer and elk harvests. While both the observation rate and age ratios collected from hunter sightings can be indicative of population trends (Ericsson and Wallin 1999, Bontaities et al. 2000), there is potential to incorporate spatial and temporal attributes of sightings data into a patch occupancy modeling framework similar to recent efforts with hunter sightings of wolves (*Canis lupus*; Rich et al. 2013). Additionally, the MFWP is exploring the cost-effectiveness of estimating population trends using the fates and reproductive status of marked individuals (*sensu* Lukacs et al. 2009) which can be integrated into population models that estimate annual growth rate (DeCesare et al. 2012).

MOOSE HARVEST STATISTICS AND TREND

As a consequence of perceived population declines and declining population indices from harvest data in recent decades, the number of moose permits issued in Montana was reduced by 53% (769 to 362) between 1995 and 2012 (Fig. 1a). Most reductions were in areas with traditionally the most available permits (Regions 1 and 3). In contrast, the first 2 permits ever offered in northeastern Montana (Region 6) were added in 2008. Notably, the 2010 hunting season was the first in more than 50 years when the number of statewide permits was <500 (Fig. 1a).

Statewide hunter success is estimated as the number of moose harvested relative to the number of permits issued, averaging 78.4% during regulated moose hunting in Montana (1945–2012; Fig. 1b). This success rate is similar to that in adjacent Idaho (61–85%; Toweill and Vecellio 2004), but relatively higher than in other areas with typically more moose and moose hunters such as Alberta (30–50%; Boyce et al. 2012), Alaska (28–37%; Schmidt et al. 2005), Newfoundland (25–54%; Fryxell et al. 1988), and Ontario (36–40%; Hunt 2013). From 2008–2012, success rates (average = 73.4%) were lower than the previous 20-year average (83.7%; $t = 2.07$, 23 df, $P < 0.001$). Additionally, hunter effort, defined as the number of days spent hunting moose per hunter, increased from 6.3 in 1986 to ≥11 days/hunter in 2010–2012 (Fig. 3). Similarly, kill per unit effort (KPUE) that integrates hunter success and effort statistics into a metric of

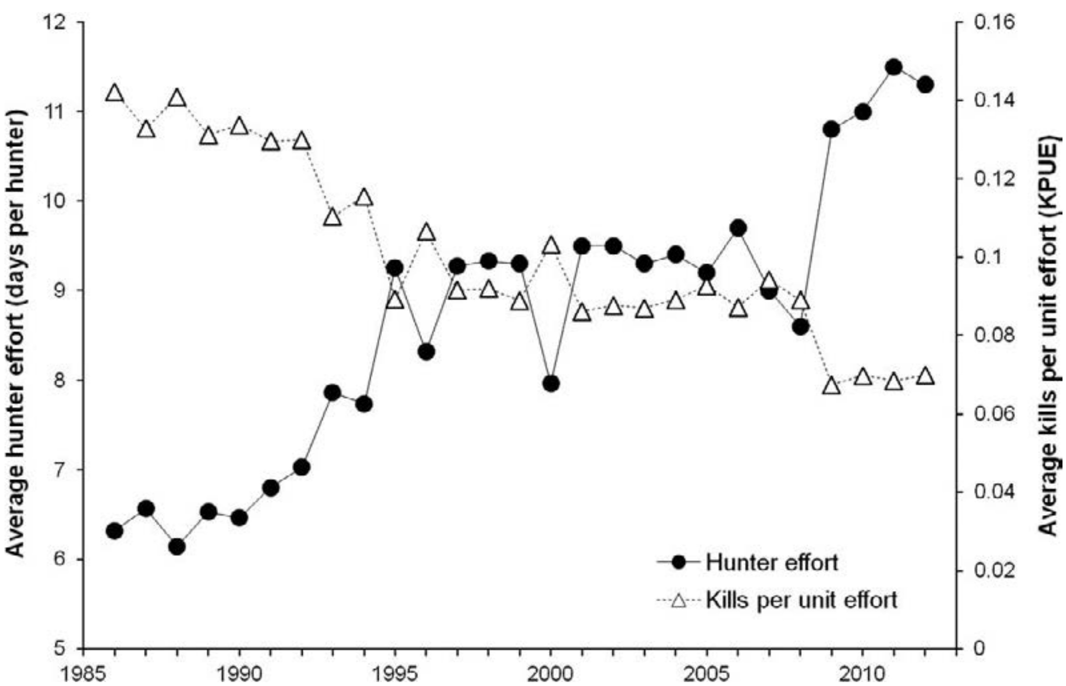


Fig. 3. Statewide annual averages of moose hunter effort (days per hunter) and moose kill per unit effort (KPUE) in Montana, 1986–2012.

hunter efficiency, declined >50% from >0.14 to <0.07 moose killed per hunter-day over the same time period (Fig. 3). The KPUE for antlered bull-specific tags also varied by hunting district level (Fig. 4), reflecting regional differences in moose distribution and ecotypes (e.g., more closed forests in the northwest compared to more open foothills and large riparian complexes in the southwest).

In combination, lower hunter success and KPUE, increased hunter effort, and a concurrent >50% reduction in available permits are indicative of a declining statewide population trend. In Ontario, years with fewer permits resulted in increased hunter success rate, even after accounting for changes in underlying moose density (Hunt 2013), which suggests that hunter behavior can complicate interpretation of hunter statistics (Bowyer et al. 1999, Schmidt et al. 2005). Change in permit type over space and time (e.g., shifting between antlered bull, antlerless, or either-sex permits) can also complicate or confound interpretation of hunter statistics. For example, recent (2008–2012) increases in KPUE also coincide with a prescribed reduction in the antlerless harvest that may reduce KPUE by limiting the proportion of animals hunters are allowed to harvest, regardless of underlying population dynamics. Thus, we cautiously interpret harvest statistics as imperfect indices. Concurrent declines in available permits, success rates, and KPUE may result from population decline and/or reflect other confounding factors.

In addition to statewide hunter statistics, regional calf:adult ratios in areas with consistent aerial survey data indicate decline in recruitment (Fig. 5). Three distinct survey areas show significant ($P < 0.05$) overall declines in ratios since 1980, though the temporal pattern of decline may be non-linear with subsequent stability at a lower level in recent years (Fig. 5). Low or declining recruitment is often associated with declining ungulate populations (e.g., DeCesare et al. 2012), so these data may be corroborative with harvest statistics that indicate a

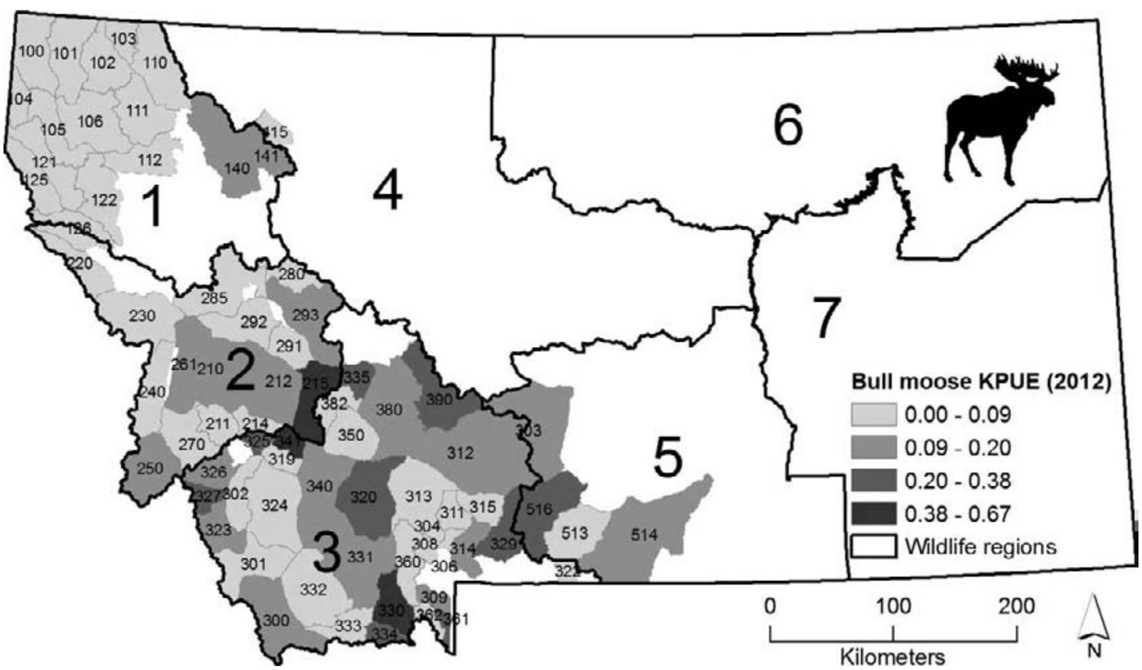


Fig. 4. Bull moose kills per unit effort (KPUE; effort recorded in days) per moose hunting district by hunters carrying antlered-bull-only permits in Montana, 2012.

declining moose population. However, declining recruitment may also reflect an ungulate population approaching carrying capacity (Gaillard et al. 1998, Eberhardt 2002), so this index also does not unambiguously indicate decline.

Biologist interviews: local trends and management

In 2010, we used structured interviews of 20 MFWP and cooperating agency biologists to assess the state of knowledge regarding moose population status, management, and factors of concern within Montana (Appendix A). A majority (63%) of responding biologists reported "decreasing" or "stable to decreasing" trends in their populations, with stable and increasing trends reported in some areas. These trend assessments are tempered, however, because only 10% of biologists had adequate data for making management decisions; 55 and 35% described their data as partially inadequate and inadequate, respectively. Lastly, when asked about factors that potentially limit local moose populations, biologist listed predation (70%), habitat succession (45%), MFWP-permitted hunter harvest (45%), parasites and/or disease (40%), Native American hunter harvest (30%), and habitat loss or fragmentation (15%).

POTENTIAL LIMITING FACTORS

Many factors may currently limit moose abundance and distribution including hunter harvest, predation, habitat succession, parasite and disease prevalence, and climatic conditions. The relative importance of these factors has likely changed over time. Overharvest may have been responsible for decline in moose numbers in the late 1800s (Stevens 1971). By the early 1970s, research

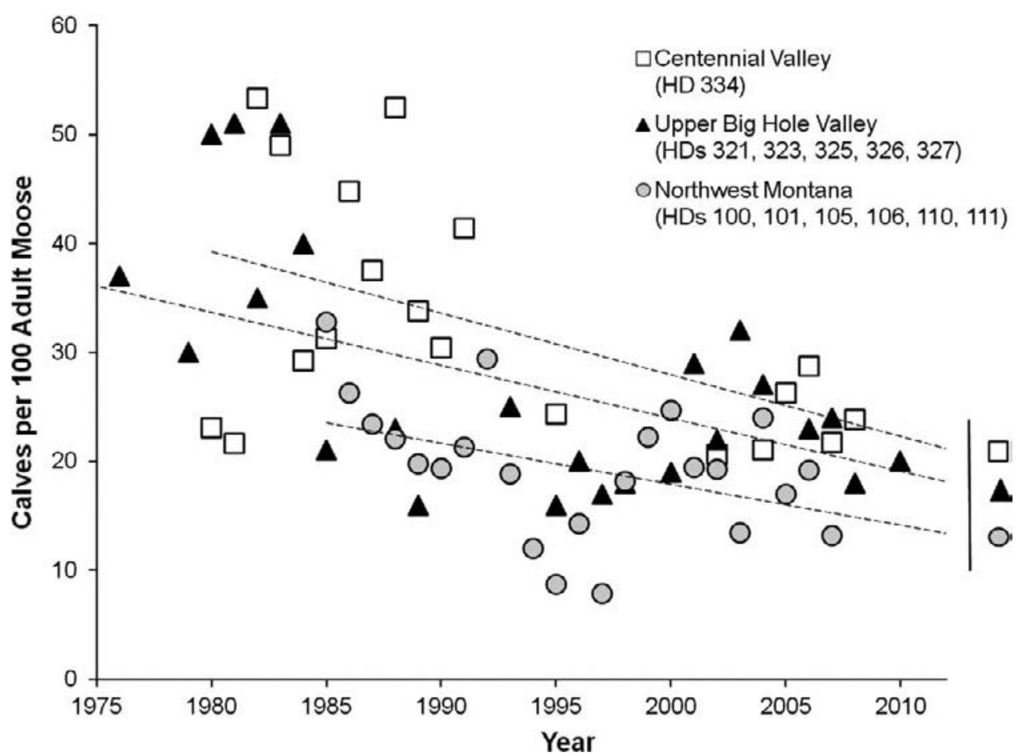


Fig. 5. Annual moose calves per 100 adult recruitment data and associated linear regression trend lines calculated from fixed-wing and helicopter late winter aerial surveys in 3 regions of Montana, 1976–2010.

in southwest Montana indicated that hunter harvest and nutritional inadequacies were the most important factors limiting moose populations, whereas parasites, disease, and predation had little direct effect on mortality rates (Schladweiler 1974). Presently there is a need to re-evaluate the relative importance of potential limiting factors in light of recent changes in many of these factors and subsequent monitoring and research in Montana and elsewhere.

Hunter harvest

The goals and objectives behind moose hunter harvest quotas vary somewhat across MFWP regional jurisdictions. Managers in Regions 1 and 3, where populations are largest, generally aim to sustainably maximize hunter opportunity and minimize landowner conflicts (e.g., greater numbers of permits that include either-sex or antlerless opportunities), whereas regions 2, 4, 5, and 6 manage harvest with less intent to affect moose population dynamics (e.g., bull-only hunting or low permit numbers). During the past 2 decades, numbers of antlerless permits were increased substantially in certain areas, particularly in Region 3, in response to depredation complaints, perceptions that moose were unfavorably limiting vegetative growth (i.e., riparian plants), and high moose counts on aerial surveys. These prescriptive increases in moose permits were intended to induce local declines in some hunting districts.

Statewide, the sex ratio of harvested adult moose (i.e., excluding calves) averaged 28% female in 1971–2008, but dropped to an average of 14% in 2009–2012; female harvest is through either-sex and antlerless-only permits. In Region 1, either-sex tags were issued historically, and harvest was typically skewed heavily towards males; the 1984–2004 harvest was 78% bulls, 19% cows, and 3% calves. As of 2012, all permits in this region were changed to antlered-bull only. In Region 3, permits have been typically specified as antlered- or antlerless-only, which is more restrictive to hunters but facilitates targeted management.

Additional moose harvest by members of the Confederated Salish and Kootenai Tribes (CSKT) is permitted off-reservation by the Hellgate Treaty of 1855. One permit per year is allowed to each interested Tribal member for hunting on primarily federal land, with mandatory reporting to CSKT officials. While the sample size of animals harvested is lower than that regulated by MFWP, these harvest data provide additional opportunity for indexing population trend and are without confounding changes in permit number and type. Trends in tribal harvest are similar to that of the MFWP (Fig. 6); total harvest peaked in 1991 at 97 representing an additional 16.3% to the MFWP harvest of 595, and in 2012 the Tribal harvest was only 18, an additional 6.6% to the MFWP harvest of 274 moose. We point out that interpretation of tribal harvest statistics with respect to the rate of population change is also not unambiguous. While some evidence exists of reduced success by tribal hunters (Fig. 6), a portion of the decline can probably be attributed to fewer permit requests. Also, these data do not include information about hunter effort or tribal interest in hunting other game species as allowed by treaty rights.

Illegal harvest of moose also occurs but has not been quantified to date. Data from Idaho suggest that illegal harvest can represent upwards of 31–50% of mortality (Pierce et al. 1985, Toweill and Vecellio 2004), warranting explicit monitoring and documentation of such in Montana.

Predation

After decades of predator control in the early and mid-1900s, and subsequent recovery efforts in the late 1900s, Montana currently hosts widespread populations of

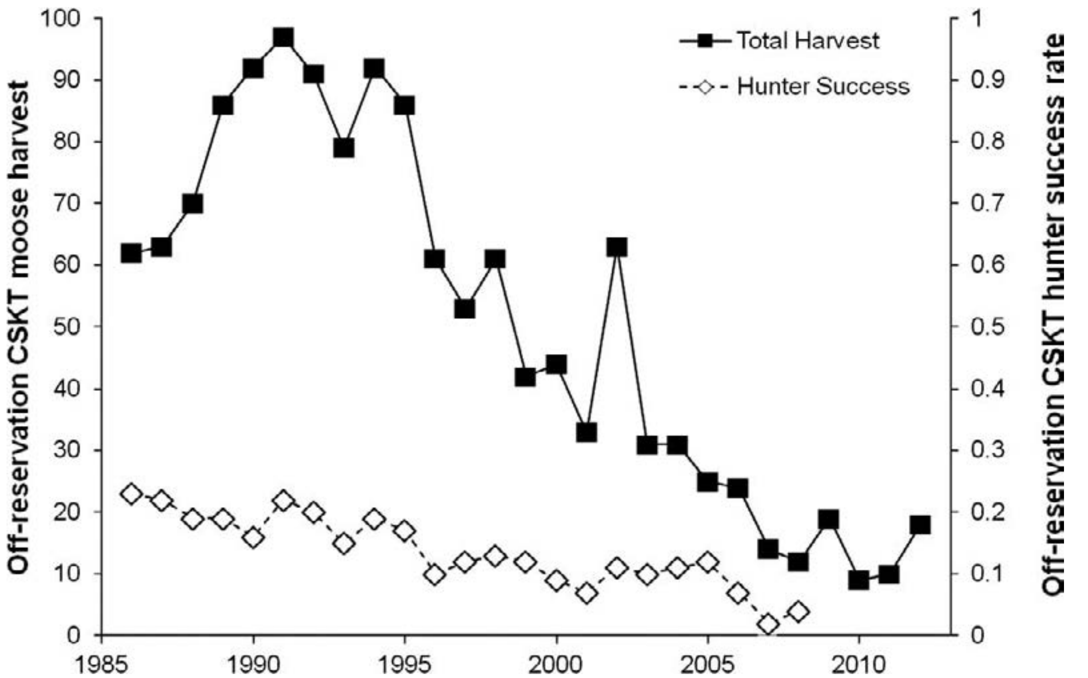


Fig. 6. Moose harvest and hunter success rates by members of the Confederated Salish and Kootenai Tribes (CSKT) off-reservation (primarily on federal lands in western Montana), 1986–2012.

grizzly bears (*Ursus arctos*), black bears (*Ursus americanus*), wolves, mountain lions (*Puma concolor*), and coyotes (*Canis latrans*). While predation was not considered a concern 40 years ago (Schladweiler 1974), the expanded composition and abundance of predator species may have the potential to limit local moose populations. Predation was the most common concern of regional biologists relative to moose population dynamics.

Research on winter prey selection by recolonizing wolves in the North Fork of the Flathead River drainage from 1986–1996 indicated that while wolves disproportionately used areas where deer were concentrated, they preferentially killed larger moose and elk over more abundant deer. Moose, particularly calves and cows, comprised a greater proportion of wolf kills as winter progressed (Kunkel et al. 2004). However, annual survival of 32 adult female moose monitored concurrently in the North Fork (1990–1992) was relatively high (0.9137 ± 0.0773; Langley 1993), with 3 mortalities attributable to predation (1 wolf and 2 grizzly bear). In a recent dietary study of 12 wolf packs in northwest Montana, moose was the most common prey item based on stable isotope analysis, constituting an average of 41% of the diet; however, these results were not supported by scat analysis from a sub-set of 4 packs in which moose averaged 18% of the diet (Derbridge et al. 2012).

High densities of elk and deer throughout much of the Rocky Mountain region may support higher predator populations and facilitate increased predation rates on sympatric moose via apparent competition (Holt 1977). In such cases, a less abundant, secondary prey species can become more vulnerable to depensatory predation when faced with predator populations boosted by more numerous primary prey species (Messier 1995, Garrott et al. 2009). While moose across much of Canada have been attributed with the role of a primary prey species driving predator-mediated declines in less abundant woodland caribou (*Rangifer tarandus caribou*) populations (DeCesare et al. 2010), they may in fact be vulnerable themselves to such a mechanism within the elk- and deer-dominated prey populations of Montana. The effects of apparent competition from increased predation risk may be reduced somewhat by differential selection of winter and calving habitat among ungulates. Moose in Montana typically use higher elevations during winter and may accordingly spatially separate themselves from increased predation risk in some cases (Jenkins and Wright 1988, Burcham et al. 2000, Kunkel and Pletscher 2001).

The ultimate effect of predators on prey dynamics varies according to predation rates on different age classes (Gervasi et al. 2011), as well as with differences in the nutritional quality of prey habitat (Melis et al. 2009). Because moose may have colonized many areas of western Montana when predators were largely reduced, it is uncertain to what extent recolonized and expanding predator populations pose an additive source of mortality on local populations. In such cases, management of moose populations may require that predation rates be accounted for when deriving sustainable harvest quotas (Hobbs et al. 2012).

Vegetative succession and degradation

Moose habitat requirements and preferences have been well documented (reviewed by Peek 2007, Shipley 2010). Moose in Montana use a variety of mid to high elevation forest types in summer, including closed canopy lodgepole pine (*Pinus contorta*) and subalpine fir (*Abies lasiocarpa*) forests, as well as aspen (*Populus tremuloids*) and willow (*Salix* spp.) stands, mountain parklands, and alpine meadows (Knowlton 1960, Peek 1962, Schladweiler 1974). During winter, they often forage on willow where available, and snow depth can either restrict local use and movement (Burkholder 2012) or shift use to conifer forests (Tyers 2003).

Many studies of Shiras moose in the Rocky Mountains have documented the importance of early successional habitats (Peek 2007). Large-extent wildfires in 1910, 1919, and 1929 converted much of the conifer forest in northwest Montana to early-seral stages and moose populations in the state appeared to increase in response (Brown 2006). While the positive association with early successional habitat following wildfires is well documented, negative impacts of the 1988 fires in Yellowstone National Park contradict this tenant (Tyers 2006; Vartanian et al. 2011). During the 1950s–1980s, timber harvest became the dominant form of disturbance shaping conifer forests in the West and was generally favorable to moose, particularly 10–30 years following harvest (Eastman 1974, Matchett 1985, Telfer 1995). It is believed that the high amount of timber harvest combined with fire history may have set the stage for abundant moose populations through the early 1990s (Brown 2006). A time-lagged decrease in early-seral forests has presumably resulted from reduced timber harvesting since the late 1980s (Spoelma et al. 2004).

Riparian areas have been severely degraded globally by a variety of stressors (Richardson et al. 2007), and in some parts of the western United States, cottonwood-willow riparian habitats have been reduced by as much as 90–95% (Johnson and Carothers 1982). Historically, persistent riparian habitat along rivers and streams may have provided long-term stability to moose populations and functioned as corridors to allow moose to expand into ephemeral post-fire habitats (Peek 2007). In many areas of Montana, habitat management has focused on restoration of riparian areas via fencing and grazing management with the goal of restoring robust willow communities.

Parasites

Moose are exposed to a suite of parasites with potential implications for population dynamics. Winter ticks (*Dermacentor albipictus*) are known to occur in moose range across much of North America south of 60° N latitude (Samuel 2004), and have been detected in disparate regions and vegetation types of Montana (N. DeCesare, unpublished data). While data are not available concerning the demographic impact of ticks on moose in Montana, negative effects of ticks on moose populations have been well documented elsewhere (Samuel 2007, Musante et al. 2010). Given that die-offs have been known to occur synchronously across various portions of moose range (DelGiudice et al. 1997), impacts of tick epizootics on moose in Montana seem likely.

Giant liver flukes (*Fascioloides magna*) were reported as the greatest single source of mortality for a declining moose population in northwest Minnesota (Murray et al. 2006, Lankester and Foreyt 2011). Such effects of flukes on moose mortality may be accentuated when individuals are malnourished (Lankester and Samuel 2007). Both *F. magna* and the common liver fluke (*F. hepatica*) have been documented widely within Montana's cattle populations (Knapp et al. 1992), and multiple species of lymnaid snails, the intermediate host, are also known to occur (Dunkel et al. 1996). Data concerning infection rates or impacts of flukes on moose or other wild ungulates in Montana are lacking.

Also of concern in Minnesota and elsewhere in eastern North American is the meningial worm (*Parelaphostrongylus tenuis*). Prevalent in central and eastern moose populations, this parasite is carried by white-tailed deer, transmitted by terrestrial gastropod intermediate hosts, and is commonly associated with moose declines in areas of high overlap with dense deer populations (Lankester 2010). While *P. tenuis* has not been documented in Montana, detection of infected white-tailed deer in western North Dakota suggest the possibility of intermittent spread into portions of Montana (Maskey 2008).

The arterial worm (*Elaeophora schneideri*) is a filarioid nematode found in the common carotid and internal maxillary arteries of ungulates in the west and southwestern US (Henningsen et al. 2012). Mule deer are definitive hosts of carotid worms, while moose and other ungulates are aberrant hosts, susceptible to blockage of blood to the optic nerve, ears, and brain and related symptoms such as blindness, ataxia, necrosis of the muzzle and nostrils, and emaciation (Hibler and Metzger 1974). *E. schneideri* was first detected in moose in Montana in 1971 (Worley et al. 1972), and subsequent sampling of 74 harvested moose detected carotid worms in 3 (4.0%; Worley 1975). More recently, approximately 30% prevalence was detected in Montana among 94 moose harvested in 2009–10 (J. Ramsey, MFWP, unpublished data) and 49% prevalence (n = 165) was detected in Wyoming (Henningsen et al. 2012). While infection is not necessarily lethal, increasing prevalence and the potential for subclinical effects warrant further investigation.

Climate

Moose in North America occur across a great range of latitudes (40° N to 70° N), though generally are best-adapted for cold climates (Renecker and Hudson 1986). Winter severity can affect physical condition (Cederlund et al. 1991) and fecundity (Solberg et al. 1999) of moose, yet recent attention has been given largely to concerns over warm temperatures. A small sample (n = 2) of captive moose in Alberta exhibited metabolic and respiratory signs of heat stress at temperatures above −5°C and 14°C in winter and summer, respectively (Renecker & Hudson 1986). In Minnesota, a heat stress index based on these thresholds explained >78% of the annual variability in moose survival (Lenarz et al. 2009), and annual population growth rates decreased with increasing summer temperatures (Murray et al. 2006). Concerns over heat stress effects on moose are compounded by predicted patterns of future climatic warming across southern moose ranges (Lenarz et al. 2010), yet much remains unclear and the relationships in Minnesota were strictly correlative.

It is not known whether the mechanism linking temperature to demography is a direct link between heat stress and malnutrition (Murray et al. 2006) or an indirect link via parasites or other mortality agents (Samuel 2007). Increased mortality as a result of heat stress is likely to result in decreased abundance and a contraction in moose distribution along the southern range extent, yet local expansions of moose in other southern jurisdictions (e.g., Base et al. 2006, Wolfe et al. 2010, Wattles and DeStefano 2011) and an Ontario field study (Lowe et al. 2010) do not directly support this hypothesis. Within Montana it is unclear whether any climatic variables underlie spatial variation in the productivity of local populations.

RESEARCH NEEDS AND FUTURE DIRECTIONS

Comprehensive review of the current status of moose and methods in practice for monitoring and management revealed 3 primary research needs in Montana: 1) calibration of various trend indices to evaluate agreement and uncertainty regarding moose population trends, 2) development or refinement of monitoring programs to produce consistent data at appropriate scales to inform harvest or habitat management decisions, and 3) research into rates of adult survival and recruitment and the potential limiting factors of each. Accordingly, during fiscal year 2012–2013 the MFWP began directing moose permit auction funds toward a new research program to address these research needs. Generally speaking, the work aims to provide rigorous and reliable information as a foundation for understanding moose population dynamics and management practices in Montana.

ACKNOWLEDGEMENTS

Funding for this work was provided by the sale of hunting and fishing licenses in Montana and matching Pittman-Robertson grants to the Montana Department of Fish, Wildlife and Parks. K. Alt (retired), H. Burt, G. Taylor, M. Thompson, and J. Williams provided valuable insights on regional histories and priorities for moose management and facilitated communication with MFWP area biologists V. Boccadori, R. Brannon, J. Cunningham, J. Brown (retired), V. Edwards, C. Fager, A. Grove, C. Jourdannais, J. Kolbe, B. Lonner, G. Olson (retired), R. Rauscher, J. Sika, B. Sterling, S. Stewart, T. Thier, R. Vinkey, J. Vore, and A. Wood. D. Becker, J. Cunningham, V. Edwards, and J. Newby were especially helpful with tracking down and interpreting moose data and reports. J. Warren provided valuable insight on moose research and habitat management as well as database development. A. Messer provided valuable guidance and advice on available GIS data, database design, and data standardization and capture. K. Smucker and J. Newby provided valuable comments on previous versions of this manuscript. J. Van Andel provided invaluable administrative support.

LITERATURE CITED

Base, D. L., S. Zender, and D. Martorello. 2006. History, status, and hunter harvest of moose in Washington state. Alces 42: 111–114.

Bontaities, K. M., K. A. Gustafson, and R. Makin. 2000. A Gasaway-type moose survey in New Hampshire using infrared thermal imagery: preliminary results. Alces 36: 69–75.

Bowyer, R. T., M. C. Nicholson, E. M. Molvar, and J. B. Faro. 1999. Moose on Kalgin Island: are density-dependent processes related to harvest? Alces 35: 73–90.

Boyce, M. S., P. W. J. Baxter, and H. P. Possingham. 2012. Managing moose harvests by the seat of your pants. Theoretical Population Biology 82: 340–347.

Brown, J. 2006. Moose management in northwest Montana: Region 1 annual report. Montana Fish, Wildlife and Parks, Libby, Montana, USA.

Burcham, M., C. L. Marcum, D. McCleerey, and M. Thompson. 2000. Final report: study of sympatric moose and elk in the Garnet Range of western Montana, 1997–2000. University of Montana, Missoula, Montana, USA.

Burkholder, B. O. 2012. Seasonal distribution, winter habitat selection and willow utilization patterns of the Shiras moose on the Mount Haggin Wildlife Management Area. M.S. Thesis, Montana State University, Bozeman, Montana, USA.

Cada, J. D. 1983. Evaluations of the telephone and mail survey methods of obtaining harvest data from licensed sportsmen in Montana. Pages 117–128 *in* S. L. Beasom and S. F. Roberson, editors. Game Harvest Management. Caesar Kleberg Research Institute, Kingsville, Texas, USA.

Cederlund, G. N., H. K. G. Sand, and Å. Pehrson. 1991. Body mass dynamics of moose calves in relation to winter severity. Journal of Wildlife Management 55: 675–681.

DeCesare, N. J., M. Hebblewhite, M. Bradley, K. G. Smith, D. Hervieux, and L. Neufeld. 2012. Estimating ungulate recruitment and growth rates using age ratios. Journal of Wildlife Management 76: 144–153.

———, ———, H. S. Robinson, and M. Musiani. 2010. Endangered, apparently: the role of apparent competition in endangered species conservation. Animal Conservation 13: 353–362.

DelGiudice, G. D., R. O. Peterson, and W. M. Samuel. 1997. Trends of winter nutritional restriction, ticks, and numbers of moose on Isle Royale. Journal of Wildlife Management 61: 895–903.

Derbridge, J. J., P. R. Krausman, and C. T. Darimont. 2012. Using Bayesian stable isotope mixing models to estimate wolf diet in a multi-prey ecosystem. Journal of Wildlife Management 76: 1277–1289.

Dunkel, A. M., M. C. Rognlie, G. Rob Johnson, and S. E. Knapp. 1996. Distribution of potential intermediate hosts for *Fasciola hepatica* and *Fascioloides magna* in Montana, USA. Veterinary Parasitology 62: 63–70.

Eastman, D. S. 1974. Habitat use by moose of burns, cutovers and forests in north-central British Columbia. Proceedings of the North American Moose Conference Workshop 10: 238–256.

Eberhardt, L. L. 2002. A paradigm for population analysis of long-lived vertebrates. Ecology 83: 841–2854.

Ericsson, G., and K. Wallin. 1999. Hunter observations as an index of moose *Alces alces* population parameters. Wildlife Biology 5: 177–185.

Fryxell, J. M., W. E. Mercer, and R. B. Gellately. 1988. Population dynamics of Newfoundland moose using cohort analysis. Journal of Wildlife Management 52: 14–21.

Gaillard, J. M., M. Festa-Bianchet, and N. G. Yoccoz. 1998. Population dynamics of large herbivores: variable recruitment with constant adult survival. Trends in Ecology & Evolution 13: 58–63.

Garrott, R. A., P. J. White, M. S. Becker, and C. N. Gower. 2009. Apparent competition and regulation in a wolf-ungulate system: interactions of life history characteristics, climate, and landscape attributes. Pages 519–540 *in* R. A. Garrott, P. J. White, and F. G. R. Watson, editors. The Ecology of Large Mammals in Central Yellowstone: Sixteen Years of Integrated Field Studies. Elsevier, San Diego, California, USA.

Gervasi, V., E. B. Nilsen, H. Sand, M. Panzacchi, G. R. Rauset, H. C. Pedersen, J. Kindberg, P. Wabakken, B. Zimmermann, J. Odden, O. Liberg, J. E. Swenson, and J. D. C. Linnell. 2011. Predicting the potential demographic impact of predators on their prey: a comparative analysis of two carnivore–ungulate systems in Scandinavia. Journal of Animal Ecology 81: 443–454.

Henningsen, J. C., A. L. Williams, C. M. Tate, S. A. Kilpatrick, and W. D. Walter. 2012. Distribution and prevalence of *Elaeophora schneideri* in moose in Wyoming. Alces 48: 35–44.

Hibler, C. P., and C. J. Metzger. 1974. Morphology of the larval stages of *Elaeophora schneideri* in the intermediate and definitive hosts with some observations on their pathogenesis in abnormal definitive hosts. Journal of Wildlife Diseases 10: 361–369.

Hobbs, N. T., H. Andrén, J. Persson, M. Aronsson, and G. Chapron. 2012. Native predators reduce harvest of reindeer by Sámi pastoralists. Ecological Applications 22: 1640–1654.

Holt, R. D. 1977. Predation, apparent competition, and the structure of prey communities. Theoretical Population Biology 12: 197–229.

Hundertmark, K. J., and R. T. Bowyer. 2004. Genetics, evolution, and phylogeography of moose. Alces 40: 103–122.

———, ———, G. F. Shields, and C. C. Schwartz. 2003. Mitochondrial phylogeography of moose (*Alces alces*) in North America. Journal of Mammalogy 84: 718–728.

———, G. F. Shields, I. G. Udina, R. T. Bowyer, A. A. Danilkin, and C. C. Schwartz. 2002. Mitochondrial phylogeography of moose (*Alces alces*): late pleistocene divergence and population expansion. Molecular Phylogenetics and Evolution 22: 375–387.

Hunt, L. M. 2013. Using human-dimensions research to reduce implementation uncertainty for wildlife management: a case of moose (*Alces alces*) hunting in northern Ontario, Canada. Wildlife Research 40: 61–69.

Jenkins, K. J., and R. G. Wright. 1988. Resource partitioning and competition among cervids in the Northern Rocky Mountains. Journal of Applied Ecology 25: 11–24.

Johnson, R. R., and S. W. Carothers. 1982. Riparian habitats and recreation: interrelationships and impacts in the Southwest and Rocky Mountain region. USAD Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, USA.

Karns, P. D. 2007. Population distribution, density, and trends. Pages 125–140 *in* A.W. Franzmann and C.C. Schwartz, editors. Ecology and Management of the North American Moose. University Press of Colorado, Boulder, Colorado, USA.

Knapp, S. E., A. M. Dunkel, K. Han, and L. A. Zimmerman. 1992. Epizootiology of fascioliasis in Montana. Veterinary Parasitology 42: 241–246.

Knowlton, F. F. 1960. Food habits, movements and populations of moose in the Gravelly Mountains, Montana. Journal of Wildlife Management 24: 162–170.

Kunkel, K. E., and D. H. Pletscher. 2001. Winter hunting patterns of wolves in and near Glacier National Park, Montana. Journal of Wildlife Management 65: 520–530.

———, ———, D. K. Boyd, R. R. Ream, and M. W. Fairchild. 2004. Factors correlated with foraging behavior of wolves in and near Glacier National Park, Montana. Journal of Wildlife Management 68: 167–178.

Langley, M. A. 1993. Habitat selection, mortality and population monitoring of Shiras moose in the North Fork of the Flathead River Valley, Montana. M.S. Thesis, University of Montana, Missoula, Montana, USA.

Lankester, M. W. 2010. Understanding the impact of meningeal worm, *Parelaphostrongylus tenuis*, on moose populations. Alces 46: 53–70.

Lankester, M. W., and W. J. Foreyt. 2011. Moose experimentally infected with giant liver fluke (*Fascioloides magna*). Alces 47: 9–15.

———, and W. M. Samuel. 2007. Pests, parasites, and disease. Pages 479–517 *in* A.W. Franzmann and C.C. Schwartz, editors. Ecology and Management of the North American Moose. University Press of Colorado, Boulder, Colorado, USA.

Lenarz, M. S., J. Fieberg, M. W. Schrage, and A. J. Edwards. 2010. Living on the edge: viability of moose in northeastern Minnesota. Journal of Wildlife Management 74: 1013–1023.

———, M. E. Nelson, M. W. Schrage, and A. J. Edwards. 2009. Temperature mediated moose survival in northeastern Minnesota. Journal of Wildlife Management 73: 503–510.

Lowe, S. J., B. R. Patterson, and J.A. Schaefer. 2013. Lack of behavioral response of moose (*Alces alces*) to high ambient temperatures near the sourthern periphery of their range. Canadian Journal of Zoology 88: 1032–1041.

Lukacs, P. M., J. A. Gude, R. E. Russell, and B. B. Ackerman. 2011. Evaluating cost-efficiency and accuracy of hunter harvest survey designs. Wildlife Society Bulletin 35: 430–437.

———, G. C. White, B. E. Watkins, R. H. Kahn, B. A. Banulis, D. J. Finley, A. A. Holland, J. A. Martens, and J. Vayhinger. 2009. Separating components of variation in survival of mule deer in Colorado. Journal of Wildlife Management 73: 817–826.

Maskey, J. J. 2008. Movements, resource selection, and risk analyses for parasitic disease in an expanding moose population in the northern Great Plains. Ph. D. Thesis, University of North Dakota, Grand Forks, North Dakota, USA.

Matchett, M. R. 1985. Habitat selection by moose in the Yaak River drainage, northwestern Montana. Alces 21: 161–190.

Melis, C., B. Jędrzejewska, M. Apollonio, K. A. Bartoń, W. Jędrzejewski, J. D. C. Linnell, I. Kojola, J. Kusak, M. Adamic, S. Ciuti, I. Delehan, I. Dykyy, K. Krapinec, L. Mattioli, A. Sagaydak, N. Samchuk, K. Schmidt, M. Shkvyrya, V. E. Sidorovich, B. Zawadzka, and S. Zhyla. 2009. Predation has a greater impact in less productive environments: variation in roe deer, *Capreolus capreolus*, population density across Europe. Global Ecology and Biogeography 18: 724–734.

Messier, F. 1995. On the functional and numerical responses of wolves to changing prey density. Ecology and conservation of wolves in a changing world. Canadian Circumpolar Institute, Occasional Publication 35: 187–198.

Murray, D. L., E. W. Cox, W. B. Ballard, H. A. Whitlaw, M. S. Lenarz, T. W. Custer, T. Barnett, and T. K. Fuller. 2006. Pathogens, nutritional deficiency, and climate influences on a declining moose population. Wildlife Monographs 166: 1–30.

Musante, A. R., P. J. Pekins, and D. L. Scarpitti. 2010. Characteristics and dynamics of a regional moose *Alces alces* population in the northeastern United States. Wildlife Biology 16: 185–204.

Nelson, E. W. 1914. Description of a new subspecies of moose from Wyoming. Proceedings of the Biology Society of Washington 27: 71–74.

Peek, J. M. 1962. Studies of moose in the Gravelly and Snowcrest Mountains, Montana. Journal of Wildlife Management 26: 360–365.

———. 2007. Habitat relationships. Pages 351–375 in *in* A.W. Franzmann and C. C. Schwartz, editors. Ecology and Management of the North American Moose. University Press of Colorado, Boulder, Colorado, USA.

Peterson, R. L. 1952. A review of the living representatives of the genus *Alces*. Royal Ontario Museum. Life Sciences Division, Toronto, Ontario, Canada.

Pierce, D. J., B. W. Ritchie, and L. Kuck. 1985. An examination of unregulated harvest of Shiras moose in Idaho. Alces 21: 231–252.

Renecker, L. A., and R. J. Hudson. 1986. Seasonal energy expenditures and thermoregulatory responses of moose. Canadian Journal of Zoology 64: 322–327.

Rich, L. N., E. M. Glenn, M. S. Mitchell, J. A. Gude, K. Podruzny, C. A. Sime, K. Laudon, D. E. Ausband, and J. D. Nichols. 2013. Estimating occupancy and predicting numbers of gray wolf packs in Montana using hunter surveys. Journal of Wildlife Management 77: 1280–1289.

Richardson, D. M., P. M. Holmes, K. J. Esler, S. M. Galatowitsch, J. C. Stromberg, S. P. Kirkman, S. P. Pysek, and R. J. Hobbs. 2007. Riparian vegetation: degradation, alien plant invasions, and restoration projects. Diversity and Distributions 13: 126–139.

Samuel, W. M. 2004. White as a Ghost: Winter Ticks and Moose. Natural History Series, Volume 1. Federation of Alberta Naturalists, Edmonton, Alberta, Canada.

———. 2007. Factors affecting epizootics of winter ticks and mortality of moose. Alces 43: 39–48.

Schladweiler, P. 1974. Ecology of Shiras moose in Montana. Montana Department of Fish and Game, Helena, Montana, USA.

Schmidt, J. I., J. A. Y. M. Ver Hoef, J. A. K. Maier, and R. T. Bowyer. 2005. Catch per unit effort for moose: a new approach using Weibull regression. Journal of Wildlife Management 69: 1112–1124.

Shipley, L. 2010. Fifty years of food and foraging in moose: lessons in ecology from a model herbivore. Alces 46: 1–13.

Smucker, T., R. A. Garrott, and J. A. Gude. 2011. Synthesizing moose management, monitoring, past research and future research needs in Montana. Montana Fish, Wildlife, and Parks, Helena, Montana, USA.

Solberg, E. J., B. E. Saether, O. Strand, and A. Loison. 1999. Dynamics of a harvested moose population in a variable environment. Journal of Animal Ecology 68: 186–204.

Spoelma, T. P., T. A. Morgan, T. Dillon, A. L. Chase, C. E. Keegan, and L. T. DeBlander. 2004. Montana's forest products industry and timber harvest, 2004. Resource Bulletin, USDA Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado, USA.

State of Montana. 1910. Biennial report of the state game and fish warden of the State of Montana, 1909–1910. Montana Fish, Wildlife, and Parks, Helena, Montana, USA.

Stevens, D. R. 1971. Shiras Moose. Pages 89–95 in T. W. Mussehl and F. W. Howell, editors. Game Management in Montana. Montana Fish, Wildlife, and Parks, Helena, Montana, USA.

Telfer, E. S. 1995. Moose range under presettlement fire cycles and forest management regimes in the boreal forest of western Canada. Alces 31: 153–165.

Toweill, D. E., and G. Vecellio. 2004. Shiras moose in Idaho: status and management. Alces 40: 33–43.

Tyers, D. B. 2003. Winter ecology of moose on the northern Yellowstone winter range. Ph. D. Dissertation, Montana State University, Bozeman, Montana, USA.

———. 2006. Moose population history on the northern Yellowstone winter range. Alces 42: 133–149.

VARTANIAN, J. M. 2011. Habitat condition and the nutritional quality of seasonal forage and diets: demographic implications for a declining moose population in northwest Wyoming, USA. M.S. Thesis, University of Wyoming, Laramie, Wyoming, USA.

WATTLES, D. W., and S. DESTEFANO. 2011. Status and management of moose in the northeastern United States. Alces 47: 53–68.

WOLFE, M. L., K. R. HERSEY, and D. C. STONER. 2010. A history of moose management in Utah. Alces 46: 37–52.

WORLEY, D. E. 1975. Observations on epizootiology and distribution of *Elaeophora schneideri* in Montana ruminants. Journal of Wildlife Diseases 11: 486–488.

———, C. K. ANDERSON, and K. R. GREER. 1972. Elaeophorosis in moose from Montana. Journal of Wildlife Diseases 8: 242–244.

APPENDIX A: MOOSE MANAGEMENT SURVEY QUESTIONS PROVIDED TO 20 MFWP BIOLOGISTS IN 2010.

1. In your experience and professional judgment, what are the major concerns or limiting factors for moose in your area of responsibility (can choose more than one)?
   [ ] Disease
   [ ] Predation
   [ ] Hunter harvest
   [ ] Habitat loss/ fragmentation
   [ ] Habitat succession
   [ ] Other: ____________
2. How would you describe the current status of moose within your area of responsibility?
   [ ] Decreasing
   [ ] Stable
   [ ] Increasing
3. What type of moose management decisions are you typically required to make?
   [ ] Harvest quota recommendations
   [ ] Habitat enhancement
   [ ] Habitat conservation
   [ ] Large carnivore harvest recommendations
4. What information do you currently have and use for moose management (this information should be collected at the time of interview)?
   [ ] Landowner reports
   [ ] Hunter reports
   [ ] Unadjusted trend counts
   [ ] Sightability-corrected population estimates
   [ ] Recruitment ratio counts
   [ ] Bull: Cow ratio counts
   [ ] Harvest estimates
   [ ] Habitat condition
5. Which limiting factors have you addressed with moose management programs or decisions (this question will be accompanied by collection of past management actions: season proposals & rationales, regulations, specific habitat enhancement projects, land management plans, etc.)?
   [ ] Disease
   [ ] Predator harvest or control
   [ ] Moose harvest
   [ ] Habitat management
   [ ] Habitat conservation
   [ ] Other: __________
6. How would you describe your moose survey and inventory information?
   [ ] Adequate to make decisions for moose management
   [ ] Adequate in some ways, not adequate in others
   [ ] Not adequate to make moose management decisions
7. What information would most help you in your efforts to conserve and manage moose populations in your area?
8. Can you list previous research projects and products from your area, and describe how results have been applied in your current management program?

APPENDIX B

H.R. Bill 5751
Shiras Moose Protection and Recovery Act

BGF
BIGGAME FOREVER

I

114TH CONGRESS
2D SESSION

H. R. 5751

To provide that any State whose wildlife agency has determined that a portion of the State is within the current range of the Shiras Moose may take management actions on certain Federal lands within that State to stem decline of that species' population in that State, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

JULY 13, 2016

Mr. CHAFFETZ (for himself, Mr. STEWART, Mrs. LOVE, Mr. TIPTON, Mr. ZINKE, and Mrs. LUMMIS) introduced the following bill; which was referred to the Committee on Natural Resources

---

A BILL

To provide that any State whose wildlife agency has determined that a portion of the State is within the current range of the Shiras Moose may take management actions on certain Federal lands within that State to stem decline of that species' population in that State, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the ''Shiras Moose Protection and Recovery Act''.

SEC. 2. STATE MANAGEMENT ACTIONS ON FEDERAL LANDS TO STEM DECLINE OF SHIRAS MOOSE.

(a) IN GENERAL.—Any State whose wildlife agency has determined that a portion of the State is within the current range of the Shiras Moose (Alces alces) may take management actions on covered Federal lands within that State to stem decline of that species' population in that State.

(b) MONITORING.—

(1) IN GENERAL.—Any State taking management actions on covered Federal lands with respect to Shiras Moose shall monitor that species' population within that State for a period of not less than ____ years following the enactment of this Act.

(2) FUNDING.—

(A) AUTHORIZATION.—There is authorized to be appropriated $________ for costs of State monitoring under this section.

(B) ALLOCATION.—Amounts appropriated under this paragraph shall be allocated and distributed among States based on—

(i) the estimated number of acres of covered Federal land in each State that is Shiras Moose habitat, divided by

(ii) the number of acres of current covered Federal land in States that is Shiras Moose habitat.

(C) CALCULATION.—For purposes of subparagraph (B), the number of acres of Shiras Moose habitat in a State shall be calculated by the head of the State agency with authority over wildlife management.

(c) RECOVERY PLANS.—

(1) IN GENERAL.—Where monitoring, combined with existing State science on the Shiras Moose population trends, shows an unacceptable decline in the populations of such species as determined by a State wildlife agency, the State may formulate a recovery plan to mitigate the population decline.

(2) FUNDING.—

(A) IN GENERAL.—The Director of the United States Fish and Wildlife Service shall provide to any State that formulates a recovery plan, upon request of the State, funding for implementation of the plan from funds appropriated to the United States Fish and Wildlife Service to implement its Northern Rocky Mountain Gray Wolf Recovery Plan and any of its other gray wolf recovery or monitoring plans.

(B) ALLOCATION.—If State requests for such funds exceed the funds so appropriated to the United States Fish and Wildlife Service for any fiscal year, the Director shall distribute such funds to such States on the same basis that funds are distributed under subsection (b)(2)(B).

(d) UTAH AND COLORADO.—Each of the States of Utah and Colorado—

(1) may manage Shiras Moose and their predators on Federal, State, and private lands to prevent declines in moose populations within that State; and

(2) shall collect, analyze, and disseminate data on the results of such management.

(e) ISSUANCE OF FINAL RULE.—Before the end of the 60-day period beginning on the date of the enactment of this Act, the Secretary of the Interior shall issue as a final rule the draft rule entitled ''Removing the Gray Wolf (Canis lupus) From the List of Endangered and Threatened Wildlife and Maintaining Protections for the Mexican Wolf (Canis lupus baileyi) by Listing It as Endangered'' as published on June 13, 2013 (78 Fed. Reg. 35664), without regard to any other provision of statute that applies to issuance of such rule.

(f) EXEMPTION OF JUDICIAL REVIEW.—The requirements and implementation of this Act are not subject to judicial review.

(g) RELATIONSHIP TO OTHER LAW.—This section shall apply notwithstanding any other provision of statute or regulation.

(h) COVERED FEDERAL LAND DEFINED.—For purposes of this section the term ''Federal land'' means—

(1) public lands, as that term is defined in section 103(e) of the Federal Land Policy and Management Act of 1976 (43 U.S.C. 1702(e));

(2) lands in the National Forest System, as such System is declared and defined in section 11(a) of the Forest and Rangeland Renewable Resources Planning Act of 1974 (16 U.S.C. 1609(a)); and

(3) any area of the National Park System, as that term is defined in section 1.4 of title 36, Code of Federal Regulations (as in effect on the date of the enactment of this Act).

○

APPENDIX C

Congressman Jason Chaffetz Press Release

BGF
BIGGAME FOREVER

Wednesday, July 13, 2016

Contact: *MJ Henshaw*

202-225-7751

PERMALINK

Chaffetz Bill Protects Moose Populations Decimated by Wolves

State wildlife management can act quickly to stem 90% decline

WASHINGTON, D.C. – Today, Congressman Jason Chaffetz (UT-03) introduced *H.R. 5751, the Shiras Moose Protection and Recovery Act* of 2016, which would allow state wildlife agencies to aggressively and proactively recover Shiras Moose populations.

"The majestic Shiras Moose has seen a dramatic population decline since the introduction of wolves in the Northern Rocky Mountains. State wildlife agencies must act now to save this iconic American mammal. States have the tools and expertise to restore these populations – they just need the authority." Chaffetz said.

Moose populations were projected to decline by 7 – 13% with the 1995 reintroduction of the wolf to the habitat according to the Wolf Reintroduction Environmental Impact Statement. In reality, declines have been as high as 90%. Only a few hundred moose remain in the largest herds around Yellowstone National Park and Jackson, Wyoming. State wildlife managers can act quickly to reverse the trend provided they have authority to manage the moose and its predators.

###

WOLF REPORT

Contract No. 136039

September 2016

BIGGAME FOREVER