FINAL ENVIRONMENTAL ASSESSMENT

PREDATOR DAMAGE MANAGEMENT IN COLORADO

Prepared by:

UNITED STATES DEPARTMENT OF AGRICULTURE
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
WILDLIFE SERVICES

in cooperation with:

Colorado Department of Agriculture
Colorado Parks and Wildlife
Bureau of Land Management
U.S. Forest Service

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EXECUTIVE SUMMARY

Wildlife in Colorado are an important part of the social fabric that comprises the human environment. Abundant wildlife populations interact with the 5 million citizens of the state every day. The wildlife brings joy, happiness, improves the quality of life and at times brings conflict, damage and some frustration. On rare occasions people get hurt or worse by wildlife and these human-wildlife conflicts sometimes are caused by people feeding wildlife. The Wildlife Services program partners with Colorado Parks and Wildlife, the U. S. Fish and Wildlife Service, U. S. Forest Service, Bureau of Land Management and several other state and federal agencies to manage wildlife for the people who live and visit Colorado. This environmental assessment analyzes the potential environmental impacts of alternatives for the United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services program in Colorado to resolve conflicts caused by predatory animals. This damage abatement and analysis includes predation on livestock, threatened and endangered species, wildlife species of management concern; damage to other agricultural resources and property from predatory animals, and harm to human safety. The proposed wildlife damage management activities would be conducted on private, public and tribal lands when the property owner or manager requests assistance.

Predatory species may be obligate carnivores or omnivores. The predatory species primarily addressed in this environmental assessment include: coyotes, black bears, mountain lions, bobcats, raccoons, skunks, opossums, red fox, swift fox, feral dogs, feral cats, badger, crows, ravens, magpies, and several other migratory birds. Some of these species cause localized or seasonal damage whereas other species impact valuable agricultural and natural resources most of the year. Other predator species addressed in this environmental assessment rarely are involved in damage but are analyzed for population level impacts should they inadvertently be captured include pine marten, weasels and mink.

The proposed action (Alternative 1) continues the current WS-Colorado predator damage management program using the full range of legally available methods in accordance with applicable federal, state and local statutes. While the greatest effort expended by WS-Colorado program is for the protection of livestock from predation there likely will be more effort put towards restoration of threatened and endangered species (e.g., black-footed ferret, Colorado greenback cutthroat trout) and wildlife species of management concern impacted by predation which are identified by Colorado Parks and Wildlife, the U.S. Fish and Wildlife Service and other federal agencies. WS-Colorado will continue to provide technical assistance about methods to abate predation including different husbandry practices, exclusion, hazing, guard animals, range riding and habitat management practices. Each year, educational programs are provided to different commodity groups and special interest organizations to inform about wildlife damage management and this form of technical assistance will continue. The WS-Colorado program has always been involved in research to support finding multiple solutions for complex wildlife problems and this environmental assessment identifies potential future research the program may become involved with in collaboration with other wildlife management agencies and local government. We will support and become involved in research to alleviate wildlife damage with local universities, the National Wildlife Research Center and other government agencies. A third part of our technical assistance program is providing information about sources of supply for predator damage management and loaning of equipment (e.g., strobe-siren, pyrotechnics) to deter predation. WS-Colorado is actively involved working for landowners and land managers to alleviate damage by predatory wildlife through operational programs using an assortment of techniques including aerial predator management, calling and shooting aided by night-vision or forward looking infra-red scopes and cameras, hazing with dogs, cornering and taking some predators with the aid of dogs, capturing and euthanizing with Best Management Practices approved traps and snares, capturing and relocating some wildlife species when directed by Colorado Parks and Wildlife, using M-44's for coyotes and red fox.

Work Plans are developed annually to address management activities on public lands. These meetings are held with the Forest Service and Bureau of Land Management to plan activities, exchange information about wildlife and public use of the national forests and other federal lands, and maintain lines of communication.

The environmental assessment considered 4 alternatives in detail, including:

- Alternative 1 where WS-Colorado continues the current predator damage management program comprised of technical assistance, educational programs, collaborating on research, and conducting operational programs.
- Alternative 2 that discontinues all WS-Colorado involvement in predator damage management including technical assistance, educational programs, research or operational programs.
- Alternative 3 where WS-Colorado only provides technical assistance, loan of equipment or educational programs to anyone requesting assistance with predation damage.
- Alternative 4 where only lethal methods would be used by WS-Colorado to alleviate predation damage to livestock, natural resources and other resources. We would verify the damage and species causing the damage and then implement corrective action only where the damage is occurring. Producers and other government agencies would implement non-lethal methods if they desired.

The environmental assessment provides a detailed analysis of the impacts of each alternative for the range of issues identified as relevant to making selections among alternatives by the lead and cooperating agencies. Issues addressed in detail include: effects on target predator species populations; effects on non-target species populations, including T&E species; impact on public safety, pets, and the environment; and effects of predator damage management activities, on the use of public lands for recreation. An additional range of issues were discussed with rationale for not addressing the issue in detail for each alternative.

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ACRONYMS USED

ACEC	Area of Critical Environmental Concern
APHIS	Animal and Plant Health Inspection Service
AUM	Animal Unit Month
BISON-M	Biota Information System of New Mexico
BLM	Bureau of Land Management
BO	Biological Opinion
CDA	Colorado Department of Agriculture
CPW	Colorado Parks and Wildlife
CDPHE	Colorado Department of Public Health and Environment
CEQ	Council on Environmental Quality
CFR	Codes of Federal Regulations
CRS	Colorado Revised Statutes
DAU	Data Analysis Unit
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FLPMA	Federal Land Policy Management Act
FONSI	Finding of No Significant Impact
FPA	Future Planning Area
FY	Fiscal Year
GAV	General Aviation
GMU	Game Management Unit
IWDM	Integrated Wildlife Damage Management
LRMP	Land and Resource Management Plan
LTO	Long Term Objective
MIS	Management Information System
MOA	Military Operation Area
MOU	Memorandum of Understanding
MUSYA	Multiple-use Sustained Yield Act
NASS	National Agriculture Statistics Service
NEPA	National Environmental Policy Act
NF	National Forest
NFMA	National Forest Management Act
NG	National Grassland
NHPA	National Historical Preservation Act
PDM	Predator Damage Management
RA	Resource Area (BLM)
RMP	Resource Management Plan
SMA	Special Management Area
SOP	Standard Operating Procedure
T&E	Threatened and Endangered
UCI	Upper Confidence Interval
USC	U.S. Codes
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
WA	Wilderness Area
WDM	Wildlife Damage Management
WHHMA	Wild Horse Herd Management Area
WP	Work Plan
WS	Wildlife Services
WSA	Wilderness Study Area

CHAPTER 1: PURPOSE OF AND NEED FOR ACTION

1.1 INTRODUCTION

Wildlife, including mammalian predators, is a valuable natural resource, but some species of wildlife can cause problems with human interests. The U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Wildlife Services (WS) program has personnel with expertise to respond to damage caused by wildlife, including mammalian predators. Numerous predators within the order *Carnivora* and the Virginia opossum (*Didelphis virginianus*) are part of Colorado's wildlife heritage, including 20 native and three introduced/feral species that have the most likely potential to cause damage to resources in Colorado. WS conducts predator damage management (PDM) for several of these species. The species in Colorado that cause frequent damage to agricultural and natural resources, property, or threaten human health and safety include coyotes (*Canis latrans*), black bears (*Ursus americanus*), mountain lions (*Felis concolor*), striped skunks (*Mephitis mephitis)*, red fox (*Vulpes vulpes*), raccoons (*Procyon lotor*), and feral/free roaming dogs (*Canis familiaris*). Other predators in Colorado that have caused only localized damage on an occasional to annual basis, and at least once in the last 5 federal fiscal years (FY10-FY14; *i.e.*, Oct. 1, 2009 - Sept. 30, 2014) include bobcats (*Lynx rufus*), feral/free roaming cats (*Felis domesticus*), badgers (*Taxidea taxus*), and opossums. WS has provided very limited operational PDM or technical assistance for these species. In addition, Colorado has a few other predators that could invoke complaints, but none of these species created problems in the last 5 FYs that WS responded to. These species include kit fox (*V. macrotis*), swift fox (*V. velox*), ringtails (*Bassariscus astutus*), marten (*Martes americana*), mink (*Mustela vison*), ermine (*M. erminea*), gray fox *(Urocyon cinereoargenteus*), feral domestic ferrets (*M. putorius furo*), eastern spotted skunks (*Spilogale putorius*), western spotted skunks (*Spilogale gracilis*), long-tailed weasels (*M. frenata*), and hog-nosed skunks (*Conepatus mesoleucus*). PDM could be initiated to target any of the above species and will be covered in this Environmental Assessment (EA) per the National Environmental Policy Act (NEPA).

The Colorado Parks and Wildlife (CPW) manages the above species populations with the exception of feral domestic pets (they have regulations allowing the take of feral dogs) and T&E species, except as authorized by the U.S. Fish and Wildlife Service (USFWS). The species managed by CPW are classified as game animals or furbearers under Colorado statutes. Game animals include the black bear and mountain lion. Furbearers with current hunting seasons include the badger, bobcat, coyote, red fox, swift fox, gray fox, marten, mink, opossum, ringtail, raccoon, western spotted skunk, long-tailed weasel, short-tailed weasel, and striped skunk. Furbearers with no current hunting seasons include kit fox and hog-nosed skunk. CPW is responsible for damage caused by these species to property, natural resources, and human health and safety, with the exception of feral animals under most circumstances. The Colorado Department of Agriculture (CDA) is responsible for damage to agriculture (e.g. livestock, crops, rangeland, and pasture) by coyotes, wolves, foxes, bobcats, raccoons, mountain lions, bears, striped skunks, and opossums. Some human health and safety problems are the responsibility of the Colorado Department of Public Health and Environment (CDPHE). Private persons or entities can take these species under a CPW permit, and under certain circumstances, people can take depredating wildlife without a permit.

This document is an EA that describes and analyzes WS-Colorado's involvement in PDM in Colorado. For the purposes of this EA, predators are defined as those mammalian species listed above. Whereas CPW is clearly responsible for native wildlife species' populations and much of their damage, WS-Colorado assists them with PDM. WS-Colorado also assists CDA, a primary cooperator by statute, CDPHE, Tribes, other federal agencies, and public entities with PDM. Therefore, WS-Colorado is providing the following analysis to determine if WS-Colorado has any significant impacts on these species or the human environment, as a result of conducting PDM. This EA will be used in a decision-making process to determine if WS-Colorado should continue to provide PDM, some modified PDM program, or not provide any PDM at all. Although WS-Colorado has federal authority to conduct wildlife damage management (WDM), WS-Colorado also has a policy of abiding by state laws and has agreed to be consistent with any management directions or plans that CPW, CDA, and CDPHE have established on behalf of the State as applicable to WS authorities.

Several other species of mammalian predators are found in Colorado and include listed sensitive or threatened and endangered (T&E) species. These include three species that were believed to be extirpated in Colorado: the State-threatened river otter, the federally-endangered black-footed ferret, and federally-threatened Canada lynx[1] which have been reintroduced back into Colorado. The federally-endangered Mexican gray wolf, the native population believed to be extirpated from the United States, has been reintroduced in western New Mexico and eastern Arizona as a nonessential, experimental population and could potentially expand their population northward. The federally-threatened gray wolves, reintroduced into the Yellowstone tri-State area, could potentially disperse into Colorado and start a population. The dividing line for the two species in Colorado is north and south of I-70, an arbitrary boundary set to insure that these species are provided adequate protection. The wolverine and grizzly bear possibly still exist, but likely have been extirpated from the State. PDM could be initiated to target these species, but would be covered in other NEPA documentation pursuant to this EA.

1.1.1 Background

Across the United States, wildlife habitat has substantially changed as human populations have expanded and land has been transformed to meet varying human needs. These changes often compete with wildlife and have inherently increased the potential for conflicts between wildlife and people. Some species of wildlife have adapted to and thrive in the presence of humans and the changes that have been made. These species, in particular, are often responsible for the majority of conflicting activities between humans and wildlife.

USDA is authorized and directed by law to protect American agriculture and other resources from amage associated with wildlife. The primary statutory authority for WS is the Animal Damage Control Act of 1931 [7 U.S. Codes (USC) 426-426c; 46 Stat. 1468], as amended in the FY01 Agriculture Appropriations Bill. To protect American resources, WS conducts WDM. The following EA describes a portion of this responsibility, PDM. Much information will be given here, but additional information will be referenced in the EA.

WDM is defined as the alleviation of damage or other problems caused by wildlife (Leopold 1933, The Wildlife Society 1990, Berryman 1991). WS uses an Integrated WDM (IWDM) approach including nonlethal strategies such as the modification of the habitat or offending animals' behavior, as well as control of the offending animals or local population of the offending species with lethal or nonlethal methods. The goal of IWDM is to stop wildlife damage or reduce it to a tolerable level. Wildlife damage is also reduced via state hunting and trapping seasons that maintain predator populations at reduced levels. Without hunting and trapping it is estimated that wildlife damage would increase from $20 billion to $70 billion in the United States, and people would become less tolerant of wildlife (International Association of Fish and Wildlife Agencies 2004).

WS's mission, developed through a strategic planning process (APHIS 2004), is to *"... provide Federal leadership in managing problems caused by wildlife. WS recognizes that wildlife is an important public resource greatly valued by the American people. By its very nature, however, wildlife is a highly dynamic and mobile resource that can damage agricultural and industrial resources, pose risks to human health and safety, and affect other natural resources. The WS program carries out the Federal responsibility for helping to solve problems that occur when human activity and wildlife are in conflict with one another*." This is accomplished through:

- training of wildlife damage management professionals;
- development and improvement of strategies to reduce economic losses and threats to humans from wildlife;
- the collection, evaluation, and dissemination of management information;
- cooperative WDM programs;
- informing and educating the public on how to reduce wildlife damage; and
- providing technical advice and a source for limited-use management materials and

[1] Scientific names for T&E species are provided in Table 11.

equipment such as cage traps.

WS' Policy Manual[2] reflects this mission, and provides guidance for engaging in WDM activities. WS cooperates with land and wildlife management agencies when appropriate, and as requested, to combine efforts to effectively and efficiently resolve wildlife damage problems in compliance with all applicable federal, state, and local laws and Memorandums of Understanding (MOUs) between WS and other agencies. Before WDM is conducted, *Work Initiation Documents* must be executed by WS and land owners/administrators, or *WS Work Plans* established in consultation with federal land management agency representatives. At the State level, WS has current MOUs or similar documents with CDA, CPW, and CDPHE that specify roles and functions of each agency with regards to WDM. The MOUs with CDA and CPW specifically address which agency is responsible for the different species causing damage and for what types of damage. National level MOUs have been signed between WS and the Bureau of Land Management (BLM) and U.S. Forest Service (USFS) that transferred the responsibilities for WDM and related compliance with NEPA from BLM and USFS to WS when WS is conducting PDM in response to requests from permittees on their lands, as appropriate.

1.1.2 The WS-Colorado Program

WS-Colorado responds to wildlife damage complaints from cooperators ranging from private citizens to other agencies. The biggest portion of the WS-Colorado program is to resolve conflicts between coyotes and livestock and this is reflected in the number of predator damage incidents that WS-Colorado recorded as work tasks in MIS. WS-Colorado recorded damage caused by 12 predator species from FY10 through FY14, with the coyote being responsible for the majority of these requests (Table 1). WS-Colorado has not received any requests for assistance for the other 11 species covered in this EA in the past 5 FYs; however, the need could arise to assist with management projects for these species.

Table 1. Average annual predator damage incidents recorded by WS-Colorado during federal Fiscal Year 2010-14 in Colorado. Numbers are the annual averages for this 5-year timeframe, rounded to the nearest whole number.

	Resource Category				
Predator Species	**Agriculture**	**Property**	**Human Health & Safety**	**Natural Resources**	**Total***
Badger	2	5	6	2	14
Black Bear	463	2	11	-	476
Bobcat	25	-	6	1	32
Feral Cat	-	1	11	-	13
Coyote	2,964	32	543	161	3,699
Feral Dog	5	-	6	-	11
Red Fox	78	3	47	1	129
Swift Fox	2	-	-	-	2
Mountain Lion	103	3	4	1	110
Opossum	-	2	-	-	2
Raccoon	98	51	73	2	224
Striped Skunk	14	38	164	-	216
Total*	3,754	138	871	167	4,930

*Totals are averages of total incidents, and may not exactly match the numbers for each category due to rounding.

[2] WS Policy Manual provides guidance for WS personnel to conduct WDM activities through Directives. WS Directives referenced in this EA can be found in the manual but will not be referenced in the Literature Cited Section.

WS-Colorado conducts PDM in cooperation with several other agencies in Colorado. CDA is a primary cooperator with WS-Colorado for predators because they have the authority to establish cooperative programs with WS and counties in Colorado. WS-Colorado and CDA have an MOU which lists responsibilities and authorities as they relate to PDM. Under the MOU, WS-Colorado has the authority to respond to all damage requests involving agricultural endeavors from predators. CPW has management authority over predators causing damage to non-agricultural property or when they are considered nuisance animals. CPW issues depredation permits to take big game and furbearers and documents the use of restricted methods such as foothold traps and snares under 30-day permits on private lands. WS-Colorado acts as an agent for entities requesting assistance with agricultural depredations and for private individuals that request assistance in reducing damage to private property. CDPHE has management authority over predators when they are impacting human health and safety and prohibited methods are needed to resolve a particular problem. WS-Colorado cooperates and acts upon requests from the CDPHE when necessary.

WS-Colorado is a cooperatively funded, service-oriented program. Cooperators range from private citizens to other agency personnel. Besides the state agencies, WS-Colorado also cooperates with many counties in Colorado and focuses most PDM efforts in these areas where funding allows for staffing. WS-Colorado generally conducts limited work in non-cooperating counties, but may consider more projects as funding becomes available from interested governmental agencies and private individuals.

Colorado encompasses about 104,000 mi^2 (66,635,566 acres) in 64 Counties (Figure 1). The human population has grown from 1.75 million citizens in 1960 to 5.4 million citizens in 2015 making Colorado the second fastest growing state (Murphy 2016, Census Scope 2001). The growth in the human population and many wildlife species had led to increased conflicts and requests to protect agriculture, natural resources, property and human health and safety. The range in values and attitudes towards wildlife has also diversified leading to many different opinions about how best to resolve wildlife conflicts. The mission of the WS program nationally and in Colorado is to provide leadership to protect resources from wildlife damage and conflict. The WS-Colorado program is divided into three geographic Districts: West Slope (northwestern Colorado), Northeast (Front Range and northeastern Colorado), and Southern (southern and southeastern Colorado). WS-Colorado receives requests for PDM throughout Colorado. At a minimum, all requesters are provided with technical assistance (self-help information). Operational assistance is primarily provided in the counties that are shaded in Figure 1; however, assistance may be provided anywhere in Colorado where a need exists and funding is available to cover such actions.

WS-Colorado personnel receive requests to conduct PDM throughout the various counties and districts on private, federal, state, tribal, county, and municipal lands. Colorado is comprised of about 55% private, 22% USFS, 13% BLM, 5% state, 3% other federal agency, 2% tribal, and less than 1% local government lands. As of October 2015, WS-Colorado had active cooperative agreements that were worked on approximately 4.958 million acres or about 7.4% of the State's total land area. The majority of property under agreement for PDM is privately owned (2.967 million acres or 60%). Other lands under agreement, 1.791 million acres of BLM or USFS administered lands, 197,771 acres of state public lands, and only 2,541 acres of tribal lands.

Whereas active agreements are in place for 15% of the lands in Colorado, WS-Colorado does not conduct PDM activities on every property under agreement each year. In the five-year period FY10-14 WS-Colorado had 10.1 million acres under agreement but only worked 4.958 million acres (7.4% of the land area of Colorado). WS-Colorado also does not work continuously throughout the year on these properties and generally spends only a few hours or days on any specific property during the year resolving damage problems. Additionally, WS-Colorado PDM is typically only conducted on a small portion of a property under agreement. For example, WS in New Mexico (WS 1997a) compared the specific pasture areas on which PDM lethal methods were expected to be used to the total area under WS agreements in the Albuquerque WS District. That analysis indicated the actual area impacted was less than 1/5 of the total area under agreement. Although a similar compilation is not available for the WS-Colorado program, we believe that the

scenario is similar in Colorado. For example, an entire property under a WS agreement may contain 6,400 acres, but the WS Specialist may determine that there is only a need to work in a particular area that covers 640 acres, because that is where the damage is occurring. Using the NM calculation above (PDM conducted on 1/5 of all lands under agreement), this suggests that no more than 1.5% of the land area of Colorado was exposed to some level of WS PDM activity during the five-year period of FY10-14. That number would be even lower (<1%) in any given year. Clearly, WS PDM actions only occur on a small fraction of the land area in the state and would therefore impact only a small proportion of the predator populations. Information on agreement acreage as well as predators taken and other information is kept in a management information system (MIS[3]). WS-Colorado does not anticipate that the percentage of lands under agreement would increase substantially over the next five to ten years and at most would work on about 7% of the lands in Colorado, as indicated by the agreements currently in place.

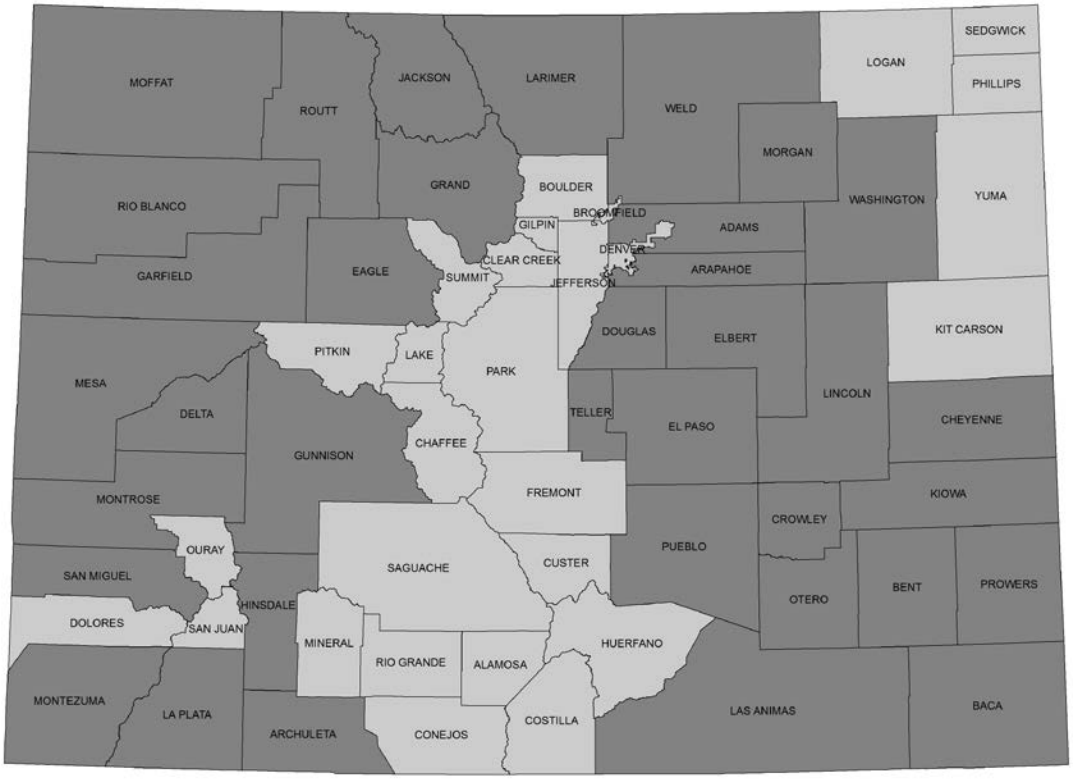

Figure 1. Counties (shaded dark gray) in Colorado where WS-Colorado has provided services to reduce predation on livestock from coyotes, black bears, mountain lions and red fox from Federal Fiscal Year 2010 to 2014.

1.2 PURPOSE

This EA evaluates a portion of WS's responsibility to protect resources in Colorado. Specifically, this EA addresses mammalian PDM for the protection of a variety of resources throughout Colorado. Predators include a range of species that prey on livestock and wildlife, damage property and other resources, or threaten human health and safety.

WS-Colorado has MOUs with CDA, CPW, and CDPHE that outline the cooperative relationship between these agencies and WS-Colorado, and the responsibilities for each agency when responding to PDM requests for the different species they manage. Feral dogs, cats, and ferrets are managed under the authority of State, county, and municipal laws, and WS-Colorado responds to complaints involving them only at the request of the appropriate Animal Control Office, County Sheriff, Health Department, or managing agency. If the agency wants assistance with a problem, an agreement is signed at that time. WS-

[3] MIS is the computer-based Management Information System used by WS for tracking Program activities. WS in Colorado has had the current MIS system operational since FY94. Throughout the text, data are reported on a federal fiscal year basis (*e.g.*, "FY14", which is the period October 1, 2013 through September 30, 2014).

Colorado refers complaints involving T&E species to USFWS, unless directed otherwise in an MOU; none of the predators covered under this EA are federally listed T&E species. However, under the direction and guidance of USFWS, WS-Colorado may respond to complaints involving these species under provisions of the Endangered Species Act (ESA) and NEPA documentation pursuant to this EA.

The analysis in this EA includes a major effort to consider existing data contained in other NEPA and related documents. WS-Colorado has previously completed three PDM EAs for Colorado (WS 1997b, 1999a. and 2005b). WS-Colorado also completes routine monitoring to determine if the work being conducted remains within the scope of the EAs. If new substantive issues arise or if routine monitoring concludes that WS-Colorado PDM activities are outside the scope of an EA, then additional NEPA documentation is prepared. This EA may be supplemented, as necessary, to include the new information and sent out for public review. New Findings of No Significant Impact (FONSI's) and Decisions would then be released, as appropriate. For example, the Western Colorado EA of 1997 (WS 1997b) was supplemented in 2001 including a new FONSI and Record of Decision (WS 2001). This EA and its final Record of Decision supersede previous EAs and FONSIs (WS 1997b, 1999a, 2001, 2005a, and 2005b) for Colorado PDM. Much of the data from prior EAs (WS 1997b, 1999a, and 2005b) and routine monitoring reports will be included in this EA.

According to the APHIS procedures for implementing NEPA, individual WDM actions may be categorically excluded (7 CFR 372.5(c), 60 Fed. Reg. 6,000-6,003, 1995). However, this EA and the prior EAs referenced herein (WS 1997b, 1999a, and 2005b) have been prepared to facilitate planning and interagency coordination, to streamline program management, and to clearly communicate with the public the analysis of cumulative impacts. The WS-Colorado program has previously determined that an environmental impact statement was not required (WS 1997b, 1999a, 2001, and 2005a) and that preparation of an EA for WS-Colorado PDM on all land classes in Colorado complies with NEPA, CEQ (40 CFR 1500), and APHIS NEPA implementing regulations (7 CFR 372).

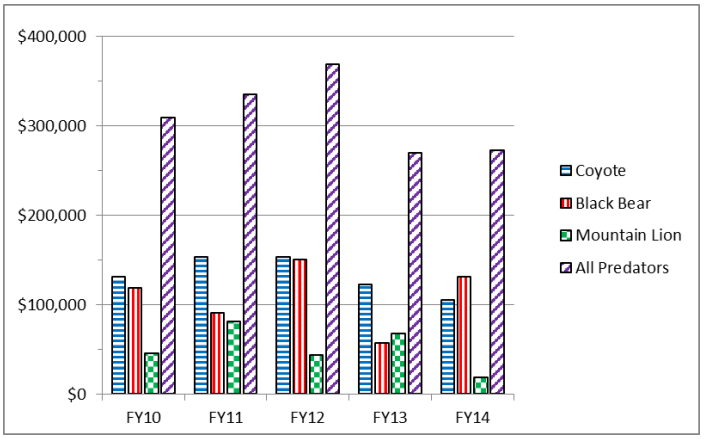

Figure 2. Dollar value of damage caused by predators recorded by WS-Colorado. Dollar values do not reflect total damage but rather an index of damage.

1.3 NEED FOR ACTION

Predators are responsible for the depredation of a wide variety of livestock, other agricultural resources, property and natural resources (Table 2). In addition, predators can be a threat to human health and safety (*e.g.*, in 1991 an 18-year-old male was killed by a mountain lion while jogging in Clear Creek County, Colorado). Table 1 shows the number of predator damage incidents recorded by WS-Colorado over the last 5 FYs (FY10-FY14), and Figure 2 shows the amount of damage from select predators recorded by WS-Colorado within this timeframe. The number of damage incidents logged, and the amount of damage recorded are both indications of the need for PDM, but they likely represent only a portion of the need. Connolly (1992) determined that only a fraction of the total predation attributable to coyotes is reported to or confirmed by WS-Colorado. He also determined that, based on scientific studies and livestock loss surveys generated by the National Agriculture Statistics Service (NASS), WS-Colorado only confirms about 19% of the total adult sheep and 23% of the lambs actually killed by predators. WS-Colorado Specialists do not attempt to locate every livestock kill reported by ranchers, but rather make attempts to verify sufficient losses to determine if a predator problem exists that requires PDM actions. Therefore, WS's damage and loss reports do not actually reflect the total number of livestock lost in the State, but provides an index of the annual losses.

Also, some people are unaware of the WS Program and may try to resolve problems on their own, or CPW may choose to handle certain depredation problems caused by furbearers or game animals without requesting WS assistance. Damage value and logged damage incidents are often more of an indicator of

the focus of WS-Colorado PDM because many requesters know that WS will respond to their needs for certain species.

Damage caused by predators in Colorado has mostly reflected coyote, black bear, and mountain lion damage, averaging 43%, 35%, and 16% (95% of total damage), respectively, of the combined damage recorded by WS-Colorado for all mammalian predators from FY10 through FY14 (Figure 2). The value of predator damage recorded by WS-Colorado is often related to the number of requests for assistance received for a particular species. However, differences can be noted among species, primarily because larger species often cause much more damage with a higher value in one incident than species that are smaller. For example, one black bear may kill 40 sheep in just a few nights or it may kill a registered thoroughbred foal, resulting in thousands of dollars damage in a single incident. In Colorado, coyotes cause the most damage annually of all mammalian predators. Black bears have fairly consistently caused the second most damage reported to WS-Colorado, although their share of damage has been increasing in recent years [35% in this EA versus 21% in the prior EA (WS 2005b)], and the annual values fluctuate more than coyotes (Figure 2). Mountain lion damage has also fluctuated more than coyote damage throughout the years, but continues to average less than 1/5 of the total predator damage. Raccoons, red fox, feral dogs, and striped skunks cause the next most damage at 2%, 1%, 1%, and 0.5%, respectively. These seven predator species account for over 99% of the damage value, and over 98% of the damage incidents recorded by WS-Colorado. Damage from the remaining seventeen predators in Colorado combined averaged less than 1% of the total value of damage, and less than 2% of the damage incidents.

PDM is conducted to protect agricultural and natural resources, property, and human health and safety from predators. PDM has been conducted since the 1920s in Colorado by WS. Over the last 5 FYs (FY10 through FY14), WS-Colorado has documented an annual average of 4,930 incidents of damage caused by mammalian predators, reported by the public and other agencies (Table 1). The majority of incidents (76%) have been to protect agricultural resources, followed by 18% of requests to protect human health and safety. Six species have been responsible for 98% of these damage incidents, including coyotes (75%), black bears (10%), raccoons (5%), striped skunks (4%), red fox (3%), and mountain lions (2%). An additional six species of predators in Colorado have only been responsible for 2% of the damage incidents during the last 5 FYs.

As discussed previously, WS-Colorado has not received any requests in recent years to resolve damage caused by the 11 other predator species not shown in Table 1, and we expect few, if any, requests for assistance concerning those species in any year. Normally, responses to such limited and rare-occurrence requests are categorically excluded under NEPA. We have chosen to cover these species within the scope of this EA to facilitate quick and efficient responses by WS-Colorado to such rare and occasional requests.

1.3.1 Need for PDM for the Protection of Livestock

Predators are responsible for the depredation of a wide variety of livestock including cattle, sheep, goats, swine, exotic pen-raised game, other hoofed-stock, and poultry. Depredation is defined as the killing, injury, or harassment of livestock resulting in monetary losses to the owner. Cattle and calves are vulnerable to predation, especially at calving (NASS 1992, 1996, 2001). Sheep, goats, and poultry are highly susceptible to year-round predation (Henne 1975; Nass 1977, 1980; NASS 1991, 1995, 2000, Tigner and Larson 1977, O'Gara *et al.* 1983). Livestock losses cause economic hardships to their owners, and without effective PDM to protect them, predation losses and, hence, economic impacts, can continue to increase (Nass 1977, 1980; Howard and Shaw 1978; Howard and Booth 1981; O'Gara *et al.* 1983). Bears and mountain lions (Mysterud 1977, Shaw 1987) are occasionally responsible for catastrophic incidents or large losses of sheep and lambs, sometimes called “surplus killings,” when only selected tissues or parts are consumed or the carcasses are not fed on at all. Bears or mountain lions may also frighten an entire flock of sheep as they attack, resulting in a mass stampede; this sometimes results in many animals suffocating as they pile up on top of each other in a confined area, such as along thick willow growth in the bottom of a drainage or in corrals. It is not uncommon to find multiple sheep killed by either of these two species after a killing frenzy; over one hundred sheep have been documented to be killed by a mountain lion in one incident (Wade and Bowns 1982).

Of the predators that kill livestock, coyotes inflict the highest percentage of damage. Coyotes accounted for 93% of all predator-killed lambs and ewes on nine sheep bands in shed lambing operations in southern Idaho and 25% of these kills were not fed upon (Nass 1977). Coyotes were also found to be the predominant predator on sheep during a study in Colorado, where more than 43% of lambs killed by coyotes were not fed upon (DeLorenzo and Howard 1977). Coyotes were also the primary predator on sheep throughout a Wyoming study and essentially the only predator in winter (Tigner and Larson 1977).

Table 2. Wildlife and feral animals reported to WS-Colorado that depredated, injured or threatened agricultural and natural resources in Colorado from Federal FY 2010 through 2014.

Resource	Predator	Number of Incidents[α]
Catfish, trout, food fish (farm raised)	Cormorant, Double-crested	9
	Crow, American	1
	Gulls	22
	Heron, Great Blue	15
	Kingfisher, belted	3
	Merganser, Common	2
	Night Heron, Black-crowned	9
	Pelican, White	4
	Raven, Common	1
	Bear, Black	1
Game birds (pen raised)	Badger	1
Elk (pen raised)	Mountain lion	4
Exotic or native large mammals, fallow deer (pen raised)	Coyote	1
	Mountain lion	3
Alpaca	Mountain lion	7
Cattle (cows, calves)	Bear, Black	25
	Bobcat	1
	Coyote	115
	Dog, Feral	5
	Mountain lion	14
	Raccoon, Stripped skunk	2
Donkeys or burros	Mountain lion	2
Goats (meat, mohair, other)	Crow, American	1
	Bear, Black	19
	Coyote	23
	Dog, Feral	1
	Mountain lion	53
Horses	Coyote	11
	Dog, Feral	1
	Mountain lion	11
Llamas	Bear, Black	2
	Mountain lion	6
Mules	Mountain lion	1
Rabbits (domestic)	Raccoon	2
Sheep (ewes, rams, lambs)	Bear, Black	858
	Bobcat	2
	Coyote	925
	Dog, Feral	1
	Mountain lion	124
	Red Fox	63
Swine (domestic)	Bear, Black	2
	Dog, Feral	3
	Mountain lion	1
Chickens	Bear, Black	5
	Bobcat	2
	Coyote	6
	Mountain lion	3
	Raccoons	6
	Fox, Red	12
	Skunk, Striped	1
	Hawk, Red-tailed	1
Ducks (domestic)	Coyote	2
	Fox, Red	3
Geese (domestic)	Coyote	1
Ostrich (domestic)	Coyote	1
Pea Fowl	Mountain lion	1
Pigeon (domestic)	Coyote	1
	Bear, Black	1
	Fox, Red	1
	Mountain lion	2
	Raccoons	1
Trout and other fish (wild)	Raccoons	1
	Cormorant, Double-crested	8
	Crow, American	1
	Gulls	13
	Heron, Great Blue	13
	Kingfisher, belted	5
	Merganser, Common	2
	Night Heron, Black-crowned	3
	Pelican, White	6
	Raven, Common	1
Least Tern (T&E Species)	Gulls	3
Piping Plover (T&E Species)	Gulls	3
Mule Deer	Coyote	1
Pets (cats, dogs)	Coyote	5
	Fox, Red	2
	Mountain lion	2
	Raccoon	5
	Skunk, Striped	1
Zoo animals	Mountain lion	1

[α] An incident can involve one or more animals.

Other predators that cause predation on cattle, calves, sheep and lambs in Colorado are black bears, mountain lions, and feral dogs. Bears and lions can cause substantial losses. Feral or free ranging dogs are also responsible for considerable predation on livestock and wildlife, and it is not uncommon to find multiple kills from them. Other small carnivores such as badgers, gray fox, red fox, raccoons, and striped skunks will prey on livestock but primarily young lambs, kid goats, and domestic fowl.

1.3.1.1 Contribution of Livestock to the Colorado Economy.

In 2012, agriculture generated $7.8 billion in annual sales from farm and ranch commodities in Colorado (NASS 2014). Livestock production, primarily cattle, sheep, swine, and poultry, accounted for $5.3 billion (69%) of this, and is therefore considered a primary agricultural industry sector in the State. Cattle, sheep, and swine production contributes substantially to local economies. Colorado livestock inventories in 2012 included 2,630,082 cattle and calves, 401,376 sheep and lambs, 727,301 swine, and 5,096,767 chickens (NASS 2014). In addition, goats, other poultry, rabbits, ratites (ostriches and emus), and exotic livestock are produced in Colorado, but at lower levels. Sheep inventories in Colorado have declined significantly over the last 15 years from a high of 840,000 in 1990 (NASS 2004). Part of the reason is that the sheep and wool market has declined making it less economical to raise sheep. However, the number of AUMs (animal unit months) allotted on BLM and USFS lands has been declining in many areas of the United States and this has had a negative impact on livestock production. In Nevada, a study determined that the reduction in AUMs there had about a 9% negative economic effect annually (Pearce *et al*. 1999) in the 1990s.

1.3.1.2 Scope of Statewide Livestock Losses.

NASS conducted comprehensive national surveys of sheep lost to predators in 1994 and 1999 (NASS 1995, 2000) and cattle lost to predators in 1995 and 2000 (NASS 1996, 2001). NASS (1995) reported that predators (coyotes, black bears, feral dogs, mountain lions, bobcats, and foxes) killed 6,200 adult sheep valued at $483,600 and 18,900 lambs valued at $737,100 in Colorado during 1994. Sheep and lamb inventory numbers dropped 32% from 647,000 head in 1994 to 440,000 head in 1999 (NASS 2004). NASS (2000) reported predators (coyotes, black bears, feral dogs, mountain lions, bobcats, and foxes) killed 2,800 adult sheep valued at $277,000 and 8,700 lambs valued at $583,000 in Colorado in 1999. Of the sheep and lambs killed by predators in 1999 (NASS 2000), coyotes were responsible for about 62%, black bears 14%, dogs 13%, mountain lion 6%, and foxes 2%. Cattle and calf predation losses in Colorado totaled 5,000 head valued at $1.5 million in 1995 (NASS 1996) and 3,500 head valued at $1.3 million in 1995 (NASS 1996). The number of cattle and calves in Colorado increased 5% from 3,000,000 in 1995 to 3,150,000 in 2000 (NASS 2004), but predation losses decreased 30%. Of predation losses to cattle in 2000 (NASS 2001), coyotes were responsible for about 80%, mountain lions 9%, and dogs 3%. These losses occurred in spite of PDM efforts by producers, who must bear the additional costs for these activities (Jahnke *et al*. 1987), and WS-Colorado personnel. NASS (2000) reported that many Colorado sheep producers used nonlethal tactics to reduce predator damage; producers used fencing (31%), guard dogs (23%), llamas (9%), donkeys (3%), lamb shed (67%), herding (7%), night penning (79%), frightening tactics (6%), and other nonlethal methods (4%). NASS (2001) also reported that Colorado cattle producers used nonlethal tactics to reduce predator damage; producers used fencing (18%), guard animals (25%), herding (7%), night penning (14%), frightening tactics (18%), livestock removal (64%), and other nonlethal methods (5%).

The Colorado NASS Office also has completed surveys of predation to sheep and lambs in Colorado, a more detailed survey than those done nationally by NASS (1995, 2000) and reflected much more damage. Predators killed 28,000 head at an estimated value of 2.08 million dollars in damage to sheep and lambs in 2002 (NASS 2003). Coyotes were responsible for 54% of the mammalian predator losses, followed by black bear (24%), mountain lions (6%), and red fox (6%). Predator losses in Colorado: 34,000 sheep and lambs lost in 1997, 27,000 in 1998, 23,000 in 1999, and 19,500 in 2000. These data (NASS 2003) are higher than the data collected nationally (NASS 2000) (probably something related to higher sampling at the local level), but both indicate the severity of the problem.

WS-Colorado also collects information on losses on those properties where WS-Colorado conducts PDM or provides advice. WS-Colorado personnel respond to reports from resource owners of losses to predators which may or may not be verified by WS-Colorado personnel. In Colorado from FY10 through FY14, WS-Colorado personnel responded to an average of 3,585 incidents of livestock loss from predators annually. Reported and verified losses from these incidents, for all classes of livestock including poultry and commercially-raised game, averaged more than 1,500 animals worth $278,000. Average annual livestock losses recorded by WS-Colorado for FY10 through FY14 included 1,241 sheep and lambs; 66 cows and calves; 49 adult goats and kids; 15 other hoofed stock; and 135 other animals including poultry, ratites, and rabbits. Of the value of these losses, coyote damage accounted for 47%, black bear 35%, mountain lion 15%, red fox 2%, and feral dog 1% annually (Table 3). All other predators combined accounted for less than 1% of the losses. Many of the other predators in Colorado covered by this EA are known to kill or injure livestock, but no losses to these predators were recorded in FY00 to FY04.

Table 3. Average annual number of livestock lost to predators in Colorado, and the value of those livestock, as recorded by WS-Colorado Specialists from FY10 through FY14. Numbers are averages of the five year period, rounded to the nearest whole number.

	Cattle & Calves		Sheep & Lambs		Goats & Kids		Other Hoofed Stock		Poultry, Ratites & Rabbits		Total[β]	
Species	**# Lost**	**Value**	**# Lost**	**Value**	**# Lost**	**Value[α]**	**# Lost**	**Value[α]**	**# Lost**	**Value**	**# Lost**	**Value**
Black Bear	10	$12,506	473	$75,115	9	$1,612	5	$7,126	29	$355	526	$96,714
Bobcat	0	$0	1	$123	0	$0	0	$0	6	$219	7	$342
Coyote	50	$34,063	648	$90,280	16	$2,157	0	$200	23	$2,659	737	$129,359
Feral Dog	3	$2,728	3	$725	0	$9	0	$100	0	$0	6	$3,562
Red Fox	0	$0	25	$3,966	0	$0	0	$0	23	$878	48	$4,844
Mountain Lion	3	$2,370	91	$16,409	24	$3,937	10	$19,797	23	$584	151	$43,097
Raccoon	0	$0	0	$0	0	$0	0	$0	30	$252	30	$252
Striped Skunk	0	$0	0	$0	0	$0	0	$0	1	$5	1	$5
Total	66	$51,667	1,241	$186,618	49	$7,715	15	$27,223	135	$4,952	1,506	$278,175

[α]Loss values are sometimes listed for losses of zero due to rounding (losses of less than three animals over the five year period are rounded to zero).

[β]Totals may not exactly match the numbers for each category due to rounding.

Bear predation on livestock has increased sharply over the last decade. The number of hours expended by WS-CO has increased along with funds expended by livestock producers to reduce losses (Moreno 2016). WS-CO expended about 900 staff hours in 2005 alleviating bear predation on livestock. This increased to about 2,900 hours in 2010 and has been at this level of loss for 3 of the last 5 years. The number of sheep lost to bear predation varies annually and coincides with effort expended to reduce bear predation losses. For example, WS-CO verified 198 sheep killed by bears in 2005 and then the losses trended upward matching peek predation years in 2010, 2012, 2014 and 2015 when 639, 636, 461, and 526 were verified killed by black bears in Colorado. The State of Colorado makes damage payments to livestock and other agricultural producers that range from $300,000 to $450,000 annually (CPW 2015). The largest payments for bear damage are for sheep predation. The amount of bear damage payments has been trending upward since 2005 while the number of claim has declined (CPW 2015). Also, during this time period legal hunter harvest has increased from about 450 bears in 2005 to almost 1,400 bears in 2014. During the same time period damage payments have increased, hours expended to alleviate predation on livestock has tripled, hunter harvest has tripled and black bear populations in Colorado increased from 12,000 bears in 2002 to an estimated 17,000-20,000 bears in 2015 (CPW 2015).

The loss of livestock in Colorado does not provide an estimate of the effectiveness of PDM provided by WS-Colorado. The only measure of success of a PDM program is the number of livestock saved from predation. And although this number cannot be accurately determined, it can be estimated. Scientific studies have revealed that in areas without some level of PDM, losses of adult sheep and lambs to predators can be as high as 8.4% and 29.3%, respectively, of the total number of head (Henne 1975, Munoz 1977, O'Gara *et al.* 1983). Other studies have indicated that sheep and lamb losses are significantly lower where PDM is applied (Nass 1977, Tigner and Larson 1977, Howard and Shaw 1978, Howard and Booth 1981).

Most requests for PDM assistance that WS-Colorado receives are to protect livestock on private lands. Lands with better agricultural value, and hence, more livestock production, were more likely to be bought or claimed by settlers when the West was first settled, and thus were more likely to enter into private ownership. As a result, many of the properties claimed were in valleys with easier terrain to manage, more productive soil conditions, and waterways that could be used to grow crops and water livestock. However, under land settlement laws, not all land was claimed, and Congress eventually took control of the remaining lands with much of it becoming National Forests (NF) and National Grasslands (NGs) owned by the USFS, and public lands administered by the BLM. Because private lands often have easier terrain for agricultural activities and more productive conditions, they tend to be used for lambing, calving and kidding grounds. This means they are more prone to having predation problems since newborn and young livestock are more vulnerable than adults. Of the livestock losses in FY10-FY14, 60% of the numbers killed or injured, and 66% of the value of losses, were on private land (Table 4). Of the cattle and sheep losses in FY10-14, 56% of the numbers lost, and 72% of the value of losses, occurred on private lands (Table 4). WS-Colorado has no authority to determine how these lands, including any associated riparian areas or wetlands, are managed.

Public lands administered by BLM and USFS, and other non-private lands in Colorado are used for grazing, primarily for sheep as reflected in the losses. Federal public lands represent only 18% of the lands under agreement by WS-Colorado. Livestock losses recorded by WS-Colorado in FY10-14 were much lower on public lands than on private lands: one sixth of the private land losses on BLM lands, and one third of the private land losses on USFS lands. Total livestock losses from predators in FY10-14 averaged 136 head valued at $23,698 on BLM lands, 362 head valued at $48,825 on USFS lands, and 8 head valued at $1,196 on other non-private lands. These numbers for non-private lands represent 34% of the value of total losses for FY10-14 (Table 4). Thus, whereas WS-Colorado has agreements on a higher percentage of non-private lands, most PDM is focused on private lands. Table 4 also breaks down these livestock losses by livestock category.

Table 4. Average annual livestock losses due to predators in Colorado recorded by WS-Colorado Specialists from FY10 through FY14 on private and public lands. Numbers are averages of these five FY's, rounded to the nearest whole number.									
Livestock	Predator	Private Lands		BLM Lands		USFS Lands		Other Public Lands	
Species	Species	# Lost	Value*	# Lost	Value	# Lost	Value	# Lost	Value
Sheep	Black Bear	52	$10,829	2	$223	82	$13,815	0	$0
	Coyote	39	$6,935	39	$6,653	1	$200	0	$0
	Feral Dog	2	$480	0	$0	0	$0	0	$0
	Red Fox	5	$880	1	$130	0	$0	0	$0
	Mountain Lion	18	$2,796	5	$910	3	$610	0	$0
	Subtotal	116	$21,921	45	$7,916	86	$14,625	0	$0
Lambs	Black Bear	79	$10,907	10	$903	108	$13,635	0	$0
	Bobcat	1	$123	0	$0	0	$0	0	$0
	Coyote	341	$45,997	74	$12,219	164	$19,721	5	$670
	Feral Dog	1	$245	0	$0	0	$0	0	$0
	Red Fox	19	$2,886	2	$296	2	$226	2	$226
	Mountain Lion	23	$2,908	0	$64	1	$667	0	$0
	Subtotal	463	$63,066	88	$13,482	274	$34,249	7	$896
Cattle & Calves	Black Bear	7	$9,439	0	$0	0	$314	0	$0
	Coyote	47	$31,486	3	$2,300	1	$637	0	$0
	Feral Dog	2	$1,785	0	$0	0	$0	0	$0
	Mountain Lion	1	$557	0	$0	0	$0	0	$0
	Subtotal	56	$43,267	3	$2,300	1	$951	0	$0
Subtotal Sheep & Cattle		635	$128,254	136	$23,698	361	$49,825	7	$896
Other Livestock (Poultry, goats, horses, swine, llamas, ratites, exotic game)	Black Bear	11	$4,740	0	$0	0	$0	0	$0
	Bobcat	6	$219	0	$0	0	$0	0	$0
	Coyote	38	$4,716	0	$0	0	$0	1	$300
	Feral Dog	0	$100	0	$0	0	$0	0	$0
	Red Fox	20	$857	0	$0	0	$0	0	$0
	Mountain Lion	30	$6,556	0	$0	0	$0	0	$0
	Raccoon	28	$227	0	$0	0	$0	0	$0
	Subtotal	133	$17,416	0	$0	0	$0	1	$300
Total		768	$145,670	136	$23,698	361	$49,825	8	$1,196

*Loss values are sometimes listed for losses of zero due to rounding (losses of less than three animals over the five year period are rounded to zero).

In addition to direct livestock losses to predators such as predation and injury, producers also lose livestock indirectly to predators. One potential indirect loss to livestock producers is disease transmission from predators. For example, cattle can become infected with rabies after being bitten by infected animals such as coyotes, skunks, and fox. Indirect losses are typically minor compared to direct losses, but they could be devastating in the event of a major outbreak. WS-Colorado periodically assists the CDC, CDPHE, and local health departments in monitoring disease prevalence by collecting samples from predators taken by WS-Colorado. WS-Colorado has a Wildlife Disease Biologist on staff to coordinate such sampling, and has collected hundreds of predator disease samples in FY10-14.

1.3.2 Need for PDM for Protection of Crops, Property, Human Health and Safety, and Natural Resources

Predators impact a number of resources in Colorado other than livestock. Typically, such damage is less than the damage to livestock, but it can be locally significant, and have a major impact on individual farmers and ranchers, as well as the public at large (*e.g.*, disease threat). Other resources that predators can damage include crops, property, human health and safety, and natural resources.

1.3.2.1 Crops.

Field crops such as melons (watermelons and cantaloupes), milo, sweet corn, field corn, and wheat have been damaged by predators such as coyotes, feral/free-roaming dogs, badgers, and raccoons. Fruits, nuts, and their trees have been damaged by bears and raccoons in Colorado. Another type of problem is improved or planted pasture damage caused by badgers and coyotes burrowing; this digging activity often leaves the ground uneven which can hamper the use of planting and mowing equipment and result in damage

to the equipment. WS-Colorado recorded an average of seven incidents of damage to crops from predators from FY10-14, with losses valued at an average of $11,243 annually (Table 5).

Table 5. Number of incidents and average annual losses due to predators to resources other than livestock in Colorado recorded by WS-Colorado Specialists from FY10 through FY14. Numbers are the averages among these five FY's, rounded to the nearest whole number.

	Crops[α]		Other Agriculture[α]		Pets & Zoo Animals		Property[α]		Human Health & Safety[α]		Natural Resources		Total	
Predator Species	Incidents[β]	Value	Incidents	Value[γ]	Incidents[β]	Value	Incidents[β]	Value	Incidents[β]	Value	Incidents[β]	Value	Incidents[β]	Value[γ]
Badger	0	$0	0	$40	0	$0	1	$130	6	$0	0	$0	7	$170
Black Bear	4	$5,467	1	$2,379	0	$0	1	$3,380	11	$6,350	0	$0	17	$17,576
Bobcat	0	$0	0	$0	0	$0	0	$0	6	$0	0	$0	6	$0
Feral Cat	0	$0	0	$0	0	$0	1	$0	11	$0	0	$0	12	$0
Coyote	26	$2,376	0	$0	6	$580	27	$0	543	$0	161	$1,000	763	$3,956
Feral Dog	0	$0	0	$0	0	$0	0	$0	6	$0	0	$0	6	$0
Red Fox	13	$0	4	$40	1	$0	2	$10	47	$0	1	$0	68	$50
Mountain Lion	0	$0	0	$0	3	$5,200	0	$0	4	$0	1	$14	8	$5,214
Opossum	0	$0	0	$0	0	$0	2	$20	0	$0	0	$0	2	$20
Raccoon	43	$3,400	40	$248	3	$10	48	$1,700	73	$0	2	$40	209	$5,398
Striped Skunk	9	$0	4	$0	0	$0	38	$1,760	164	$0	0	$0	215	$1,760
Total	95	$11,243	49	$2,707	13	$5,790	120	$7,000	871	$6,350	165	$1,054	1,313	$34,144

[α]Crops includes corn, watermelon, fruits/nuts, and trees; Other Agriculture includes hives, aquaculture, worms, eggs, pasture, irrigation systems, and feed; Property includes turf, structures, landscaping, and aircraft; Human Health & Safety includes attacks, disease threats, and aircraft strike hazards.

[β]Sometimes there is no value attributed to a number of incidents; this reflects the threat of damage even when no damage occurred. For example, threat of disease without actual transmission to

[γ]Sometimes a value is attributed to zero incidents due to rounding (fewer than three incidents over five years results in an average of zero).

1.3.2.2 Other Agriculture.

Several other agricultural commodities can be damaged by predators such as beehives, haystacks, aquaculture, livestock feed, eggs, and irrigation systems. From FY10-14, most of this type of damage has been sporadic, and most has involved black bears and raccoons (Table 5). WS-Colorado recorded an average of 5 incidents of predator damage annually to these resources, worth an average of $2,707 annually. These numbers are considerably lower than those documented in the prior EA (WS 2005b), which may be due to improved techniques to prevent predator damage, effective PDM, or both. This could also be due to changes in agricultural practices in Colorado; for example, if fewer farmers are producing honey as a crop, less damage to beehives would be expected. Unfortunately, WS-Colorado does not have data on these practices. Not shown in the table is an average of one incident of property damage from Virginia opossums, valued at an average of $20. Several other species can be responsible for these types of damage, but such damages were not recorded by WS-Colorado in FY10-14.

1.3.2.3 Pets and Zoo Animals.

Pets and zoo animals, considered property, are occasionally killed by predators. This can be more common in suburban areas where coyotes, foxes, and other generalist predators adapt well and flourish in the new habitat provided by humans. Coyotes have long been known for their adaptability and ability to thrive in suburban neighborhoods. They are especially aggressive towards dogs during the breeding season and will attack and kill them, even those being walked on a leash. Deer often feed in these environments, attracting mountain lions, which will also take pets. These species become accustomed to human smells and, over time, can lose much of their fear of humans. In FY10-14, WS-Colorado documented average of 13 incidents of predator damage annually to pets and zoo animals, with an average value of $5,790 annually. Most of these economic losses were caused by mountain lions and coyotes. Some incidents, involving zoo animals for example, result in much higher losses than others (Table 5).

1.3.2.4 Property.

WS-Colorado also responds to requests from landowners and other agencies to alleviate property damage from predators such as: black bears breaking in and destroying the interiors of homes or other structures; raccoons and skunks burrowing into or under homes to den; skunks and raccoons gaining access into a home through a pet door; and badgers, skunks, or raccoons causing damage to landscaping, gardens, or golf courses from feeding activities. From FY10-14, WS-Colorado recorded predator damage to a variety of property

in an average of 12 incidences per year from badgers, black bears, raccoons, and striped skunks, with average annual losses worth $6,770 (Table 5). All of the predator species in this EA have the potential to be involved in property damage. It is not uncommon for species such as marten and ringtails to gain access into cabins through chimneys and raid them. The protection of property is the most likely reason WS-Colorado would respond to a complaint invoked by predator species that are rarely encountered.

1.3.2.5 Human Health and Safety.

WS-Colorado conducts limited PDM actions in Colorado to reduce human health and safety concerns for the public. Human health and safety concerns include: human attacks from mountain lions, black bears, and coyotes that result in injuries or death; disease threats (*e.g.*, rabies and plague outbreaks) where predators act as reservoirs (as discussed under 1.3.2.2 for livestock); odor and noise from skunks, opossums, and raccoons in attics and under houses; and aircraft strike hazards from coyotes and red fox crossing runways at airports or airbases. One of the biggest threats to public safety is attacks on people by large predators. Fortunately, these are rare. Still, mountain lion attacks on humans in the western U.S. and Canada, have increased markedly in recent decades, primarily due to increased lion populations and human use of lion habitats (Bier 1992). No lion-caused fatalities have been clearly documented in Colorado in FY10-14, but they have occurred in prior years. Coyotes can also be a threat to human safety, and attacks by coyotes are more common, presumably due to their higher populations in urban areas, combined with a loss of fear of humans in areas where they are neither hunted nor trapped, and perhaps an association of humans with food, such as pets, pet food, and hand-outs. After several human-coyote interactions in an area, Baker and Timm (1998) concluded that the use of foothold traps to capture and euthanize a few coyotes would be the best method to resolve the problem and have the most lasting effects. Also, after a child was killed by a coyote in Glendale, California, city and county officials trapped 55 coyotes in an 80-day period within one-half mile of the home (Howell 1982). This is an unusually high number of coyotes for such a small area, but it underscores the possibility.

WS-Colorado assists many residents, especially in urban areas such as the Denver metropolitan area, concerned about coyote attacks on their pets and their apparent loss of fear of humans. Predator attacks on humans fortunately occur rarely, but could result in requests for assistance under the current program. During FY10-14, WS-Colorado responded to incidents involving people attacked and/or injured by coyotes (17 incidents), black bears (nine incidents including five injuries), striped skunks (nine incidents), red fox (seven incidents), and raccoons (six incidents). The recent outbreak of skunk rabies in Colorado is responsible for many of the incidents involving skunks, foxes, and raccoons (and some coyotes). WS-Colorado has also responded to complaints involving mountain lions that were perceived as threats to public safety, but no attacks were documented. Recommendations are generally made to consider exclusion methods to reduce human health and safety concerns, but the animals present are often removed, especially when dealing with coyotes and larger predators which have lost their fear of humans. Research suggests that the removal of these individual animals is the best way to solve the problem (reviewed in Baker 2007). Coyotes (62%), striped skunks (19%), raccoons (8%), red fox (5%), feral cats (1%), black bears (1%), feral dogs (<1%), bobcat (<1%), mountain lions (<1%), badgers (<1%), and swift fox (<1%) were responsible for an average of 871 human health and safety responses annually from in FY10-14, including aircraft strike hazards, disease threats, threats of attack, and nuisance complaints.

1.3.2.6 Natural Resources.

Predators are sometimes responsible for damage to natural resources, including T&E, sensitive, and game species. In FY10-14, WS-Colorado responded to an annual average of 167 incidents of predator damage or threats to natural resource. Most of these responses (93%) were to protect Gunnison sage-grouse from predation by coyotes and other predators. WS-Colorado also responded to requests to protect piping plovers from predation by coyotes, mule deer from predation by coyotes and mountain lions, and

bighorn sheep from predation by mountain lions. WS-Colorado is responsive to agencies with management responsibilities for wildlife species that are impacted by predation. PDM for wildlife protection can be very effective when predation has been identified as a limiting factor. WS-Colorado works with these agencies to identify and provide the level of protection needed. When such actions are requested by USFWS or another Federal agency, the responsibility for NEPA compliance rests with that agency. However, WS-Colorado could agree to take on the responsibility for NEPA compliance at the request of the other Federal agency.

1.3.2.6a Predator – Prey Relationships Involving Wildlife.

Predator management looks at the effects of age-specific survival on population growth and possible interactions between predation, forage availability (i.e. nutrition) and weather (Forrester and Wittmer 2013). Determining if predation, nutrition, weather or other factors are limiting growth of a population are complex. Additionally, Monteith *et al.* (2014) summarized that evidence of mortality is often used to justify predator management to increase ungulate populations which underscores the need to correctly interpret the consequences of mortality. Factors limiting growth of ungulate populations are difficult to understand because they are numerous, interacting and subject to variability (Bishop *et al*. 2009) (Table 6). Early debates about ungulate populations were based on competing hypotheses of population effects caused by food limitations and predation (Peek 1980). It is now recognized, as the base of knowledge has grown from further research, that food limitations and predation simultaneously affect ungulates population dynamics (Sinclair and Krebs 2002). Further, the interactions between nutrition and predation are likely mediated by weather (Hopcraft *et al*. 2010). That being said, predation can affect a prey population only if mortality is at least partially additive to mortality from other causes (Caughley 1976). Multiple studies have identified three conditions that must be met to ascertain predators are effecting an ungulate population (Forrester and Wittmer 2013, Hurley *et al*. 2011, Theberge and Guthier 1985). The conditions that must be met to consider predation may be affecting an ungulate population are 1) the ungulate population is below carrying capacity, 2) mortality is a primary factor influencing change in prey abundance and 3) predation is the major cause of mortality.

Coming to an agreement about the role of predation in shaping the growth of a local ungulate population is complex due to the interaction of environmental variables that influence potential population growth rate and density (Hurley *et al*. 2009). Moreover, determining if mortality is additive or compensatory, the role of alternate prey, whether the predator prey interactions are influenced by multiple predators or multiple prey species and whether the cause of mortality is proximate or ultimate complicates agency decision making, and understanding by the public and numerous constituencies with an interest in wildlife. Compensatory mortality is the additional risk of death that caused a reduction in other forms of mortality so the overall mortality either does not change or is less than it would be if additive. Additive mortality is the additional risk of death does not cause a reduction in other forms of mortality but increases the overall mortality (Bartmann *et al*. 1992).

Predation and malnutrition/disease mortality in ungulate populations, especially mule deer, can be high and the most abundant cause of death (Forrester and Wittmer 2013, Hurley *et al*. 2011, Bishop *et al*. 2009). In fact, predation is the largest proximate cause of mortality in both adult female and fawn mule deer in all studies reviewed by Forrester and Wittmer (2013). Yet, many of these studies found mortality was compensatory and other forms of mortality (i.e., nutrition, weather) were the ultimate cause of death (Forrester and Wittmer 2013). Determining if predation was the primary factor causing a population decline and the ultimate cause of death is more complicated in multiple predator, multiple prey systems (Leblond *et al*. 2016, Latham *et al*. 2013,) Monteith *et al*. (2014) proposed a methodology requiring a short term research project to determine if predation or nutrition were the cause of mule deer population declines, whether predation mortality was

additive or compensatory or if habitat improvement and/or deer density reduction would improve population growth. Bishop *et al*. (2009) reached similar conclusion about determining if mortality was additive or compensatory. To illustrate the point of complex interpretations of data, Hurley *et al*. (2011) study of mule deer populations in southeastern Idaho found evidence of compensatory mortality from coyotes and inconsistent effects of predator management on mule population metrics. The study found decreased mortality of 6-month old fawns and adult does with increased lion removal which could lead readers to conclude predator management had a benefit. However, the magnitude and frequency of weather caused mortality overwhelms the effects of predators regulating mule deer populations in southeastern Idaho. The greatest potential for population growth in southeastern Idaho was likely from improving habitat to improve nutrition for mule deer. However, Hurley *et al*. (2011) postulated that coyote removal may have the possibility of success but was contingent on lagomorph and small mammal population levels measured in April.

Managing ungulate populations requires wildlife agencies to examine many factors to understand why a population may have declined (Table 6) and to guide management efforts to increase a population. Populations can be affected by climate variation, predation, habitat (nutrition) or the relationship to carrying capacity (Bishop *et al*. 2009). While wildlife and land management agencies can manipulate predation or habitat to attempt to reach population management goals, climate and weather operate independently of agency actions. Predation is often seen by concerned citizens and sometimes biologists as the cause of an ungulate population decline, but the complexities of interpreting predation and habitat data findings that are modified by variable weather and climate which often lead to calls for predator management when other management prescriptions may be likely to meet management goals (Ballard *et al*. 2001).

1.3.2.6b Mule Deer Populations in the West.

WS-Colorado has been requested to reduce predation on several ungulate species over the years. Mule deer are the species WS-Colorado would most likely be requested by state or federal wildlife management agencies to protect from predation, if predation was determined to be limiting population maintenance or growth. Mule deer populations have historically exhibited volatile population fluctuations in the western United States (Unsworth *et al*. 1999, Peek *et al*. 2002). The history of mule deer populations can be characterized by gradual population increases in the 1920's, peaking in the 1940's to early 1960's and then declining in the late 1960's to mid- 1970's. Mule deer populations then exhibited growth in the 1980's followed by decline in the 1990's in some areas of the west (Denny 1976 cited in Hurley *et al*. 2011). A complex combination of factors influence these population fluctuations including climate, habitat changes, predation, competition with other herbivores, and interactions among factors (Forrester and Wittmer 2013, Hurley *et al*. 2011, Ballard *et al*. 2001).

Mule deer populations are defined by parameters (Forrester and Wittmer 2013). The parameters characterize adult does and fawns since they have the greatest influence of population response. The list of mule deer population parameters would include the following: Mule deer have lower and more variable fawn survival than other ungulate species (Forrester and Wittmer 2013), whereas adult doe survival appears high and stable throughout the geographic range of the species. Adult survival was an important secondary factor in changes in population growth. Observed low fawn survival appears compensated for by high fecundity. Local snowfall has a large impact on overwinter fawn survival. Predation is the primary proximate cause of mortality for all age classes. In addition, predation is an important source of summer fawn mortality. In multiple prey, multiple predator systems predation is an important source of mule deer mortality. An important point is predation is compensatory, especially in populations near or at carrying capacity. Lastly, nutrition and weather shape population dynamics.

1.3.2.6c Effectiveness of Predator Damage Management.

Forrester and Wittmer (2013) reviewed a number of experimental studies on the effects of predator control to manage mule deer populations. The results of these predator control studies remains variable which contributes to the complexity to understand influence of predation on mule deer populations. The studies were predominately from high density mule deer populations relative to nutritional carrying capacity. The conclusions from these studies were that coyote removal generally has no effect on mule deer populations, and mountain lion and coyote predation was compensatory rather than additive may only be applicable to high density mule deer populations near nutritional carrying capacity (Forrester and Wittmer 2013, Ballard *et al*. 2001). In summary, the relationship between mule deer and predators is complex, rarely results in simple linear relationships and should not be oversimplified (WAFWA 2016).

Forrester and Wittmer's (2013) review of population dynamics of mule deer only found 6 studies that reported vital rates for the studied mule deer population and where predators were removed. The results in these studies found coyote and lion predation was compensatory with possibly one study being additive. Wolf predation was found to be additive in the one mule deer study reviewed.

Table 6. Variables and factors that wildlife agencies consider when evaluating the decline or increase of a mule deer population. Variables are dynamic, interact with each other, and change annually.

Variable	Proximate factor	Ultimate factor
Coyote predation	Lagomorph (e.g. rabbit) density	Previous year's summer rainfall affects lagomorph and microtine density
	Microtine (e.g. vole, mice) density	
	Lagomorph and coyote populations are highly synchronized	In dry years coyotes depredate more deer fawns than expected
		In wet years coyotes may exclusively depredate lagomorphs
Mule deer fawn survival	Doe body condition contributes to fawn body mass and survival	Previous summer rainfall influences fat deposits and body condition of doe
	Highly variable, unpredictable fawn survival to $\geq$ 7 months age	Coyote predation in first month of life
		Summer rainfall in current year
		Julian calendar date of birth
		Body weight at birth
		Early summer rains cause death from exposure
		Disease
		Age of doe or senescence
	Quality of summer range (nutrition)	Age and diversity of plant species
	Yearling survival (Jan. – April)	Winter snowfall
		Late summer and fall rains
		Lion predation (additive or compensatory)
		Coyote predation (additive or compensatory)
		Disease
Adult doe mule deer survival	Quality of summer range	Age and diversity of plant species
		Quantity and timing of precipitation
	Quality of winter range	Age and diversity of plant species
		Timing and quantity of winter precipitation
	Pregnancy rate, fetus and neonate survival	Previous summers precipitation
		Timing and quantity of winter precipitation
		Body condition to survive birth and lactation
		Nutrition of fawning habitat
		Doe age and physical condition
Lion predation	Additive or compensatory mortality	Winter weather
	Doe physical condition and fat reserves	Previous summer precipitation
		Malnutrition or disease
Bear predation	Quality of fawning habitat	Increased bear population
		Disease
		Habitat fragmentation

Ballard *et al*. (2001) review of mule deer – predator relationships found predation by coyotes, mountain lions or wolves may be significant mortality factors under some conditions. They thought predation could only be identified as a major limiting factor of ungulate populations through manipulative studies. Where predators were identified as a major limiting factor, deer populations were well below forage carrying capacity and study areas generally were small (< 180 km^s). The review of 16 studies to examine predation on mule deer determined that 8 had additive mortality from coyote, lion and wolf predation and one had additive and compensatory mortality from coyote predation. Ballard *et al*. (2001) found empirical evidence exists for predator damage management to increase moose, caribou and one black-tailed deer population. The challenge that Ballard *et al*. (2001) reported in determining if predation on a mule deer population was additive, was the short duration of most studies, weather patterns, and variation in habitat carrying capacity. Also, many studies are silent whether predation limits or regulates the deer population (Ballard *et al*. 2001). Finally, Ballard *et al*. (2001) concluded that elimination of major predators, livestock grazing, competition with livestock and other wild ungulates, fragmentation of habitats and other human influences alter relationships among predators, habitat, weather and harvest by humans. LeBlond *et al*. (2016), Laliberte and Ripple (2004) and Forrester and Wittmer (2013) expressed similar concerns about how relationships among predators and other factors have been altered by man.

Forrester and Wittmer (2013) noted two exceptions to the pattern of compensatory predator mortality where summer fawn mortality and predation in multiple predator, multiple prey systems. Predation plays a larger role in multiple predator, multiple prey systems that experience large and recent changes in predator or alternative prey populations (Hatter and Janz 1994, Robinson *et al*. 2002, Cooley *et al*. 2008). Recently, Latham *et al*. (2013) and Leblond *et al*. (2016) demonstrated how man altered the natural environment which caused predation to suppress and prevent recovery of the prey species. Latham *et al*. (2013) reported white-tailed deer (*Odocoileus virginianus*) extended their range into new habitat in Alberta and concomitantly increased in abundance 17 fold since the 1990's resulting in an alternative prey that nearly doubled the local gray wolf population resulting in increased predation on woodland caribou (*Rangifer tarandus caribou*). Caribou naturally had spatial separation from gray wolves during calving and summer. Now, the occurrence of white-tailed deer has provided an additional summer food source to beaver, and gray wolves no longer have spatial summer separation from caribou resulting in new and increased mortality and caribou population decline. Leblond *et al*. (2016) also studied predation on woodland caribou by gray wolves and black bears in a human altered environment in Quebec. The environment was largely altered by timber harvest, roads, which fragmented the habitat to the benefit of black bears. Caribou are a predator avoidance specialist unable to adjust to a now abundant predator (i.e. black bears) which became abundant via new rich food resources caused by timber harvest. Black bear predation on calves represents 94% of all mortality in the human altered landscape and prevents recovery of woodland caribou (Leblond *et al*. 2016). Both studies are examples of additive mortality affecting an ungulate population's growth. A similar study by Eacker *et al*. (2015) looked at elk calf survival in a multi-predator system with mountain lions, wolves and black bears and concluded juvenile recruitment into the population may depend on the carnivore assemblage as well as compensation from weather and forage. In this study, mountain lions had constant predation pressure on elk calves regardless of forage availability or weather severity indicating predation was additive.

Models or feedback patterns are useful for analyzing and then categorizing observations. Forrester and Wittmer (2013) created three feedback patterns which can be useful to classify ungulate population dynamics. The feedback pattern was developed to look at mule deer population dynamics, depending on the ecological context of the deer population (Table 7). This feedback pattern is useful to make preliminary judgments whether an ungulate population is subject to population declines caused ultimately by excessive predation. Further analysis or small research projects could supplement the

feedback pattern to determine if a larger scale research or management action is warranted.

A recent study by Treves et al. (2016) criticizes certain research on lethal predator damage management methods and recommends suspension of these tools until more rigorous scientific studies prove their efficacy. The authors in this paper call for new study designs that use the same standards as those in controlled laboratory settings for biomedical research. NWRC research scientists have evaluated this paper and do not agree with the authors' assessment that existing research is flawed. There are important differences between research studies conducted in a field environment and studies in biomedical laboratory settings. Field research inherently brings in variables such as weather, varying habitat quality, and movement of wildlife that cannot be controlled. Assumptions must be made when trying to answer complex ecological questions in field settings. Scientists address and acknowledge these variabilities using well-established and recognized field study designs, such as the switch-back and paired block designs. Additionally, Treves et al.'s (2016) critique of at least two studies by scientists currently working for WS did not accurately interpret or represent the studies' designs or results and raises questions regarding additional misrepresentations and errors in the paper. Details on WS' review of Treves et al. (2016) are provided in Appendix E.

WS agrees that predation damage management tools and techniques must be based on rigorous, scientifically-sound principles. Researchers at NWRC are dedicated to gathering information, testing new ideas and methods and using experiments (versus observational studies) as much as possible. WS' scientists at NWRC's Utah Field Station are leaders in the design and implementation of controlled studies to evaluate predation and predator control methods. They collaborate with experts from around the world to conduct these studies and findings are published in peer-reviewed literature.

1.3.2.6d Mule deer populations in Colorado.

Colorado had a statewide mule deer population of about 390,000 deer in 2013 down from 600,000 deer in 2006. The state wildlife agency, Colorado Parks and Wildlife, manages distinct mule deer populations in Data Analysis Units (DAU) which represents the year round range of a big game herd. Data Analysis Units may be comprised of one or more Game Management Units. Management prescriptions address unique habitat, weather, and changing environmental conditions within the unit. CPW considers harvest of male and female deer in each DAU and adjusts harvest to reduce or restrict female hunting mortality when the goal is to increase the deer population. For western Colorado, a mule deer management strategy for the West Slope was developed after extensive public input in 2014 (CPW 2014e). The plan was developed to address declining mule deer populations on the West Slope that are well below population objectives and the decline is atypical. Colorado Parks and Wildlife staff are evaluating a number of variables to understanding mule deer population decline on the West Slope including: barriers to migration, competition with elk, disease, doe harvest, declining habitat quality, habitat loss, highway mortality, predation, recreational impacts and weather. Other populations in Colorado in the mountainous center of the state or eastern prairies may also have mule deer populations below population objectives that will need to be assessed.

Colorado Parks and Wildlife is following the West Slope Mule Deer Strategy to assess deer populations within DAUs. Each DAU has different variables influencing demographic performance of the deer population. The different variables result in different prescriptions to change demographic performance of the mule deer population. For example, in DAU D-9 deer-vehicle collisions are a major mortality factor. Colorado Parks and Wildlife has worked with Colorado Department of Transportation to install overpasses and underpasses in 2015 and 2016 to significantly reduce deer and elk collisions with motor vehicles (Bulger 2016). Additionally, a similar assessment of the deer populations in DAU 19 and 40 was assessed to be below nutritional carrying capacity

and possibly had a predation issue suppressing the local deer population. An intensive multi-year study indicated while there was predation affecting the population, the mortality effects were compensatory and the habitat needed to be improved to increase the size of the local deer herd (Bishop *et al*. 2009).

Several concurrent studies were conducted in the DAU 19 and 40 to evaluate applicability of finding by Bishop *et al*. (2009). These studies evaluated fawn survival, body condition response and deer density in response to habitat management. Bergman *et al*. (2014) demonstrated habitat management increased fawn survival 10% on units with advanced habitat treatments versus no treatments. Habitat management in pinyon-pine habitat of DAU 19 and 40 consisted of two types of treatments. The traditional treatment of pulling a rollerchopper with a bulldozer which uprooted trees and other vegetation then broke the plant material into small pieces. The advanced habitat treatment included the same rollerchopper treatments plus reseeding key browse species

Table 7. Feedback patterns to assess if predation, nutrition or weather are driving ungulate population dynamics.

Feedback Pattern	Parameters	Conditions
1	a) High-density ungulate population near carrying capacity	a. Pattern seen in stable food webs
	b) Nutrition interacting with weather determines population equilibrium	b. Long-term population cycles driven by nutrition from weather and habitat change
	c) Predation is primarily compensatory	c. Compensatory predation, malnutrition and disease regulate population around shifting equilibrium.
	d) Predation, malnutrition and disease are regulating forces.	d. Extreme weather events will de-stabilize population dynamics causing large and abrupt changes in survival
		e. Changes in survival can linger through future cohorts
2	a. Diverse predator community	a. Fawn survival and recruitment affected by nutrition and summer fawn predation
	b. Large population of predators and prey	b. Adult survival mainly affected by nutrition and possibly senescence
	c. Fawns limited by predation and nutrition interactions	c. Maternal condition affects birth weight and fecundity
	d. Adult females limited by nutrition	d. Complex interaction between nutrition and predation which determines recruitment and population change
	e. Population growth constrained by fawn predation and nutritional effects on fecundity	e. These interactions change depending on predator diversity and ungulate density
		f. More evidence needed on effect of bears in fawn predation
3	a. Anthropogenic changes to habitat lead to lower nutritional capacity	a. This pattern likely to exist where landscape altered by humans
	b. Anthropogenic changes lead to large changes in predator or alternative prey populations	b. Lower nutritional carrying capacity caused by human activity
	c. Mule deer carrying capacity modified by these anthropogenic changes	c. Food webs and species composition are changed by human activity
	d. Large changes in predators or alternative prey change predation risk for primary prey	d. Mule deer are susceptible to any alteration that lowers survival of adults
	e. Ungulate population likely to be de-stabilized	e. Food web and community composition and spatial distribution will be important in this pattern
		f. This pattern will become more common in future

Feedback patterns modeled after Forrester, T. D. and H. U. Wittmer. 2013. Population dynamics of mule deer and black-tailed deer. Mammal Review 43:292-308.

and herbicide treatments for cheat grass and goat grass. Habitat treatments preceded the study by 2-8 years.

Additionally, deer in treated areas had higher internal body fat than deer on untreated areas (Bergman *et al*. 2014a). Total body fat is a metric of deer health and adult female mule deer body fat increased on treated habitats, albeit the magnitude of the effects were subtle with considerable variation between years and individuals (Bergman *et al*. 2014a).

Lastly, Bergman *et al*. (2015) evaluated deer density across the two habitat treatment sites and reference sites in DAU 19 and 40. There were many stochastic variables (winter range, treated habitats, transition range, weather, individual animal response on the same treatment, etc.) that drive deer density that more sensitive population parameters (e.g., overwinter survival or late winter body condition) should be used in tandem with density.

Predator damage management to increase fecundity and population growth is complex with many variables that need to be addressed to make a determination why a population is performing below objective. With each passing decade more is learned about managing populations to achieve desired outcomes and new challenges emerge due to changing environmental variable or actions by man. These environmental variables and actions by man require additional research to enlighten and guide management actions. Ballard *et al*. (2001) called for intensive radio telemetry and manipulative studies to identify if predation was a limiting factor. Monteith *et al* 2014) called for assessments to be made to quantify the influence of predation on large ungulates correctly by assessing the degree of compensatory or additive mortality on the nutritional capacity to young. Hurley *et al*. (2011) stated monitoring lagomorphs and small mammals in late April may provide a method to assess if coyote removal may have the possibility of success. Also, Bishop *et al*. (2009) called for additional research to determine if habitat improvements are capable of causing an increase in population growth. WS-Colorado would work with CPW, USFWS and other agencies when requested to participate in monitoring and research actions to determine appropriate management actions to meet population objectives. Some potential research projects summarized below are to evaluate management prescriptions to increase mule deer populations in central and western Colorado (Appendix A and B).

Mule deer survival in the Piceance Basin, Colorado. The Piceance Basin in northwest Colorado (GMU 22) represents winter range supporting the largest migratory mule deer (*Odocoileus hemionus*) population in Colorado. This area has been the focus of research and monitoring efforts since the late 1940's and likely represents one of the best documented mule deer populations in North America. Research efforts conducted during the 1980s (Bartmann *et al*. 1992) documented a high density deer population (mean winter density = 63/km^2) that appeared to be at or near carrying capacity. During the early 1990s, this population declined to about 1/3 of the previous winter range density (mean winter density = 23/km^2; White and Bartmann 1998), likely due to exceeding the forage capacity on winter range. Thirteen years later (January 2008), another research effort was initiated to address mule deer/energy development interactions in the Piceance Basin (Anderson 2015; Federal Aid Project No. W-185-R), where similar data are being collected to provide comparisons to mule deer demographic data from the 1980s and early 1990s. In comparing data between the 2 time periods (1982-1990 before the decline and 2008-present from unmanipulated control areas): (1) December fawn weights have increased (averaging 3.7 kg heavier), (2) over-winter fawn survival (Dec – June) has more than doubled (averaging 0.737 versus 0.351), and (3) winter starvation has become rare (<3% of collared fawns), which was common during the 1980s (averaging 33% annually), which suggests mule deer in the Piceance Basin are no longer limited by habitat conditions. Further evidence that this population is no longer limited by forage conditions is evident in the animal-indicated Nutritional Carrying Capacity (NCC; Monteith *et al*. 2014) from doe body condition measurements providing annual lamda estimates ranging from 1.01 – 1.04 (values >1.0 suggest the population is below NCC), except during 2011 when lamda was slightly below 1.0.

While current research (Anderson 2015; Federal Aid Project No. W-185-R) indicates habitat no longer appears to be the limiting factor, annual winter fawn recruitment has declined from ~73 fawns/100 does to ~49 fawns/100 does, and the average mule deer densities since 2008 (mean late winter density = 19.1/km^2) are comparable to the relatively low levels observed during 1994 and 1995 (mean mid-winter density = 23.5/km^2; White and Bartmann 1998). Because over-winter fawn survival is high, but early winter fawn recruitment appears low, there is need to discern why fewer fawns may be arriving on winter range in the Piceance Basin. Data collected during the ongoing research largely rules out issues surrounding low fecundity as measured pregnancy and twining rates have been consistently high averaging 95% since 2009 and 1.75 in utero fawns/doe. Thus, evidence suggests that wildlife biologists need information to better understand early fawn survival, from birth until December.

Newborn fawn survival has been addressed in the Piceance Basin the past 4 years (in partial collaboration with Colorado State University). Thus far, neonate survival has been relatively low (~40%) with a large portion of mortality attributed to predation (at least 49% of collared fawns) and low frequency of malnutrition (<4%). This suggests predation may be limiting neonatal (i.e., 0–6 months old, June – December) survival and recruitment to winter range if predation is additive to other types of mortality (e.g., disease, starvation). Monteith *et al*. (2014) reported high predation rates of mule deer neonates in California (>60% bear predation) and document that predation rather than nutrition was limiting the population.

Past research evaluating success of predator reduction to enhance ungulate populations has provided mixed results. Hurley *et al*. (2010) addressed coyote (*Canis latrans*) and cougar (*Puma concolor*) reduction to enhance mule deer populations in Idaho. They reported that coyote predation of mule deer was related to lagomorph abundance and coyote control exhibited no influence on early winter fawn recruitment. However, cougar reduction resulted in increased survival and winter fawn recruitment, but was largely ineffective when environmental factors (drought, severe winters) limited mule deer populations. Keech *et al*. (2011) addressed wolf (*C. lupus*) and bear (*Ursus* spp.) predation on moose (*Alces alces*) in Alaska and noted that predator reduction enhanced moose populations when environmental factors were non-limiting (i.e., during summer, fall). Predator reduction may benefit prey populations when they are not limited by habitat/environmental conditions, when predation is identified as a limiting factor, and when predator reduction is focused in scale to effectively reduce predation rates and timed to address critical periods in prey survival (Mule Deer Working Group 2012).

To address the reason for declining winter fawn recruitment in the Piceance Basin and identify potential management options, we propose to continue monitoring newborn fawn survival for another 3 years, while simultaneously implementing short-term and focused predator control in a treatment area and comparing fawn survival to an unmanipulated control area. This information will provide evidence to determine if predation is additive or compensatory to other types of mortality (e.g., disease, starvation). If neonate predation appears additive to other forms of mortality, focused predator reduction during mule deer parturition may be useful to enhance neonate survival and recruitment in mule deer populations experiencing decline and not limited by environmental conditions. If, on the other hand, neonate predation appears compensatory, predator management should be disregarded as a management option to enhance neonate survival and recruitment. Conditions in the

Piceance Basin are comparable to other western Colorado mule deer populations where high winter fawn survival and low starvation frequency has been documented and this information will likely be applicable to declining or below objective deer herds in the western third of the state exhibiting factors inconsistent with climate or habitat limitations (e.g., low starvation frequency, good forage conditions).

Mule deer survival and effects of cougar predation on a central Colorado population. The recently adopted Colorado mule deer strategy identifies predation as one of the potential factors limiting Colorado mule deer populations. Since the adoption of the mule deer strategy by the Parks and Wildlife Commission, members of the Leadership Team developed a plan for the implementation of the strategy. As part of the implementation strategy, staff examined existing predator and deer research and monitoring data to identify areas where predation may be most limiting to mule deer, which in turn could be used to inform predator harvest/management decisions. In June 2015, CPW personnel from the SE Region, Terrestrial, and Research branches met to explore the concept for a project that examines how deer demographic parameters may change following cougar suppression.

Deer data analysis unit (DAU) D-16 is comprised of game management units (GMUs) 49, 57, 58 and 581 which are located on the north side of the Arkansas River between the towns of Leadville and Canon City (Figure 1). Beginning in 1999, D-16 was added as one of 5 intensive deer monitoring DAUs in the state. Under the intensive monitoring protocol, we typically monitor 80-90 radio collared adult does to determine annual survival rates and 60 radio collared fawns annually to determine over winter fawn survival rates. Since 1999, we have radio collared 1,086 adult does and 898 fawns in D-16 to examine annual adult survival and winter fawn mortality.

From 1999-2014 , averaging across all years, the leading known cause of both doe (6.4%) and fawn (7.5%) mortality has been cougar predation (Figure 3, 4 and Table 1, 2). Cougar predation has ranged from 0 to 60% (avg. 28%) of the total mortality for does and 0 to 64% (avg. 32%) of the total mortality for fawns (Calculated from table 1,2). Currently, the mule deer population in D-16 is (11,247) below the long-term population objective of 16,000-20,000 deer. Based on survival data from 1999-2014, deer population growth in D-16 might partially be limited by cougar predation on fawns and adult does (Figure 3 and 4).

Predation on mule deer is often identified as one of the potential reasons that populations are below the long-term objectives (Colorado West Slope Mule Deer Strategy http://cpw.state.co.us/Documents/MuleDeer/MuleDeerStrategy.pdf, Ballard *et al*. 2001). In D-16, the adult survival data and relatively high predation rates from 2008-2012 (Table 1) suggests that cougar predation could be contributing to this lower than objective mule deer population.

Overwinter fawn survival has shown similar patterns to annual doe survival ranging between 59.2% and 86.2% (Table 2). Since 2013, overwinter fawn survival has been near 80% (Table 2). However, early winter fawn:doe ratios in D-16 have averaged 54.7 fawns per 100 does (range 38.5 to 68.0) since 1995 (CPW, unpublished data). Assuming fetal rates for adult (≥ 2 years old) mule deer of 1.8 (Bishop *et al*. 2008), it would appear neonate survival is a bigger issue for population growth and recruitment than other demographic rates, unless doe survival drops below 80%. Using the above fetal rate (1.8),

early winter fawn:doe ratio (54.7), and overwinter survival of 80%, survival to age one for mule deer would be 24.3%.

The success of a project to control predators to increase a population of mule deer is dependent upon the deer population in relation to the habitat carrying capacity (Ballard *et al*. 2001). If the population is at, or surpassed the habitat carrying capacity, it is likely that increases in survival rates caused by predator control will be compensated by other factors of mortality, such as malnutrition (Bartman *et al*. 1992). Conversely, if the population is below the habitat carrying capacity, reduction in mortality caused by predation could provide an additive response to increase survival rates of a mule deer population (Bleich and Taylor 1998; Hurley *et al*. 2004).

Examination of the malnutrition rates of fawns in D-16 can give some indication about whether a given population is at or exceeds carrying capacity. Since 1999, the highest rate of malnutrition was observed in 2004, when 5 of 57 (9%) fawns died from malnutrition causes (Table 2). Bartman *et al*. (1992) observed significantly higher rates of malnutrition in a NW Colorado mule deer herd, in which they documented reductions in predation rates being compensated by higher rates of malnutrition. The relatively low rates of malnutrition (1.6%) observed since 1999 suggests that the current population is below carrying capacity and limiting factors, such as predation, may be restricting mule deer population growth in D-16.

In order to assess the effect of management manipulations it is necessary to do this in an experimental framework with a control and treatment study area, otherwise the magnitude of the effect will be unknown as other limiting factors fluctuate. D-34 (GMUs 69, 691, 84, 86, and 861) is an adjacent mule deer DAU to the south of D-16, which has a similar mule deer population size (10,468) and habitat. Surveys (winter flights) also suggest that demographic rates are similar in terms of population ratios (45.2 fawns per 100 does based on 5 year average). Using D-16 and D-34 in a crossover design will allow for the manipulation of a potential limiting factor for mule deer population growth or survival and examining similarities in the response as the control and treatment is switched between the areas.

A research project will be conducted, beginning in the winter of 2016/2017, to examine the mule deer population response to cougar suppression. The study will be conducted in D-16 and the adjacent DAU, D-34. A crossover design will be used to examine the effects of cougar suppression in three stages. In stage one (years 1-3), cougar populations in D-16 will be suppressed (50% of population potential), while cougar populations in D-34 will be allowed to increase towards habitat potential with light harvest(10% harvest). Stage 2 (years 4-6) represents a recovery stage where both populations will be allowed to increase towards habitat potential (10% harvest). The final stage (years 7-9) represents the crossover where D-34 cougar populations will be suppressed (50% of population potential), while D-16 will continue to be allowed to increase towards habitat potential with light harvest (10% harvest).

The impact of cougar hunting on cougar populations, especially high levels designed to suppress populations, can be varied and is not well understood. Anderson and Lindzey (2005) demonstrated that a Wyoming cougar population could be significantly suppressed through 2 years of heavy harvest. Harvest rates of approximately 15% of the population have generally been shown as the tipping point between maintaining stable populations and decreasing populations. However, the percent adult female harvest is the crucial factor in population change.

The direct effect of harvest on population size is fairly clear but more subtle impacts on other demographic parameters is less clear, primarily due to a lack of information on these parameters. Cougars are inherently difficult to study because of their reclusive nature, small population sizes and large movement patterns. Technological advances, such as GPS collars, are only now allowing for the detailed study of cougars to understand these more subtle impacts. Past research has been limited by small sample sizes and case studies of a few events observed during the course of monitoring studies.

Harvest structure can be a useful tool for monitoring and managing cougar populations (Anderson and Lindzey 2005). Because the sex and age classes of cougars exhibit different behaviors and movement patterns (Barnhurst 1986) they also tend to differ in their vulnerability to harvest. The management experiment being conducted provides a unique opportunity to more completely develop our understanding of the relationship between harvest structure and cougar population structure. Understanding this relationship as populations are manipulated throughout the management experiment will provide critical information for management in the future as decisions are made about suppressing, stable or increasing cougar populations.

In addition to furthering CPW's understanding of harvest structure, this management experiment will provide us a significant amount of information on population level responses to various harvest strategies within a crossover design. Several studies have examined the impacts of harvest on cougar populations (Anderson and Lindzey 2005, Cooley *et al*. 2009, Ruth *et al*. 2011, Wielgus *et al*. 2013, Maletzke *et al*. 2014, Logan 2015), however no study that we are aware of has examined the impact of hunting at these two ranges in harvest level within a controlled crossover design. Such detail should allow for detailed data during decreasing and increasing phases of the population across the two study areas.

Density-dependent population regulation has a rich history and provides much of the basis for sustainable hunting and game management (Caughley 1977, Caughley and Sinclair 1994, Strickland *et al*. 1994). Compensatory mortality would predict that harvest mortality would be offset by density-dependent responses in reproduction, cub survival, and female population growth if harvest is primarily males because of reduced competition for resources. However, Wielgus *et al*. (2013) suggest that harvest of male cougars is not compensatory but is additive or possibly even depensatory.

One aspect of this study will be to closely examine cause specific mortality and develop a thorough understanding of levels of mortality in relation to population size and hunting pressure. Previous studies have suggested that male survival is lower in hunted populations (Lambert el al. 2006, Robinson *et al*. 2008, Ruth *et al*. 2011) but that female survival is lower in non-hunted populations (Logan and Sweanor 2001). Part of this is due to hunter selectivity on males but under situations of heavy harvest selectivity may decrease (Anderson and Lindzey 2005). The progression of the management experiment will directly allow us to measure cause specific survival during declining and increasing phases of a cougar population and under heavy and light harvest scenarios. This will allow a clear examination of non-hunting mortality rates, such as disease, intra-specific strife, or other natural mortality.

Similarly, cause specific survival of kittens throughout the stages of the project will provide essential information for management as this directly relates to population growth and recovery. Past research has suggested that

increased harvest has actually led to decreased kitten survival because of infanticide (Cooley *et al*. 2009, Ruth *et al*. 2011). Increased infanticide has been suggested to relate to high male harvest as this leads to an increase in subadult males in the population and territorial instability (Logan and Sweanor 2010, Ruth *et al*. 2011). However, recent cougar research in Colorado have shown higher infanticide rates during a 5 year non-hunting period than the subsequent 5 year hunting phase of the study (Logan 2015).

Other aspects of cougar population growth are reproductive rates and immigration/emigration rates. Theory behind density-dependent relationships would suggest that reproductive rates would increase during scenarios of increased harvest. Increased male immigration has been documented as a result of increased harvest levels (Cooley *et al*. 2009, Wielgus *et al*. 2013). Almost all males disperse, regardless of cougar density, with typical dispersal distances of 85 to 100 km (Sweanor *et al*. 2000). However, 50 to 80% of females remain in their natal range, establishing overlapping home-ranges with other breeding females (Sweanor *et al*. 2000). In a recent cougar study in the Front-Range of Colorado, a significant portion of subadult males did not disperse (Alldredge, unpublished data). It is unclear how various levels of harvest will impact immigration/emigration rates and the potential impact that this could have on reproductive rates. Wielgus *et al*. (2013) suggest that increased immigration actually decreased female reproductive success.

There is also the perception that high immigration rates of subadult males will lead to increases in human conflict and livestock depredation. Some studies have indicated that harvest and subsequent increases in subadult males have correlated with human-cougar conflict (Peebles *et al*. 2013, Maletzke *et al*. 2014). However, Kertson *et al*. (2013), suggest that demographic class did not relate to human-cougar interaction. This management experiment will provide direct information on human-cougar interactions with respect to changes in cougar populations, age structure, and immigration rates.

Cougar hunting has also been linked to changes in movement patterns, home-range size and diet composition. Keehner *et al*. (2015) suggested that female cougars will switch primary prey in an attempt to avoid conflict with male cougars in a hunted population. Increased hunting pressure was also suggested to increase home-range size and overlap in Washington (Maletzke *et al*. 2014) suggesting increased intraspecific conflict. Avoidance behaviors, increased space use and changes in movement patterns could all impact energetic demands of cougars, which could then alter foraging behavior.

Estimating cougar population size or density is also very useful for management purposes but has proven to be difficult and expensive to do. Historically mark-recapture techniques have been used, which require the physical capture and handling of animals and is therefore expensive. More recently developments have been made for noninvasive genetic sampling of cougars to get population estimates using scat detection dogs or hair snags. Alldredge (unpublished data) has been developing the hair snag approach and it is showing promising results. In a hunting situation, especially when reporting is mandatory, harvest data can be used to supplement these data in statistical population reconstruction models (Fieberg *et al*. 2010, Skalski *et al*. 2012, Gast *et al*. 2013). Through this management experiment both hair snag and harvest data will be available to test these procedures and develop techniques to obtain better population densities statewide. GPS collared cougars will provide baseline data for assessing potential bias in estimates.

1.3.2.6e Pronghorn (*Antilocapra americana*) and Bighorn Sheep (*Ovis canadensis*) affected by predation.

Under certain conditions, predators, especially coyotes and mountain lions, can have a significant adverse impact on bighorn sheep and pronghorn antelope populations, and this predation is not necessarily limited to sick or inferior animals (Pimlott 1970, Bartush 1978, USFWS 1978, Trainer 1983, Hamlin *et al*. 1984, Neff *et al*. 1985, Shaw 1977). Connolly (1978) reviewed 68 studies of predation on wild ungulate populations and concluded that in 31 cases, predation was a limiting factor.

Predation can be one of the main limiting factors for pronghorn antelope. Jones (1949) found coyote predation to be the main limiting factor for Texas pronghorns. A six-year radio telemetry study of pronghorn in western Utah showed that 83% of all fawn mortality was attributed to predators (Beale and Smith 1973). In Arizona, Arrington and Edwards (1951) showed that intensive coyote damage management was followed by an increase in pronghorn to the point where they could once again be hunted. No such increase was noted in areas without coyote damage management. Similar observations of improved pronghorn fawn survival and population increase following damage management have been reported by Riter (1941), Udy (1953), and Smith *et al.* (1986).

In Arizona, coyote damage management on Anderson Mesa increased the pronghorn herd from 115 animals to 350 in just three years. This trend continued until coyote damage management was discontinued in 1971, peaking at 481 animals (Neff *et al.* 1985). After coyote damage management was stopped, the pronghorn fawn survival dropped to only 14 and 7 fawns per 100 does in 1973 and 1979, respectively. The land managers on Anderson Mesa then re-initiated a coyote damage management program in 1981, removing an estimated 22% of the coyote population in 1981, 28% in 1982, and 29% in 1983. By 1983, the pronghorn population on Anderson Mesa had risen to 1,008 antelope, exceeding 1,000 animals for the first time since 1960. Fawn production increased from a low of 7 fawns per 100 does in 1979 to 69 and 67 fawns per 100 does in 1982 and 1983, respectively. After a five-year study, Neff and Woolsey (1979, 1980) determined that coyote predation on pronghorn fawns was the primary factor causing fawn mortality and low pronghorn densities on Anderson Mesa. Smith *et al.* (1986) noted that controlling coyote predation on pronghorn fawns could result in 100% annual increases in population size, and that coyote removal was a cost-effective strategy in pronghorn management.

Bighorn sheep populations are also very susceptible to predation, especially where their populations have reached precariously low numbers (Mooring *et al.* 2004). Mountain lions are the primary predator of bighorns, but coyotes and bobcats will also take them. Mooring *et al.* (2004) found that in New Mexico, rams had the highest predation rates and attributed most predation to mountain lions. These and other authors have attributed the high ram mortality to rams' use of habitat conducive to predation by lions, poor post-rut body condition, and occlusion of rear vision due to their larger horns (Harrison and Hebert 1989, Schaefer *et al.* 2000, Mooring *et al.* 2004). However, other studies found that lambs (Ross *et al.* 1997) and ewes (Krausman *et al.* 1989) were taken more by mountain lions in proportion to their population. Still other studies found that predation rates reflected the proportion of sex and age classes in the population (Hayes *et al.* 2000), or a particular lion's predation habits (Ross *et al.* 1997). In New Mexico, mountain lion management is used to protect desert bighorn sheep, which are on the NM State endangered species list (New Mexico Game and Fish, 2010). CPW does not currently use routine mountain lion management to protect desert or rocky mountain bighorn sheep in Colorado (George *et al.*, 2009), but WS-Colorado could be asked to assist with such actions in the future, especially where bighorn sheep populations may drop below a level where herd size has anti-predator strategies (Mooring *et al.* 2004).

Under some circumstances, PDM can be an important tool in attaining specific wildlife management objectives. The use of PDM activities to protect big game species in

Colorado is a decision that primarily rests with CPW; WS-Colorado may assist CPW at their request. In such cases, WS-Colorado will use those PDM strategies which would likely be effective and successful (Ballard *et al.* 2001). However, as the management agency, CPW would determine when and where PDM would be conducted.

1.3.2.6f Nesting Upland Gamebirds, Waterfowl, and Shorebirds.

WS-Colorado has not received requests from CPW or other agencies to provide protection for nesting upland gamebirds, waterfowl, or shorebirds from predators recently. However, WS-Colorado does conduct PDM projects in several other parts of the U.S. to protect nesting birds that are federally listed T&E species, and similar assistance could be requested of the WS-Colorado program in the future. For example, WS conducted PDM for Attwater's greater prairie-chickens in Texas (USFWS 1998b) where predation by skunks, coyotes, and other species was identified as a limiting factor in their recovery. Avian species that are federally listed in Colorado and that could be impacted by predators include: the least tern (endangered) and the Gunnison's sage-grouse (threatened). Additional support may be given to these species should it be determined by an agency with management authority over such species that predation from predators has limited their viability. PDM projects to protect nesting birds are typically of short duration and limited to just prior to and during the critical nesting periods when the eggs, chicks, and setting birds are most vulnerable. PDM activities for nesting birds are typically focused on a few species of mammalian predators known for depredating nests of eggs and nestlings such as raccoons, skunks, and coyotes.

Greater sage-grouse (*Centrocercus urophasianus*) populations have declined throughout Colorado and the western U.S. over the last several decades due to a variety of environmental factors (Connelly and Braun 1997). Sage-grouse occupying habitats that are highly fragmented or in poor ecological condition may exhibit relatively low nest success, low juvenile recruitment, and poor adult survival that may be related to increased predation (Gregg 1991). Populations of some of the most important prairie grouse predators have increased dramatically over the last 100 years (see analysis related to coyote and red fox in Chapter 4), and even in areas of good habitat, predator populations can be so abundant that habitat alone may not suffice to allow grouse populations to increase (Bergerud 1988). Schroeder and Baydack (2001) suggested that as habitats become more fragmented and populations of prairie grouse become more threatened, it becomes more important to consider PDM as a potential management tool. Because damaged sagebrush habitats may take 15-30 years to recover, a predator damage management strategy that effectively increases nest success and juvenile survival may be useful in offsetting some of the negative effects of poor habitat. This approach might also allow a more rapid recovery of grouse populations following habitat recovery. For example, after 3 years of monitoring the movement, survival, and reproduction of reintroduced sharp-tailed grouse (*Tympanuchus phasianellus*) in northeastern Nevada, Coates and Delehanty (2001) recommended that future reintroductions of sharp-tailed grouse be preceded by 2 months of PDM to increase survival of released birds. In a survey of U.S. public attitudes regarding predators and their management to enhance avian recruitment, Messmer *et al.* (1999) found that, given information suggesting predators are among the threats to a declining bird population, the public generally supported using PDM for the protection of bird populations.

Batterson and Morse (1948) documented heavy predation on sage-grouse nests in northeastern Oregon, and, whereas the greatest limiting factor was common raven (*Corvus corax*) predation, coyotes and badgers also contributed to nest predation. Keister and Willis (1986) suggested that the major factor in determining sage-grouse population levels in their study area in southeastern Oregon was loss of nests and chicks during the first 3 weeks after hatching. Coyotes and ravens were suspected as the primary nest predators. A coyote removal project was implemented on their study area, and sage-grouse productivity increased dramatically from 0.13 chicks/hen to 2.45 chicks/hen in just 3 years. Willis *et al.*

(1993) analyzed data on sage-grouse and predator populations, weather, and habitat from an area of Oregon that had some of the best sage-grouse habitat in the state. The only meaningful relationship they found was a significant negative correlation between coyote abundance and the number of sage-grouse chicks produced per hen. They concluded that fluctuation in predator abundance was probably the single most important factor affecting annual productivity of sage-grouse in their study area. Presnall and Wood (1953) documented an example illustrating the potential of coyotes as predators on sage-grouse. In tracking a coyote approximately 5 miles to its den in northern Colorado, they found evidence along the way that the coyote had killed three adult sage-grouse and destroyed a sage-grouse nest. Examination of the stomach contents from an adult female coyote removed the next day revealed parts of an adult sage-grouse hen plus six whole newly-hatched sage-grouse chicks. The area around the den was littered with sage-grouse bones and feathers. No other prey remains were found around the den, and it appeared that the pups had been raised largely upon sage-grouse.

Burkepile *et al.* (2001) radio-marked 31 chicks from 13 broods in 1999, and 44 chicks from 15 broods in 2000. Survival estimates for 1999 and 2000 were only 15% and 18%, respectively. Radio-tracking allowed the authors to positively identify the reason for most losses, and they found that predators were responsible for 90% of the mortality in 1999 and 100% of the mortality in 2000. Red fox were believed to be one of the primary chick predators, but predation was also confirmed by unidentified avian and other mammalian predators as well. Bunnell and Flinders (1999) also documented significant predation by red fox on sage-grouse in their study area in Utah, and recently revised sage-grouse management guidelines, suggesting that red fox populations should be discouraged in sage-grouse habitats (Connelly *et al.* 2000). To the extent that red fox, coyotes, and other predators which prey on chicks are also preying on eggs, reducing the populations of these predators from sage-grouse nesting and early brood-rearing areas has the potential to benefit both nesting success and chick survival.

A more recent review of the effects of raven and coyote removal in relation to temporal variation in climate on greater sage grouse nest success was undertaken (Dinkins et al. 2016). Depredation of sage grouse nests can limit productivity. Ravens have become more abundant in sage habitat due to increases in anthropogenic structures and supplemental food sources. Dinkins et al. (2016) showed removal of ravens can increase nest success and may have a place in sage grouse management as an interim mitigation measure until long term solutions are found. While coyote removal was found less effective in wet years since nest success declined. A number of potential causes for lower sage grouse nest success during wet years was postulated but the cause of lower nest success was outside the scope of the study. WS-CO conducts intensive coyote removal from Axial Basin in Moffat County to protect sheep on lambing grounds. The Basin is thought to have some of the highest densities of greater sage grouse in Colorado, likely due to removal of large numbers of coyotes that would depredate adult grouse, chicks and eggs. Coyote removal may benefit sage grouse.

Habitat losses remains the greatest cause of greater sage grouse population declines (Connelly at al. 2000, Walker et al. 2016) and it has long been recognized that protecting large continuous blocks of viable sagebrush habitat are required for conservation of sage grouse (Beck and Mitchell 2000). Large expanses of sagebrush were burned or chemically treated after World War 2 for forage production for livestock. Influences of livestock grazing on sagebrush habitats were evaluated by Beck and Mitchell (2000). Livestock impacts on sage grouse can be positive, negative or neutral (Guthrey 1996). Impacts of livestock grazing on sagebrush is highly variable and related to stocking densities and forage management practices (e.g., fire, herbicides)(Guthrey 1996). While higher densities of livestock in past decades affected sagebrush habitats, (Gunnison Sage Grouse Rangewide Steering Committee 2005), The lower densities of sheep on the range over the last 40 has likely had less harmful effects. Grazing can reduce fire frequency by reducing fuel loads and can increase sage brush density through grazing. However,

trampling by livestock can kill smallersage brush plants and over time can affect the plant community. Also, cattle may step on grouse nests. The time of year grazing occurs affects sage brush communities with spring grazing resulting in more sagebrush while fall grazing results in more grasses and forbes. Sage grouse use sagebrush, grasses and forbes at different times of the year for foraging, raising young and wintering. Livestock grazing can be compatible with sage grouse when stocking rates are low or moderate since grasses, forbes and sagebrush remain for nesting (Beck and Mitchell 2000). Some higher stocking rates of livestock following a drought can reduce available habitat for nesting sage grouse. In summary, livestock grazing affects are highly variable with the effects most minimized by stocking rates.

Gunnison sage grouse (*Centrocercus minimus*) are listed as federal threatened species in Colorado. Gunnison sage grouse occur on sage brush habitats and rangelands with a sage brush component in central Colorado in and near the Gunnison Basin. The species has declined in abundance due to substantial changes in habitat from human disturbance and small population size (Gunnison Sage Grouse Rangewide Steering Committee 2005). These population declines are exacerbated by the interaction of predation with habitat loss and small population size (Gunnison Sage Grouse Rangewide Steering Committee 2005). Changes in habitat affect the distribution of Gunnison sage grouse on the landscape. Some habitat changes have resulted in increases in wildlife species that depredate Gunnison sage grouse resulting in negative population effects.

The decline of Gunnison sage grouse is due to poor or no productivity (Davis et al. 2015), especially among the 7 small satellite populations (Davis et al. 2015, Oyler-McCance et al. 2005). Taylor et al. (2012) found female survival and chick survival were the most important vital rates for greater sage grouse population growth, which is similar to little to no population growth afflicting Gunnison sage grouse populations. The poor productivity and survival of chicks is likely attributed to declining habitat quality and introduction of anthropogenic habitat alterations harmful to sage grouse survival. Many studies report habitat characteristics that have changed to the detriment of Gunnison and greater sage grouse (Hovick et al. 2014, Aldridge et al. 2012, Hess and Beck 2012). Whereas habitat loss or change may be the proximate cause of sage grouse decline, these changes introduce ultimate factors, such as predation, that cause population loss (Gregg and Crawford 2007).

Raven and corvid populations have increased significantly over the last 40 years as man has introduced anthropogenic structures into sagebrush habitat (Coates et al. 2016, Coates and Delehanty 2010, Manzer and Hannon 2005). Ravens are one of the predators depredating sage grouse and in some locations are impacting population growth and survivability of nests and eggs (Coates and Delehanty 2010,). These population losses normally would not occur in pristine sage brush habitat. WS-Colorado has conducted limited raven damage management to protect Gunnison sage grouse at one satellite population.

Dumke and Pils (1973) reported that ring-necked pheasant (*Phasianus colchicus*) hens were especially prone to predation during their nest incubation period. Trautman *et al.* (1974) examined the effects of predator removal on pheasant populations in South Dakota by monitoring pheasant populations in similar 100 mi^2 plots with and without PDM. They examined two variations of predator removal, one targeting only red fox for 5 years, and the other targeting badger, raccoon, striped skunks and red fox for 5 years. They found pheasant densities were 19% and 132% higher in predator removal areas than in non-removal areas during fox removal and multiple predator species removal, respectively. Chesness *et al.* (1968) examined the effects of predator removal on pheasant populations in paired treatment and non-treatment areas in Minnesota over 3 years by targeting primarily nest predators, including skunks, raccoons, and crows. They reported a 36% hatching success in predator removal areas versus a 16% hatching success in non-removal areas, as well as higher clutch sizes and chick production in predator removal areas.

Nohrenberg (1999) investigated the effects of limited predator removal on pheasant populations on his study areas in southern Idaho and found consistently higher pheasant survival and productivity in predator removal areas as compared to similar non-removal areas.

Thomas (1989) and Speake (1985) reported that predators were responsible for more than 40% of nest failures of wild turkeys (*Meleagris gallopavo*) in New Hampshire and Alabama. Everett *et al.* (1980) reported that predators destroyed 7 of 8 nests on his study area in northern Alabama. Lewis (1973) and Speake *et al.* (1985) reported that predation was the leading cause of mortality in turkey poults, and Kurzejeski *et al.* (1987) reported in a radio-telemetry study that predation was the leading cause of mortality in hens. Wakeling (1991) reported that the leading natural cause of mortality among older turkeys was coyote predation, with the highest mortality rate for adult females occurring in winter. Other researchers report that hen predation is also high in spring when hens are nesting and caring for poults (Speake *et al.* 1985, Kurzejeski *et al.* 1987, Wakeling 1991). Williams *et al.* (1980) reported a 59% hatching success for turkeys prior to a predator poisoning campaign, versus a 72% hatching success following the predator poisoning campaign.

In a study of waterfowl nesting success in Canada, researchers found that eggs in most nests were lost to predators such as red foxes, coyotes, striped skunks, raccoons, Franklin's ground squirrels (*Spermophilus. franklinii*), badgers, black-billed magpies (*Pica pica*) and American crows (*Corvus brachyrhynchos*) (Johnson *et al.* 1988). Cowardin *et al.* (1985) determined that predation was by far the most important cause of nest failure in mallards (*Anas platyrhynchos*) in their study area. Various studies have shown skunks and raccoons to be a major waterfowl nest predators resulting in poor nesting success (Keith 1961, Urban 1970, Bandy 1965). For example, on the Sterling Wildlife Management area in southern Idaho, striped skunks, red fox, and black-billed magpies were documented as common predators of nesting ducks, with magpie predation identified as the most significant factor limiting waterfowl production (Gazda and Connelly 1993).

In documenting the effects of red fox predation on waterfowl in North Dakota, Sargeant *et al.* (1984) concluded that reducing high levels of predation was necessary to increase waterfowl production. Balser *et al.* (1968) determined that PDM resulted in 60% greater production in waterfowl in areas with predator damage management, as compared to areas without it. They also recommended that when conducting PDM, the entire complex of potential predators should be targeted, or compensatory predation may occur by a species not being managed, a phenomena also observed by Greenwood (1986). Rohwer *et al.* (1997) documented a 52% nesting success for upland nesting ducks in an area receiving PDM, versus only a 6% nesting success in a similar non-treatment area. Garrettson and Rohwer (2001) likewise documented dramatically higher duck nesting success in areas where predators were removed during the nesting season as compared to areas where no predators were removed, and noted that the annual nature of predator removal allowed for greater management flexibility than most habitat management efforts.

Production of sandhill cranes at Malheur National Wildlife Refuge in southeastern Oregon was severely limited by predation from coyotes, ravens, raccoons, and mink. PDM for these species on the refuge resulted in increased colt survival (from 1 crane colt surviving to 60) as well as increased production of other waterfowl (USFWS 1989, 1990, 1991, 1994). Several other predators can also damage nesting waterfowl, primarily their eggs, such as skunks and foxes. Typically the goal of PDM is to suppress local predator populations during the birds' nesting season to increase the birds' production.

1.3.2.6g Other Species.

WS-Colorado may be requested to use PDM to help protect other species as well. If a management agency finds that a particular species has been impacted by predation, WS-

Colorado could assist in determining if PDM efforts could help protect the species, and implement any appropriate PDM actions to address it. Species being given protection often are T&E species. For example, one such T&E species that was reintroduced in Colorado and was given protection from predators, especially prior to their reintroduction, is the black-footed ferret. In the first reintroduction effort by USFWS, 34 of 39 reintroduced ferrets were killed by predators. As a result of the impact of predation, PDM is now commonly conducted where ferrets are going to be reintroduced. Several other Federal and State listed T&E species in Colorado are impacted by predators, including Canada lynx and kit fox.

1.4 RELATIONSHIP OF THIS EA TO OTHER ENVIRONMENTAL DOCUMENTS

1.4.1 WS-Colorado EAs.

WS-Colorado has completed three prior EAs for Colorado: eastern Colorado (WS 1999a), western Colorado (WS 1997b), and statewide (WS 2005b). The western Colorado EA was supplemented in 2001 (WS 2001). This EA will replace the 2005 statewide EA, and includes much of the information contained therein.

1.4.2. National Level Memoranda of Understanding.

MOUs have been signed between WS and BLM, and between WS and USFS which recognize WS's authority and responsibility for WDM, and related compliance with NEPA, on BLM and USFS lands. WS is recognized through the MOUs with BLM and USFS as being the lead agency concerning most WDM on public lands; USFS and BLM are responsible for NEPA compliance when WDM is to protect federal resources such as gopher control to protect planted seedlings. In the current MOUs that WS has with USFS and BLM, it is recognized that the State has management authority over resident wildlife. CPW and CDA are the State entities that have been given the primary management authority for resident wildlife and establishes the management objectives for these species and their damage. WS defers to State laws in the management of predators on these federal lands.

1.4.3 USFS Land and Land and Resource Management Plans (LRMPs).

The National Forest Management Act requires that each NF and National Grassland (NG) prepare a Land and Resource Management Plan (LRMP) for guiding long-range management and direction. Colorado has all or part of 11 NFs and 2 NGs; these are managed under the direction of 7 Forest Supervisors and are divided into 34 Ranger Districts in Colorado. WS-Colorado conducted PDM on 4 NFs and 1 NG (10 Ranger Districts) in FY10-14. WS-Colorado provides USFS District Rangers, the Forest Supervisors, or both with Work Plans annually on those Ranger Districts where WS-Colorado expects to conduct PDM. USFS discusses the compatibility of the proposed PDM activities with the LRMP. WS-Colorado conducts the PDM activities according to all applicable laws and regulations. If requested, WS-Colorado could potentially conduct PDM on all NFs/NGs in the State where appropriate (*e.g.*, to protect livestock on grazing allotments, wildlife, or human safety). If WS-Colorado is requested to conduct PDM on USFS lands not covered by the scope of this EA, then a determination of the need for additional NEPA compliance would be made at that time.

1.4.4 BLM Resource Management Plans (RMPs).

BLM currently uses RMPs to guide land management for public lands it administers and has completed EISs to cover their implementation (see BLM in Literature Cited for a list of them). Colorado has 11 BLM Resource Areas (RAS), covering about 10 million acres of land, and a BLM State Office in Denver. WS-Colorado conducted PDM on 7 of the 11 BLM RAS in FY10-14. WS-Colorado provides the appropriate BLM Field Offices with Work Plans annually where WS-Colorado expects to conduct PDM. BLM discusses the compatibility of the proposed PDM activities with the RMP. WS-Colorado conducts the PDM activities according to all applicable laws and regulations. If requested, WS-Colorado could potentially conduct PDM on any BLM RA in the State where appropriate (*e.g.*, to protect livestock, wildlife, or human safety). If WS-Colorado is requested to conduct PDM on BLM lands not covered by the scope of this EA, then a

determination of the need for additional NEPA compliance would be made at that time.

1.4.5 CPW Management Plans.

CPW has management plans for mountain lions and black bear, and outlines CPW's objectives for these species populations in Data Analysis Units (DAUs) and for Colorado as a whole. These clarify the management objectives for these species in Colorado. WS-Colorado take of these species are included in the total mortality in the DAUs and the State. WS-Colorado mostly responds to requests concerning agricultural related damage for these species and some human health and safety threats. WS-Colorado relies on CPW to determine what the management objectives are in each DAU and ensure that management objectives are met. WS-Colorado cannot know in advance which DAUs might experience damage from these species, or where WS-Colorado would respond to resolve these problems. However, CPW includes estimates of non-hunter and hunter mortality in making recommendations for the upcoming hunting seasons, which includes WS-Colorado take.

1.5 DECISIONS TO BE MADE

WS-Colorado is the lead agency for this EA, and therefore responsible for the scope, content, and decisions made. Cooperating agencies in the production of this EA are CDA, CPW, BLM and USFS. Each of the cooperating agencies was asked to provide input and direction to WS-Colorado to insure that Program actions are in accordance with applicable regulations and policies, and with the desires of the State of Colorado.

Based on the scope of this EA, the following decisions need to be made:

- Should PDM, as currently implemented, be continued in Colorado?
- Does the proposed action have significant impacts requiring preparation of an EIS?

1.6 SCOPE OF THIS ENVIRONMENTAL ASSESSMENT ANALYSIS

1.6.1 Actions Analyzed

This EA evaluates PDM to protect livestock, crops, property, natural resources, and human health and safety in Colorado at the statewide level.

1.6.2 American Indian Lands and Tribes

WS-Colorado conducts PDM on Tribal Lands only at a Tribe's request. Because Tribal lands are sovereign and the methods employed are the same as for any private land upon which WS-Colorado provides services, Tribal officials determine if PDM is desired and the PDM methods allowed. Because the Tribal officials have the ultimate decision on whether PDM is conducted, no conflict with traditional cultural properties or beliefs is anticipated. Therefore, this EA would cover PDM on Tribal lands, where requested and implemented.

1.6.3 Federal Lands

Colorado has a fairly large proportion of federal lands and WS-Colorado is often requested to conduct PDM on them. The methods employed and potential impacts on wildlife would be the same on these lands as they would be on private lands upon which WS-Colorado provides service. Therefore, if WS-Colorado were requested to conduct PDM on federal lands for the protection of livestock, property, human health and safety, or natural resources such as T&E species, this EA would cover such actions implemented. NEPA compliance for PDM conducted to protect natural resources such as T&E species at the request of USFWS or other federal agency is the requesting agency's responsibility. WS-Colorado could accept the NEPA responsibility at the request of another agency, but that agency would still be responsible for issuing a NEPA Decision.

1.6.4 Site Specificity

This EA analyzes potential impacts of PDM on the human environment as required by NEPA and addresses WS-Colorado PDM activities on all lands under *Cooperative Agreement* or *Agreements for Control*, or as otherwise covered by *WS Work Plans* (*e.g.*, on federal lands) within Colorado. It also addresses the impacts of PDM on areas where additional agreements with WS-Colorado may be written in the reasonably foreseeable future in Colorado. Because the proposed action is to continue the current PDM program, and because the current program's goal and responsibility is to provide service when requested within the constraints of available funding and manpower, it is conceivable that additional PDM efforts could occur. Thus, this EA anticipates potential expansion and analyzes the impacts of such expanded efforts as part of the current program.

Planning for the management of predator damage is conceptually similar to federal or other agency actions whose missions are to stop or prevent adverse consequences from anticipated future events, for which the actual sites and locations where they will occur are unknown, but could be anywhere in a defined geographic area. Examples of such agencies and programs include fire and police departments, emergency clean-up organizations, insurance companies, etc. Although some of the sites where predator damage is likely to occur and lead to requests to WS-Colorado for assistance can be predicted, all specific locations or times where such damage will occur in any given year cannot be predicted. This EA emphasizes major issues as they relate to specific areas whenever possible; however, many issues apply wherever predator damage and resulting management occurs.

The standard WS Decision Model (Figure 3; Slate *et al*. 1992) and WS Directive 2.105 are the site-specific routine thought processes for determining methods and strategies to use or recommend for individual actions conducted by WS-Colorado. The Decision Model is not intended to require documentation or a written record each time it is used, and it necessarily oversimplifies complex thought processes. Decisions made using the model would be in accordance with SOPs described herein and adopted or established as part of the decision.

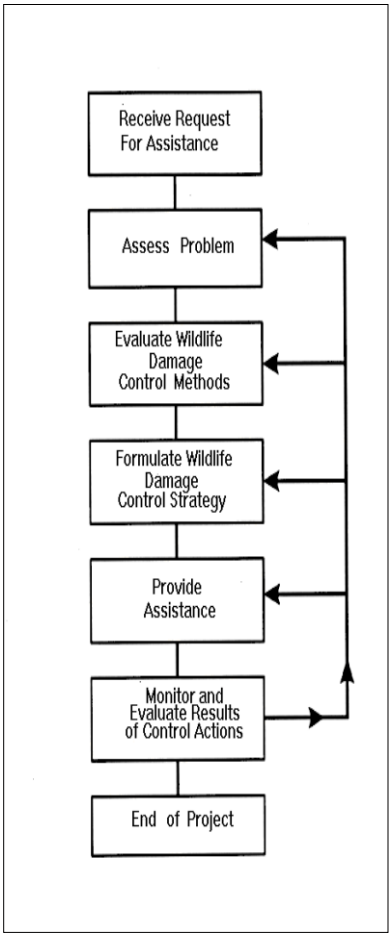

Figure 3. WS Decision Model used at the field level (Slate *et al.* 1992).

The determination of the relevant geographical region to be covered by an EA falls within the informed discretion and expertise of the agency responsible for conducting the proposed action (*Kleppe v. Sierra Club*, 427 U.S. 390, 414 (1976)). WS-Colorado has considered both the proposed action and the geographic area involved and has determined that the preparation of this EA to address WS-Colorado' PDM activities on a statewide basis for the state of Colorado is the appropriate approach to take. Wildlife populations, with the exception of T&E species, are monitored over large geographic areas (*e.g*., the West, the state of Colorado) and smaller geographic areas (*e.g.*, game management units, CPW "Data Analysis Units"). WS-Colorado monitors target predator and non-target take for the State and in each of the WS-Colorado Districts. The game management units and WS-Colorado Districts do not correspond to each other in Colorado; thus, analysis of wildlife population impacts is best analyzed at the statewide level. Additionally, harvest by sportsmen in Colorado is estimated by CPW from phone surveys. Statistically, the variance at the local level (*e.g.*, the game management unit or County) is very high and can be ± 100% making the data less useful. However, the variance is much lower at the statewide level, and thus, cumulative harvest data at the statewide level is much more reliable.

Moreover, if a determination is made through this EA that the proposed action would have a significant environmental impact, then an EIS would be prepared, and the State of Colorado would be the most appropriate geographical range for such. This EA appropriately, effectively, and adequately covers all of the direct and indirect impacts, as well as the site-specific and cumulative effects issues related to WS-Colorado' PDM actions in Colorado.

1.6.5 Interdisciplinary Development of the EA

Comments were solicited from the BLM, USFS, CDA, CPW, CDPHE, and USFWS to facilitate an interdisciplinary approach to analysis. Comments are maintained in an administrative file located at the WS-Colorado State Office, 12345 West Alameda Parkway, Suite 204, Lakewood, CO 80228.

1.7 AUTHORITY AND COMPLIANCE

1.7.1 Authority of Federal and State Agencies for WDM in Colorado

1.7.1.1 WS Legislative Authority. USDA is authorized and directed by law to protect American agriculture and other resources from damage associated with wildlife. The primary statutory authority for USDA is the *Act of March 2, 1931* and the *Rural Development, Agriculture, and Related Agencies Appropriations Act of 1988 (7 USC 426-426c; 46 Stat. 1468)*, as amended in the Fiscal Year 2001 Agriculture Appropriations Bill, which provides that:

> *"The Secretary of Agriculture may conduct a program of wildlife services with respect to injurious animal species and take any action the Secretary considers necessary in conducting the program. The Secretary shall administer the program in a manner consistent with all of the wildlife services authorities in effect on the day before the date of the enactment of the Agriculture, Rural Development, Food and Drug Administration, and Related Agencies Appropriations Act, 2001."*

Since 1931, with the changes in societal values, APHIS-WS policies and programs place greater emphasis on the part of the Act discussing "bringing [damage] under control," rather than "eradication" and "suppression" of wildlife populations. In 1988, Congress strengthened the legislative authority of APHIS-WS with the Rural Development, Agriculture, and Related Agencies Appropriations Act. This Act states, in part:

> *"That hereafter, the Secretary of Agriculture is authorized, except for urban rodent control, to conduct activities and to enter into agreements with States, local jurisdictions, individuals, and public and private agencies, organizations, and institutions in the control of nuisance mammals and birds and those mammal and bird species that are reservoirs for zoonotic diseases, and to deposit any money collected under any such agreement into the appropriation accounts that incur the costs to be available immediately and to remain available until expended for Animal Damage Control activities."*

WS-Colorado conducts WDM in cooperation with and under the authorities of CDA and CPW. The WS-Colorado Program works cooperatively with local livestock associations and county governments to provide PDM assistance for its constituents. PDM assistance is provided statewide in areas where funding has been provided. PDM activities occur on both private and public lands, but the use of foothold traps, snares, and toxicants is very limited on public lands, due to the limited exceptions permitted under Amendment 14. WDM methods that can be used in different wildlife damage situations are discussed in detail in Chapter 3.

1.7.1.2 Colorado Department of Agriculture. Colorado Revised Statutes (CRS) Title 2, Article 12 (1995) discusses CDA's responsibilities regarding depredating animal control. CRS Title 35 states the Commissioner of Agriculture has exclusive jurisdiction over the control of depredating animals (coyotes, wolves, foxes, bobcats, raccoons, mountain lions, bears, striped skunks, and opossums). CRS Title 35 also authorizes CDA to enter into agreements with WS-Colorado for the purpose of cooperating in the management of damage caused by coyotes, wolves, mountain lions, bobcats, and other depredating animals where they are damaging agricultural resources. It also allows CDA to enter into agreements with other entities to conduct PDM. CDA currently has an MOU with WS-Colorado. This document establishes a cooperative relationship between WS-Colorado and CDA, outlines responsibilities, and sets forth objectives and goals of each agency for resolving wildlife damage in Colorado. CDA also regulates pesticide uses in Colorado.

1.7.1.3 Colorado Parks and Wildlife. CPW has the responsibility to manage all protected and classified wildlife in Colorado, except federally-listed T&E species, regardless of the land class on which the animals are found (CRS Title 33). CPW is authorized to cooperate with WS-Colorado for controlling nuisance and non-agriculture property damage caused by big game and furbearers. Landowners, lessees or any other person may obtain a permit to take any wildlife species causing excessive damage to property in Colorado (CRS 33-3-106), and predators can be taken year-round when they are causing damage on lands owned or leased by private individuals (CRS 33-6-107 {9}). WS-Colorado is considered an agent of the landowner for the purpose of this section. WS-Colorado has an MOU with CPW that details the responsibilities of each agency and the cooperative relationship.

1.7.1.4 Colorado State Land Board. The Colorado State Land Board is responsible for maximizing economic returns from State Trust Lands in Colorado for the benefit of Trust beneficiaries. Livestock grazing leases are one source of economic return realized from State Trust Lands. As such, the Board has a vested interest in maintaining the economic viability of ranching operations that pay grazing leases on State Trust Lands. Wildlife provides a limited economic benefit to the trust because CPW purchases the right for licensed sport hunters to pursue such activities on a portion of the State Trust land in the analysis area. In general, however, State Trust Lands are not considered public lands and are not open for public use. PDM has been cited by many livestock producers to be a critical element in maintaining their economic viability and is, therefore, an area that is also of concern to the Board. State land grazing lessees are responsible for requesting and authorizing WS-Colorado PDM actions on State Trust lands. The Board is a signatory party to a state level MOU between WS-Colorado and other state and federal agencies.

1.7.1.5 Colorado Department of Public Health and Environment. Under Amendment 14, the Colorado Department of Public Health and Environment can issue a permit to use prohibited methods for the protection of human health and safety, including issues involving predators. Most public health crises involve the outbreak of a disease.

1.7.1.6 U.S. Fish and Wildlife Service. USFWS has statutory authority to manage federally-listed T&E species through the Endangered Species Act of 1973 (ESA) (16 USC 1531-1543, 87 Stat. 884), and migratory birds under the Migratory Bird Treaty Act of 1918 (16 USC 703-711; 40 Stat. 755), as amended. They are also responsible for managing refuges and conflicts with predators if they conflict with the refuge management goals.

1.7.1.7 U.S. Forest Service and Bureau of Land Management. USFS and BLM have the responsibility to manage the resources on federal lands for multiple uses including livestock grazing, timber production, recreation, and wildlife habitat, while recognizing the State's authority to manage wildlife populations. These uses are outlined in LRMPs and RMPs. WS-Colorado conducts PDM activities on USFS and BLM lands in

accordance with all applicable laws and regulations. These agencies recognize WS-Colorado's expertise in PDM and rely on WS-Colorado to determine the appropriate methodologies for conducting PDM to reduce losses of livestock and other resources, sometimes on adjacent properties. USFS and BLM can conduct some WDM activities themselves to protect resources on their lands, but would be responsible for the NEPA associated with such activities.

1.7.2 Compliance with Federal Laws and Executive Orders

Several federal laws authorize, regulate, or otherwise affect WS-Colorado PDM activities. WS-Colorado complies with these laws, and consults and cooperates with other agencies as appropriate.

1.7.2.1 National Environmental Policy Act. Most Federal actions are subject to NEPA (Public Law 91-190, 42 U.S.C. 4321 et seq.) and its implementing regulations established by the Council on Environmental Quality (CEQ) (40 CFR 1500-1508). In addition, WS-Colorado follows USDA (7 CFR 1b) and APHIS (7 CFR 372) NEPA implementing regulations as a part of the decision-making process.

1.7.2.2 Migratory Bird Treaty Act of 1918 (16 USC 703-711; 40 Stat. 755), as amended. The Migratory Bird Treaty Act provides the USFWS regulatory authority to protect native species of birds that migrate outside the United States. The law prohibits any "take" of these species, except as permitted by the USFWS. Such take falls outside the scope of this EA, which is limited to management of damage by mammalian predator species.

1.7.2.3 Endangered Species Act. The ESA states that all federal agencies shall seek to conserve T&E species and shall utilize their authorities in furtherance of the purposes of the Act (Sec.2(c)). WS-Colorado conducts consultations with the USFWS, as required by Section 7 of the ESA, to use the expertise of the USFWS, to ensure that "*any action authorized, funded or carried out by such an agency . . . is not likely to jeopardize the continued existence of any endangered species or threatened species. . .*" (Sec.7(a)(2)). WS-Colorado has conducted a biological assessment of potential effects on T&E species in the State and prescribing reasonable and prudent measures for avoiding jeopardy (WS 2011), and obtained a letter of concurrence from USFWS (USFWS 2011). This letter of concurrence includes authorization for the incidental take of Canada lynx (*Lynx canadensis*) in the event that WS-Colorado actions ever inadvertently result in capture or killing of a Canada lynx in the State, and further prescribes reasonable and prudent measures with terms and conditions by which WS-Colorado abides to minimize the risk of take.

1.7.2.4 Fish and Wildlife Act of 1956 (section 742j-1) - the Airborne Hunting Act. The USFWS regulates the Airborne Hunting Act but has delegated implementation to the various States. CDA and CPW are responsible for issuing permits for aerial predator management in Colorado; WS-Colorado abides by these laws and regulations.

1.7.2.5 Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). FIFRA requires the registration, classification, and regulation of pesticides used in the United States. All pesticides used or recommended by WS-Colorado are registered with and regulated by the Environmental Protection Agency (EPA) and CDA. WS-Colorado uses the chemicals according to labeling procedures and requirements as regulated by EPA and CDA.

1.7.2.6 National Historical Preservation Act of 1966, as amended (NHPA). The NHPA and its implementing regulations (CFR 36, 800) require federal agencies to initiate the section 106 process if an agency determines that the agency's actions are undertakings as defined in Sec. 800.16(y) and, if so, whether it is a type of activity that has the potential to cause effects on historic properties. If the undertaking is a type of activity that does not

have the potential to cause effects on historic properties, assuming such historic properties were present, the agency official has no further obligations under section 106. None of the WDM methods described in Chapter 3 that might be used operationally by WS-Colorado cause major ground disturbance; any physical destruction or damage to property; any alterations of property, wildlife habitat, or landscapes; or involve the sale, lease, or transfer of ownership of any property. In general, such methods also do not have the potential to introduce visual, atmospheric, or audible elements to areas in which they are used that could result in effects on the character or use of historic properties. Therefore, the methods that would be used by WS-Colorado under the proposed action do not have the potential to affect historic properties. If an individual activity with the potential to affect historic resources is planned under an alternative selected as a result of a decision on this EA, then site-specific consultation as required by Section 106 of the NHPA would be conducted as necessary.

Noise-generating methods such as propane exploders, pyrotechnics, or firearms that are used at or in close proximity to historic or cultural sites for the purposes of hazing or removing nuisance predators have the potential for audible effects on the use and enjoyment of a historic property. However, such methods would only be used at a historic site at the request of the owner or manager of the site to resolve a damage or nuisance problem, which means such use would be to benefit the historic property. Another mitigating factor for the noise issue is that virtually all of the methods involved would only have only temporary effects on the audible nature of a site and can be ended at any time to restore the audible qualities of such sites to their original condition with no further adverse effects. Site-specific consultation as required by Section 106 of the NHPA would be conducted as necessary in those types of situations.

1.7.2.7 Native American Graves Protection and Repatriation Act. The Native American Graves Protection and Repatriation Act requires Federal agencies to notify the Secretary of the Department that manages the Federal lands upon the discovery of Native American cultural items on Federal or Tribal lands. Federal projects would discontinue work until a reasonable effort has been made to protect the items and the proper authority has been notified. All WS-Colorado employees will continue to abide by this Act.

1.7.2.8 The Wilderness Act (Public Law 88-577(USC 1131-1136)). The Wilderness Act established a national preservation system to protect areas within the United States "*where the earth and its community of life are untrammeled by man.*" Wilderness Areas (WAs) are devoted to the public for recreational, scenic, scientific, educational, conservation, and historical use. This includes the grazing of livestock, and activities necessary to support grazing (e.g., PDM), where it was established prior to the enactment of the law (Sept. 3, 1964). The Act also preserved the jurisdiction and responsibility of the States to manage fish and wildlife in federal wilderness areas. Some portions of WAs in Colorado have historic grazing allotments. WS-Colorado occasionally conducts limited PDM in certain WAs in Colorado for the protection of livestock and other resources, and follows all applicable laws and regulations in doing so.

1.7.2.9 Environmental Justice and Executive Order 12898 - Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. Environmental Justice has been defined as the pursuit of equal justice and equal protection under the law for all environmental statutes and regulations without discrimination based on race, ethnicity, or socioeconomic status. Executive Order 12898 requires Federal agencies to make Environmental Justice part of their mission, and to identify and address disproportionately high and adverse human health and environmental effects of Federal programs, policies and activities on minority and low-income persons or populations. A critical goal of Executive Order 12898 is to improve the scientific basis for decision-making by conducting assessments that identify and prioritize environmental health risks and procedures for risk reduction. Environmental Justice is a priority within

USDA, APHIS, and WS. APHIS plans to implement Executive Order 12898 principally through its compliance with the provisions of NEPA.

WS activities are evaluated for their impact on the human environment and compliance with Executive Order 12898 to ensure Environmental Justice. WS personnel use WDM methods as selectively and environmentally conscientiously as possible. The use of chemicals by WS is regulated by the EPA, CDA, by MOUs with Federal land managing agencies, and by WS Directives. The WS operational program properly disposes of any excess solid or hazardous waste. WS assistance is provided on a request basis in cooperation with State and local governments and without discrimination based on race, ethnicity, or socioeconomic status. The nature of WS's PDM activities is such that they do not have much, if any, potential to result in disproportionate environmental effects on minority or low-income populations. Therefore, no such adverse or disproportionate environmental impacts to such persons or populations are expected.

1.7.2.10 Executive Order 13045 - Protection of Children from Environmental Health and Safety Risks. Children may suffer disproportionately from environmental health and safety risks, including their developmental physical and mental status, for many reasons. Because WS makes it a high priority to identify and assess environmental health and safety risks, WS has considered the impacts that alternatives analyzed in this EA might have on children. All WS predator damage management is conducted using only legally available and approved damage management methods where it is highly unlikely that children would be adversely affected at all, much less in any disproportionate way.

1.7.3 Compliance with State Laws

CPW manages big game (mountain lions and black bear) and furbearers, CDA manages damage to agricultural and rangeland resources from predators, counties and local agencies manage feral domestic animals, and CDPHE manages some threats to human health and safety. These agencies are bound by several State laws that regulate PDM. WS-Colorado complies with these State laws as appropriate, and consults and cooperates with State and local agencies. These laws are in the CRS or Administrative Codes.

Amendment 14, an Initiative Measure amending Article XVIII of the Colorado State Constitution, was implemented in 1997. Amendment 14 prohibits or restricts the use of foothold traps, snares, and registered toxicants to take wildlife in the State of Colorado. Exceptions include: (1) protection of human health or safety as determined by municipal departments of health; (2) use of nonlethal traps and snares for research, falconry, relocation, or for medical treatment; and (3) use on private property for agricultural production by private landowners, lessees, or their employees for no more than a 30-day period per year and so long as the owner can present on-site evidence that ongoing damage to livestock or crops has not been alleviated by the use of non-lethal PDM methods which have not been prohibited. The prohibited methods that can be used for a consecutive 30 day period in a calendar year include foothold traps, quick-kill traps, snares, M-44s, and gas cartridges. Amendment 14 did not limit the use of shooting or live traps as lethal methods, which can be used by private persons to manage damage on private or public lands. Unless Amendment 14 is revoked or modified, or the State otherwise provides an interpretation that it is inapplicable to Federal programs and actions, WS-Colorado will continue to abide by Amendment 14 in accordance with WS's policy of abiding by State and local laws.

CHAPTER 2: ISSUES AND AFFECTED ENVIRONMENT

Chapter 2 contains a discussion of the issues and affected environment, including issues that will receive detailed environmental impacts analysis in Chapter 4 (Environmental Consequences), issues that were used to develop SOPs, and issues that will not be considered in detail, with brief discussions of those issues. Also included is a list of issues identified and addressed in previous WS-Colorado PDM EAs and Decisions (WS 1997b, 1999a, 2001, 2005a, and 2005b), but for which explanations are not repeated in detail in this document because the analysis and discussion of those issues in those prior EAs remains virtually the same. Pertinent portions of the affected environment are described within the discussions of the issues. Descriptions of additional portions of the affected environment will be incorporated into the discussion of the environmental impacts in Chapter 4 and the description of the current program (the "no action" alternative) in Chapter 3.

2.1 THE AFFECTED HUMAN ENVIRONMENT

NEPA requires federal agencies to determine if federal actions affect the quality of the "*human environment*." As defined by NEPA implementing regulations, the "*human environment shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment*" (40 CFR 1508.14). Therefore, when a federal agency analyzes its potential impacts on the "*human environment*," it is reasonable for that agency to compare the effects of the federal action against the human-caused effects that would occur, or can be expected to occur, in the absence of the federal action. This concept is applicable to situations involving federal assistance in managing damage associated with State-resident wildlife species and unprotected wildlife species. This section discusses the human environment that may or may not potentially be affected by WS-Colorado PDM.

2.1.1 Aspects of the Human Environment Relevant to WS PDM Actions

WS-Colorado's PDM activities are conducted on a variety of land classes, primarily: private, BLM, and USFS. WS-Colorado PDM is carried out in several kinds of habitats throughout the state including forests, rangeland, and riparian areas, as well as suburban and urban areas. All of these habitats and lands have been impacted, and continue to be impacted, by humans in a variety of ways independent of the actions or involvement of WS-Colorado.

The natural and physical environment includes a multitude of native and introduced/invasive animal and plant species, as well as the air, water, soils, terrain, and human developments that make up these habitats. WS-Colorado PDM in Colorado targets several animal species and may take others incidentally. Impacts on these species are analyzed in the EA under 6 alternatives (Chapter 4). Additionally, WS-Colorado PDM can be conducted to protect natural resources, primarily other species of wildlife, where predation has been identified as a limiting factor, and when requested by other agencies or entities with management authority over the species involved. The PDM methods used (Chapter 3) which have the potential to affect the natural and physical environments include removing wildlife, physical exclusion methods, and habitat alterations. The PDM methods that WS-Colorado uses are legal and allowed under applicable laws and regulations. The primary methods used by WS-Colorado include wildlife removal techniques. WS-Colorado may occasionally use physical exclusion methods (e.g., assistance in installing predator-proof fencing) and habitat alterations (e.g., brush removal near runways on an airport). Colorado State laws allow property owners to conduct these activities in the absence of federal assistance. Thus, these activities may be conducted by private individuals and other non-federal entities with or without assistance from WS-Colorado.

Human relationships with the natural and physical environment have resulted in the establishment and management of virtually all of the resources protected by WS-Colorado PDM, such as agricultural resources and property. For example, livestock raised or maintained on private and public lands in the State have been placed there, and are managed by, humans. Thus, the livestock and their human owners/managers are a long established part of the human environment. They are also a primary group requesting WS-Colorado PDM assistance in counties where WS-Colorado

has programs. Urban and suburban residential and commercial structures developed and maintained by humans are also established components of the human environment. People living, working, and recreating in urban and suburban areas, as well as in rural areas where wildlife and their habitats exist, are also established components of the human environment. Threats to the health and safety of people as a result of interactions with predators can and do result in PDM actions by WS-Colorado. These actions could also be conducted by private or local/state government entities to reduce such threats, and those types of actions by such non-federal entities are also established components of the human environment. It is common knowledge that humans have altered, and continue to alter, the natural and physical environment. Such alterations are part of the "human environment".

WS-Colorado PDM activities do not affect habitat to any substantial degree. On occasion, program personnel might perform minor habitat alterations in specific isolated situations to reduce the attractiveness of a site to problem-causing wildlife (e.g. removal of brush that serves as hiding cover for coyotes near an airport runway, or direct assistance with the installation of a barrier fence to exclude predators from lambing grounds). However, most such alterations are not done by WS-Colorado, but by the resource owner or manager, which means they are included among the human relationships that exist with the natural and physical environment. Larger actions that alter one habitat into another, such as housing developments, generally result in major shifts in wildlife species composition, diversity, and population levels. Several of the species that cause needs for PDM in Colorado (*e.g.*, raccoons and coyotes) often thrive in these heavily human-altered environments. For example, raccoon densities can increase substantially in urban settings as a result of increased availability of food, water, and cover. As a result, an increase in PDM may be needed in such areas to prevent damage to houses, landscaping, pets, or to reduce threats to human health and safety. All of these human-caused changes to the natural and physical environment are established components of the human environment.

The human environment also includes less concrete relationships between people and the environment, including the animal species found there. Many people experience aesthetic appreciation or enjoyment of the outdoors or of wildlife viewing. Others can be fearful of or attacked by large predators and may deem their experience with such wildlife as negative. Livestock and other resource owners may not have a favorable opinion of some predators because of the damage such predators have caused or may cause. The human environment also includes the use of PDM methods and their potential risks to the public. Most PDM methods used by WS-Colorado can also be used by the public as allowed under State and local laws. Inherent dangers of use may increase for the public depending on who is conducting PDM and which methods are being used (analyzed in Chapter 4). All of these types of human relationships are established components of the human environment.

2.1.2 The Environmental Baseline

To determine impacts of federal actions on the human environment, an environmental baseline needs to be established with respect to the issues considered in detail so that the impacts of the alternatives can be compared against the baseline. Considering the existing human environment described above, and the numerous types of human relationships that are established components of that environment, it is quite apparent that the baseline appropriate for analysis in this EA is not a "pristine" or "non-human-influenced" environment, but one that is already heavily influenced by human actions and direct management.

Information necessary to determine the baseline for issues relevant to this EA include data on species take during PDM, wildlife populations and trends, the effects of PDM on recreation, and the relative safety of PDM methods used. For wildlife populations, definitive numbers are not often available but can be estimated from the best natural history information available regarding densities and occupied range or habitat types. Current and past harvest information (especially for those species which have current hunting/trapping seasons) can be used to compare impacts, because wildlife populations are a renewable resource and a certain percentage can be taken from the population without adverse impacts. The wildlife population baselines are those that are in

place under the current condition of the human environment which means they incorporate and reflect the populations as they have been and are being affected by humans. Effects by humans are caused by sportsman harvest (hunting and trapping), road kill mortality, loss of habitat to development (*e.g.*, construction, logging, and mineral and energy extraction activities), and poaching. Little or no information is available to quantify the effects of some of these actions on the different wildlife species populations. Nevertheless, such effects are already part of the existing human environment.

The environmental baseline is also expected to include PDM and other types of wildlife management by non-federal entities. Predators are managed under different federal, state, and, on occasion, local laws. Unprotected wildlife species, such as most non-native invasive species, are not protected under state or federal law, while feral domestic animals are typically managed under State and local laws. Most State-resident wildlife species are managed under State authority or law without any federal oversight or protection. CPW and CDA have authority to issue permits in Colorado for the take of certain wildlife species causing damage (including predators discussed in this EA). When a non-federal entity (i.e. CPW, CDA, CDPHE, municipalities, counties, private companies, individuals, etc.) takes a management action on a State-resident wildlife species or unprotected wildlife species, the action is not subject to NEPA compliance due to the lack of federal involvement in the action. Under such circumstances, the environmental baseline must be viewed as an environment that includes those species as they are managed or impacted by non-federal entities in the absence of the proposed federal action. Therefore, in those situations in which a non-federal entity has decided that a management action directed towards a state protected or unprotected wildlife species will occur, and even the particular methods that will be used, WS-Colorado's involvement in the action will not affect the environmental baseline. WS-Colorado's decision-making ability in such situations is restricted to one of two alternatives: either taking the action using the specific methods as decided upon by the non-federal entity, or taking no action at all at which point the non-federal entity will likely take the same action anyway.

In some situations, certain aspects of the human environment may actually benefit more from WS-Colorado's involvement than from a decision not to assist. For example, many cooperators believe that WS-Colorado has greater expertise to selectively remove a target animal than a non-WS entity. In these cases, WS-Colorado management activities may have less of an impact on target and non-target species than if the non-federal entity conducted the action alone. Thus, in those situations, WS-Colorado involvement may actually have a beneficial effect on the human environment when compared to the environmental baseline in the absence of such involvement.

In this EA, we evaluate the impacts of WS-Colorado PDM actions by comparing them against the baseline for the human environment that would exist with no federal involvement in PDM in Colorado. The analysis in Chapter 4 uses the best available information to determine the relative impacts of the proposed action and alternatives on the current environmental baseline (the human environment as it is today which includes ongoing PDM actions).

2.1.3 Connected Actions

Connected actions are the activities necessary to meet the need for action. The need for action in this EA is to protect resources from predators. WS-Colorado conducts WDM in Colorado for other wildlife species, but only predators are included within the scope of this EA. Other WS-Colorado WDM programs are not connected to PDM and they are not necessary to achieve the need for action.

2.1.4 Cumulative Actions

"Cumulative actions" are defined in CEQ's NEPA regulations as "actions which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement" (1508.25(a)(2)). "Cumulative impact" is defined in those regulations as the "impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions..." (40 CFR 1508).

In its June 24, 2005 guidance memorandum to federal agencies on the consideration of past actions in cumulative effects analysis, CEQ advised that agencies should:

> *"…focus on the extent to which information is 'relevant to reasonably foreseeable significant adverse impacts,' is 'essential to a reasoned choice among alternatives,' and can be obtained without exorbitant cost. 40 CFR 1502.22. Based on scoping, agencies have discretion to determine whether, and to what extent, information about the specific nature, design, or present effects of a past action is useful for the agency's analysis of the effects of a proposal for agency action and its reasonable alternatives*."

CEQ also advised in that guidance that:

> "*Agencies are not required to list or analyze the effects of individual past actions unless such information is necessary to describe the cumulative effect of all past actions combined. Agencies retain substantial discretion as to the extent of such inquiry and the appropriate level of explanation. Generally, agencies can conduct an adequate cumulative effects analysis by focusing on the current aggregate effects of past actions without delving into the historical details of individual past actions*."

Accordingly, cumulative actions are activities that when combined with the proposed federal action, can be additive to create impacts (cumulative impacts) on the resources that are affected by the proposed federal action and include past, present, and reasonably foreseeable future activities on those affected resources. Cumulative impacts on the environment affected by WS-Colorado PDM actions in CO include sportsman harvest (hunting and trapping), private PDM actions, and potential growth of WS-Colorado PDM actions. These are discussed in relationship to each of the issues under the four alternatives. Of primary concern are the cumulative impacts to native wildlife species directly targeted and/or those species not targeted but directly affected by WS-Colorado' PDM actions in CO (*i.e.*, the potentially affected nontarget species addressed in this chapter). Thus, the cumulative impacts that are analyzed are those that affect the same environmental wildlife resources as those affected by WS-Colorado PDM actions in CO and that are caused by past, present, and reasonably foreseeable future activities, regardless of who undertakes such activities.

In the prior PDM EA (WS 2005b), a few commenters claimed that impacts on wildlife resources caused by actions such as residential and commercial land development, oil and gas development, and timber harvesting are among the cumulative impacts that should be analyzed by WS-Colorado as cumulative effects to be considered in reference to WS-Colorado PDM actions in Colorado. However, those actions typically do not directly affect the same wildlife resources that WS-Colorado PDM actions affect. WS-Colorado acknowledges that other types of actions may occasionally have some impacts on the wildlife species that WS-Colorado impacts with its PDM actions but such impacts are usually only indirect and minor impacts.

2.1.5 Similar Actions

Actions similar to WS-Colorado PDM, such as private landowners conducting PDM for themselves, are analyzed in this document where information is available. CPW keeps take records on wildlife species for the depredation permits CPW issues. However, several species can be hunted during the regular hunting seasons and coyotes can be taken year-round. These animals are not recorded under depredation permits, but in sportsman harvest estimates. Sportsman harvest is considered in cumulative impacts analysis, and thus is not considered here. As far as other issues related to privately conducted PDM, much information is unknown. Little is known about actions similar to WS-Colorado PDM, including their effects on target species, non-targets, people, pets, the environment, humaneness and recreation. The potential effects of privately conducted methods of PDM can only be theorized from the best available information. For example, it has been well documented that landowners frustrated by damage-causing predators can resort to questionable or illegal techniques, leading to potentially serious environmental impacts. This includes poaching (illegal hunting) of such predators, and using illegal chemicals and methods. Obviously, accurate reports of the extent of illegal wildlife control activities are not available, because persons

engaging in them cannot be expected to readily volunteer such information. However, it is reasonable to expect that such activities would be likely to increase if professional government-provided assistance in resolving wildlife damage problems was reduced, eliminated, or rendered less effective by excessive restrictions.

2.1.6 Resources Not Impacted by WS PDM

The following resources within Colorado are not expected to be impacted to any consequential degree under any of the alternatives analyzed in this EA: soils, geology, minerals, water quality and quantity, floodplains, wetlands and other aquatic resources, visual resources, air quality, prime and unique farmlands, timber, and rangeland. Neither the current program nor the other four alternatives would cause major ground disturbance, physical destruction, or damage to property. They will not cause more than minor alterations of property, wildlife habitat, or landscapes, nor will they involve the sale, lease, or transfer of ownership of any property. The proposed methods do not have the potential to affect the character or use of historic properties through introduction of visual, atmospheric, or audible elements in the areas in which they are used. These resources will not be further analyzed.

2.1.7 Irreversible and Irretrievable Commitments of Resources

No irreversible or irretrievable commitments of resources are expected, other than the minor use of fuels for motor vehicles and other equipment, and similar materials. These will not be discussed further.

2.2 ISSUES

The following issues or concerns about PDM have been identified through interagency planning and coordination, and from the EAs which preceded this document as areas of concern that will be addressed in this EA.

- Effects on Target Predator Species Populations
- Effects on Non-target Species Populations, Including T&E Species
- Impacts on Public Safety and Pets
- Effects on Sociocultural Resources
- Effects of PDM, especially Aerial predator management Activities, on the Use of Public Lands for Recreation
- Humaneness and Ethical Perspectives

2.2.1 Effects on Target Predator Species Populations

Maintaining viable populations of all native species is a concern of the public, as well as biologists within state and federal agencies, including WS. The U.S. Government Accounting Office (1990) analyzed the effects WS PDM on predators in the western United States and determined that WS PDM activities had no overall effect on predator populations. However, a concern of some is that WS PDM will adversely affect populations of target species, which, for purposes of this EA are primarily: coyotes, red fox, striped skunks, black bears, raccoons, feral dogs, mountain lions, and bobcats. Several species' populations have steadily increased in recent decades due to adaptability to human-made environments, and damage from these species has increased accordingly (International Association of Fish and Wildlife Agencies, 2004). To address these concerns, the effects of the alternatives on populations for each target species were examined. To fully understand the need for PDM, it is important to have knowledge about the species that cause damage and the likelihood of damage. Full accounts of life histories for these species can be found in mammal reference books (*e.g.*, Fitzgerald *et al*. 1994). Some background information is given here for the predator species in Colorado covered by this EA, especially information pertaining to their range in Colorado. The species are basically given in order of WS-Colorado PDM efforts directed towards them, their subsequent take, and the occurrence and value of damage that the species cause in Colorado. Some of the lesser damaging species are lumped with others where life history and damage are somewhat similar. Finally, it should be reiterated that jurisdiction and management of these species mostly lies with CPW, which was discussed in Chapter 1, except that damage to agriculture by coyotes, wolves, foxes, bobcats, raccoons, mountain lions, bears, striped skunks, and opossums is CDA's responsibility. Additionally, most of the predators addressed in this EA have been harvested in Colorado by hunters and trappers afield. Historic (prior to the execution of Amendment 14 in 1997) and recent (within the last 12 years) sportsman harvest estimates provide valuable insight into the abundance of these species in Colorado (Table 8; CPW 2014b, 2014c, and 2014d). It should be noted that hunting and/or trapping seasons were closed in 1995 for the gray, kit and swift foxes, spotted and hog-nosed skunks, weasels, mink, marten, ringtail, and opossum (few were incidentally taken following the season closures, but not included in Table 8). Some of these seasons have since been re-opened.

Table 8. Historic and recent annual averages of sportsman harvest of predators in Colorado. Averages are calculated from estimates provided by Colorado Parks and Wildlife.

	Average Sportsman Harvest	
Species	Historic[α]	Recent[β]
Badger	927	224
Black Bear	496	1,103
Bobcat	1,082	1,644
Coyote	32,541	39,977
Gray Fox	574	607
Kit Fox	13	NA
Red Fox	2,363	1,287
Swift Fox	602	214
Marten	1,885	327
Mink	324	8
Mountain Lion	288	407
Opossum	204	45
Raccoon	8,037	2,845
Ringtail	168	28
E. Spotted Skunk	3	NA
W. Spotted Skunk	98	0
Striped Skunk	10,353	1,254
Long-tailed Weasel	187	0
Short-tailed Weasel	31	0

NA: data not available, either due to lack of a season, or lack of data.

[α]Historic average is the average from 1987 through 1996, excluding 1991 due to anomolies with the data.

[β]B. Recent average are harvest estimates from the 5 most recent years data is available. Some years had less than 5 years of data to average.

2.2.1.1 Coyote. In Colorado, coyotes are managed by CPW as a furbearer and can be taken year-round, though a limited season could be established at some time in the future. In FY10-14, coyotes were responsible for 46% of the livestock losses recorded by WS-Colorado, and 42% of the value of all losses due to predators. The value of losses from coyotes averaged $133,315 per year (Table 9). They are therefore a major focus of WS-Colorado PDM efforts in Colorado. The resources that WS-Colorado protects from coyote depredation include: livestock (primarily lambs and calves), crops, property (*e.g.*, drip irrigation lines and pets), human health and safety (*e.g.*, prevention of attacks on humans), and natural resources (*e.g.*, protection of threatened piping plovers). Whereas they are technically considered carnivores (Order Carnivora), coyotes enjoy an omnivorous diet, and will readily eat crops such as cantaloupe and watermelons, which are major crops in

some areas of southeastern Colorado. Coyote predation on wildlife species in Colorado, such as sandhill cranes, least terns, mule deer, and antelope has also created concern in some areas, but no value is presented here for such losses.

Table 9. Summary of average annual losses from predators reported by WS-Colorado in FY10-14. Numbers of incidents and dollar values are the average of these five years, rounded to the nearest whole number.

	Livestock		Other resources		Total	
Species	**Incidents (%)**	**Value (%)**	**Incidents (%)**	**Value (%)**	**Incidents (%)**	**Value (%)**
Badger	0 (0%)	$8 (0%)	14 (1%)	$170 (<1%)	14 (<1%)	$178 (<1%)
Black Bear	443 (12%)	$96,713 (35%)	33 (2%)	$17,615 (52%)	476 (10%)	$114,328 (36%)
Bobcat	25 (<1%)	$342 (<1%)	7 (<1%)	$0 (0%)	32 (<1%)	$342 (<1%)
Feral Cat	0 (0%)	$0 (0%)	12 (<1%)	$0 (0%)	12 (<1%)	$0 (0%)
Coyote	2,937 (82%)	$129,359 (46%)	762 (57%)	$3,956 (12%)	3,699 (75%)	$133,315 (42%)
Feral Dog	5 (<1%)	$3,562 (1%)	6 (<1%)	$0 (0%)	11 (<1%)	$3,563 (1%)
Red Fox	62 (2%)	$4,844 (2%)	67 (5%)	$50 (<1%)	129 (3%)	$4,894 (2%)
Swift Fox	2 (<1%)	$0 (0%)	0 (0%)	$0 (0%)	2 (<1%)	$0 (0%)
Mountain Lion	103 (3%)	$44,486 (16%)	20 (1%)	$5,214 (15%)	123 (2%)	$49,700 (16%)
Opossum	0 (0%)	$0 (0%)	2 (<1%)	$20 (<1%)	2 (<1%)	$20 (<1%)
Raccoon	15 (<1%)	$252 (<1%)	209 (15%)	$5,398 (16%)	224 (5%)	$5,650 (2%)
Striped Skunk	1 (0%)	$5 (<1%)	215 (16%)	$1,760 (5%)	216 (4%)	$1,765 (<1%)
Total	3,593	$279,571	1,347	$34,183	4,940	$313,754

Coyotes were once found only in western States, but have expanded their range in recent history to much of North America as a result of changes in habitat, loss of wolves, and possible introductions into other parts of the country where they were previously not found (Bekoff and Wells 1982, Voigt and Berg 1999). They are extremely common in Colorado and found statewide at moderate to high density levels (USFWS 1978) with lowest densities in dense coniferous forests and highest in the eastern plains (Fitzgerald *et al.* 1994). They have consistently been the species most harvested by sportsmen in Colorado averaging almost 40,000 annually from 2007 to 2013 (Table 8). Coyotes are ecological generalists; they can adapt to many different environments and diets. Even among ecological generalists, many wildlife biologists characterize coyotes as having a unique resilience to change. In fact, the habitat changes that have occurred over the last two hundred years have generally favored the species.

To understand the impacts of sportsman harvest and PDM on the coyote population, it is useful to have a relative idea of the population size. However, determinations of coyote densities are frequently limited to educated guesses (Knowlton 1972). This is likely due in part to the fact that coyotes are highly mobile animals with home ranges (territories) that vary seasonally as well as with the sex, age, and breeding status of the animal (Todd and Keith 1976, Althoff 1978, Pyrah 1984). Coyote home ranges have been documented to vary from 2.0 mi^2 to 21.3 mi^2 (Andelt and Gipson 1979, Gese *et al.*1988[4]). Some researchers have also observed a wide overlap among coyote home ranges; so much overlap in fact, that they did not consider coyotes to be territorial (Ozoga and Harger 1966, Edwards 1975, and Danner 1976). Moreover, coyote pack size varies considerably. Each coyote territory may have several nonbreeding helpers at the den during whelping; thus each defended coyote territory may have more than just a pair of coyotes (Allen *et al.* 1987, Bekoff and Wells 1982). Messier and Barrette (1982) reported that from November through April, 35% of the coyotes were in groups of three to five animals. Gese *et al.* (1988) reported that 40% of coyotes were found in groups of two, whereas 53% were found in groups of three-to-five. Food density can also affect coyote density and home range. For example, a positive relationship was established between coyote densities in mid-late winter and the availability of dead livestock (Roy and Dorrance 1985).

Such variations in food concentrations, pack size, and home range can influence coyote densities, and complicate efforts to estimate abundance (Danner and Smith 1980). As

[4] All literature citations reported in km^2 have been converted to mi^2 for reader convenience and to maintain consistency.

such, coyote population estimates specifically for Colorado are not available from CPW or other researchers. However, a reasonable estimate can be made using information on coyote biology and population dynamics in the western United States. These types of estimates of carnivore populations are based on knowledge of the species, experience, and intuition, and may be as accurate as those based on more scientific methods.

Many authors have estimated coyote populations throughout the West and elsewhere, and coyote density has been shown to vary depending on the time of year, food abundance, and habitat (Andelt 1985, Pyrah 1984, Camenzind 1978, Knowlton 1972, Clark 1972, USFWS 1979). Coyote densities have been shown to range from 0.4/mi^2 prior to whelping, when populations are lowest, to 3.6/mi^2 just after whelping, when populations are highest (Pyrah 1984, Knowlton 1972). Knowlton (1972) estimated average coyote density in the western United States to be 0.5/mi^2 to 1.0/mi^2 over a large portion of the coyote's range, but coyote densities as high as 5/mi^2 have been reported in the southwest United States (Voigt and Berg 1999). Scent-post surveys for Colorado from 1972 to 1977 averaged 110 coyote visits/1,000 scent posts in one of the most widespread studies undertaken on predator densities (USFWS 1979). These numbers concur with those of Knowlton and Stoddart (1983), who estimated Colorado to have moderate densities of coyotes compared to other western States. Among the 13 western States studied, coyote populations were generally higher in the south and lower in the north, averaging 149 visits/1,000 scent posts in the southern tier of western States, 114/1,000 in central tier of western States, and 83/1,000 in the northwestern tier of States (Knowlton and Stoddart 1983). The observations of WS-Colorado Specialists that conduct PDM in Colorado generally concur that coyote numbers in Colorado are relatively moderate with some areas of very high density.

Considering the published range from 0.4/mi^2 to 5/mi^2, CPW and WS believe that a density of 1.5/mi^2 is a conservative but reasonable estimate for Colorado. Colorado encompasses 104,000 mi^2, and the coyote is found throughout the State. Thus, a conservative estimate of the coyote population in Colorado, based on what we believe to be a conservative estimate of 1.5 coyotes/mi^2, is 156,000 coyotes.

2.2.1.2 Foxes. CPW is the agency responsible for the management of foxes in Colorado, which are classified as furbearers; however, CDA is responsible for fox damage to agriculture. Foxes are regarded as nuisance predators in many regions, preying on wildlife and livestock, and have become notorious in many areas of the world as carriers of diseases (Ables 1969, Andrews *et al.* 1973, Tabel *et al.* 1974, Tullar *et al.* 1976, Pils and Martin 1978, Sargeant 1978, Allen and Sargeant 1993, Voigt 1999). WS-Colorado recorded an annual average of $4,894 in damages due to red foxes in FY10-14 (Table 9). These damages were mostly due to depredation of livestock, including lambs and poultry (Table 2 and 3).

Red fox are the most common and well-known species in the genus *Vulpes*, and are the most widely distributed nonspecific predators in the world (Voigt 1999). Red fox are found throughout much of North America and are common in varying abundance throughout most of Colorado, about 90% of the State. In the early 1900s, red foxes were not as abundant in Colorado, and generally only found in the mountainous areas. But foxes have expanded their range into all but the southeastern quarter of the Plains (Fitzgerald *et al*. 1994); their range has expanded as a result of red fox introductions from abandoned fur farms and probable expansion from the east into agricultural areas. Like coyotes, red foxes are ecological generalists, and therefore very adaptable to new environments. The red fox has a high reproductive rate, a dispersal capacity similar to coyotes, and can withstand high mortality within the population (Allen and Sargeant 1993, Voigt 1999, Voigt and MacDonald 1984, Harris 1979, Pils and Martin 1978, Storm *et al.* 1976, Andrews *et al.* 1973, and Phillips and Mech 1970). Red fox eat mostly small mammals, birds, insects and mast, but will also take small livestock and poultry. Of the foxes in Colorado, red fox

cause the most damage, often involving livestock. Voigt and Earle (1983) and Gese *et al.* (1996) found that red foxes avoided coyotes but coexisted in the same area and habitats.

Red fox have a home range of 1-2 mi^2, but often travel outside of that home range. Storm *et al.* (1976) found that 95% of the females (43.6% were less than 1 year old) bred successfully in a population in Illinois and Iowa. Rowlands and Parkes (1935) and Creed (1960) reported that male red fox breed in their first year. Litter sizes averaged about 4.7 among 13 research studies, with litters up to 17 offspring reported (Storm *et al.* 1976, Voigt 1999). Ables (1969) and Sheldon (1950) reported that more than one female was observed at the den and suggested that red fox have "helpers" at the den, a phenomena observed in coyotes and other canids.

Red fox densities have been shown to range from 0.3/mi^2 in the alpine tundra to 80/mi^2 in urban areas with abundant food (Voigt 1999, Harris 1977, MacDonald and Newdick 1982, Harris and Rayner 1986). Much of the available habitat in Colorado, including agricultural and suburban habitats, would support densities of red fox on the higher end of this scale; very little of the State is low-density habitat such as alpine tundra (Voigt 1999). Thus, an average density for red foxes in Colorado might be conservatively estimated at 1/mi^2. Considering that red fox occupy approximately 90% of Colorado, and that Colorado encompasses 104,000 mi^2, CPW estimates the population of red foxes in Colorado to be approximately 94,000 red fox, with highest densities in suburban and agricultural areas (A. Holland, CPW, pers. com., 2/15/2015).

Red fox currently have the only open hunting season of the foxes in Colorado. Red fox are harvested by sportsmen in higher numbers than most predator species (except for coyotes), averaging 1,287 annually in recent years (Table 8, CPW 2014d).

Gray fox tend to prefer coniferous forests, chaparral, and rimrock country with scattered pinyon-juniper. To a lesser extent, they also occupy some agricultural habitats. They primarily feed on small mammals, birds, mast, and insects. Gray fox in Colorado cause little damage and WS-Colorado did not record any damage caused by gray foxes in FY10-14. In general, most damage from gray fox is due to depredation of poultry.

Gray fox have 3-7 pups per litter, and den in hollow logs, under rocks, and sometimes in underground dens. They are found in the foothills of the Front Range, throughout southeastern Colorado, and at lower elevations in the western fifth of the State; they occupy approximately 35% of the State (Fitzgerald *et al.* 1994). The gray fox has expanded its range, and therefore probably has a higher population than its historic abundance. Harvest by sportsmen averaged 461 animals in recent years (Table 8, CPW 2014d). Published estimates of gray fox range from 3.1-5.4/mi^2 with densities probably lower over broader areas (Fritzell and Haroldson 1982, Fritzell 1987). Since gray fox occur spottily throughout their range except in southern Colorado where they are more abundant, a density of 1.0/mi^2 over its range (a third of the lowest density estimate), would provide a conservative estimate of about 36,000 gray fox in Colorado.

Swift fox are a grassland species found in most of eastern Colorado, covering about 35% of the State (Fitzgerald *et al.* 1994). They prefer areas with loose-textured soils suitable for easily digging underground dens which are used throughout the year. Swift fox can occasionally be found on the fringe of agricultural lands, and are therefore capable of causing damage to agricultural resources. Swift foxes are most common in areas that support large populations of prey such as black-tailed jackrabbits (*Lepus californicus*), cottontail rabbits (*Sylvilagus spp*.), kangaroo rats *Dipodomys* spp., deer mice (*Peromyscus* spp.), birds, and insects. They reach reproductive maturity between 10 and 22 months of age and litters average 3-5 pups. Data on swift fox density is limited, but in eastern Colorado it has been shown to range from 0-2.2/mi^2, with an average density of 0.4/mi^2 (Finley 1999, Finley *et al*. 2005). We consider a density of 0.25/mi^2 to be a conservative but reasonable estimate for swift fox in Colorado. Thus, over their range of 35% of the

State, and using 104,000 mi^2 for the area of Colorado, CPW estimates the swift fox population to be approximately 9,100 individuals (A. Hollard, CPW, pers. com., 2/15/2015). Swift fox populations were reduced in the early 20th century as a result of rodent and predator poisoning campaigns. However, more recently their population has been increasing in many parts of their range. Since 2010, CPW sportsman harvested an estimated average of 214 swift fox annually in Colorado, although historic take was considerably higher (Table 8; CPW 2014d). In fact, before the trap ban, Colorado had the highest sportsman harvest among the states in their range (Scott-Brown *et al.* 1999). Damage from swift foxes is sporadic and limited in Colorado. During FY10-14, WS-Colorado recorded only two incidents of the threat of damage from swift foxes, but no damage was recorded.WS-Colorado took at total of four swift fox for PDM in Colorado in FY10-14, averaging less than one animal per year.

Kit fox are similar to swift fox in many ways, and most of the above information on swift fox behavior, diet, and life history also applies to kit fox. One notable difference is that kit fox occupy desert areas in western Colorado, primarily in Delta and Montrose Counties, though they may also occur in the southwest corner of the State. Their habitat makes up about 2% of Colorado; however, much of that habitat has been lost to development and agriculture and it is likely that only about 25% of actual habitat remains. This equates to 0.5% of the area of Colorado. Data on kit fox densities are limited, but studies in California and Utah found kit fox densities anywhere from 0.25-6/mi^2 (O'Farrell 1999). We consider a kit fox density of 0.25/mi^2 for Colorado to be conservative but reasonable. Thus, CPW estimates the population of kit foxes in Colorado to be approximately 130 individuals (A. Holland, CPW, pers. com., 2/15/2015). Kit fox cause only sporadic and limited damage to agriculture in Colorado, and WS-Colorado did not record any damage from kit fox in FY10-14. WS-Colorado also did not take any kit fox in Colorado in FY10-14.

2.2.1.3 Skunks. Three species of skunks are known to inhabit Colorado: the striped, western spotted, and eastern spotted skunk. Records exist for a fourth, the hog-nosed skunk, in southeastern Colorado, but no hog-nosed skunks have been found in Colorado since several were collected in the 1920s, so they may not exist in Colorado anymore. Additionally, eastern spotted skunks are spottily distributed within Colorado, and in fact may be extirpated from the state (Kahn 2001). Skunks are managed by CPW and protected under Colorado wildlife laws; however, hunting and trapping seasons on the spotted and hog-nosed skunk species have been closed since 1995. All skunk species have white on black pelage and have short, stocky legs with long claws used for digging. Their most notable characteristic is the ability to discharge nauseating musk from their paired anal glands.

The striped skunk is by far the most common in Colorado. It is a large skunk, up to 10 pounds, with two white stripes down its back. The spotted skunks are much smaller, typically not weighing much more than a pound, and have a number of white spots covering their backs, sides, and head. The western spotted skunk is differentiated from the eastern spotted skunk by its smaller size, and in Colorado, by their range.

Skunks cause odor problems around homes; potentially transmit diseases such as rabies to humans, domestic animals, and livestock; and sometimes prey on poultry and their eggs. Skunks are primarily targeted to reduce these types of problems. The majority of damage complaints are due to skunks living and spraying in and around residences. Most of the complaints are from striped skunks. WS-Colorado recorded an annual average of 216 incidents of damage, with annual losses of $1,765 due to striped skunks in FY10-14 (Table 1, Table 5). Losses from striped skunks were less than 1% of the total predator damage recorded by WS-Colorado, but most of the skunk damage incidents we recorded were threats to human health & safety, including concern over the spread of skunk rabies (Table 1, Table 5). Accordingly, skunk damage management is only a minor part of WS-Colorado's PDM activities. Western spotted skunks were responsible for only one

incident, which was odor related, within the five-year timeframe of FY10-14. Eastern spotted skunks may also cause problems, but WS-Colorado did not record any incidents of damage from this species in Colorado in FY10-14.

Striped skunks are found throughout the United States, including all of Colorado, and have expanded their range with the encroachment of people. Skunks are found in a variety of habitats including woodlands, grasslands, desert, and chaparral. Striped skunks are often found in association with farmland and urban areas, whereas the other skunks are mostly associated with grasslands and rocky areas, such as in canyons and outcrops (Rosatte 1999). Skunks eat a variety of food including small rodents, insects, fruits, and eggs, and sometimes kill poultry. Skunks nest in underground dens, hollow logs, under buildings and in rock crevices. During the winter they will go through periods of inactivity, especially when it is extremely cold. Skunks are typically solitary, except they may communally roost in the winter, especially the females, for warmth.

The home range of striped skunks varies spatially and temporally in order to accommodate life history requirements such as raising young, winter denning, feeding activities, and dispersal (Rosatte 1999). Home ranges have been reported between 0.11mi^2 and 1.4 mi^2 for striped skunks in rural areas (Houseknecht 1971, Storm 1972, Bjorge *et al.* 1981, Rosatte and Gunson 1984). Striped skunk densities reported in the literature range from 0.85/mi^2 to 67/mi^2 (Jones 1939, Ferris and Andrews 1967, Verts 1967, Lynch 1972, Bjorge *et al.* 1981, Rosatte *et al.* 1992). Many factors may contribute to the widely differing population densities, including habitat type, food availability, disease, season of the year, and geographic area (Storm and Tzilkowski 1982). With densities varying greatly and ideal habitat distributed throughout the state, we believe that 2/mi^2 is a conservative but reasonable estimate of the average density throughout Colorado. Using this density, CPW estimates the striped skunk population in Colorado at approximately 208,000 (A. Holland, CPW, pers. com., 2/15/2015). Sportsman harvest of striped skunks has decreased in recent years, averaging 1,254 animals annually, but historic harvest averaged 10,353 animals (Table 8; CPW 2014d).

Western spotted skunks are found sporadically along the Front Range from about Denver south and in southern and western Colorado (about 30% of the State). Eastern spotted skunks may be found sporadically (though potentially extirpated) in the South Platte and Arkansas River Valleys of far eastern Colorado in about 3% of the state (Fitzgerald *et al.* 1994). Spotted skunks are found in diverse habitats over small portions of the state preferring rocky canyons and outcrops in woodlands and prairies, especially shrub habitats in broken country. They often take advantage of the food and cover in agricultural areas. Spotted skunks make their dens in cracks and crevices among rocks, woodrat nests, hollow logs, burrows under large rocks, and sometimes under buildings. Unlike striped skunks, spotted skunks are adept climbers. They are almost entirely nocturnal and seldom are seen in the daytime. A major difference between the two species of spotted skunks is their breeding season; eastern breed in spring whereas westerns breed in late summer and fall. The western spotted skunk exhibits delayed implantation of the eggs meaning that the eggs do not implant until spring and they then give birth in late spring or early summer following a 50-65 day gestation period. Additionally, the two species are geographically isolated, and though once believed to be the same species, they are now recognized as two distinct species. CPW estimates that there was no sportsman harvest of western spotted skunks in 2010, the only recent year for which data are available (Table 8, CPW 2014d). CPW stopped collecting sportsman harvest data on eastern spotted skunks, but historic estimates were very low: only three skunks annually on average (Table 8, CPW 2014d). Little information is available on spotted skunk densities. One study in Iowa found an average density of 5.7/mi^2 in appropriate habitat in Iowa (Crab 1948 *in* Rosatte 1999). If spotted skunk densities are conservatively estimated at the lowest reported density for striped skunks (0.85/mi^2), the populations could be conservatively estimated for Western spotted skunks at about 26,500 and 2,650 for Eastern spotted skunks (A. Holland, CPW, pers. com., 2/15/2015).

Hog-nosed skunks are common in the Southwest United States where they are found in warm woodlands, grasslands, and deserts which have rocky areas for denning (Roseatte 1999). Residential areas and farmlands are classified as secondary habitat (Thompson *et al.* 1992). The hog-nosed skunk's status in Colorado is relatively vague as Colorado represents its northernmost range and very few records have ever existed (Fitzgerald *et al.* 1994); it is doubtful that an extant population exists in the State or more evidence of them would have been recorded. However, a few probably wander into Colorado from time to time from New Mexico.

2.2.1.4 Black Bear. Black bear are protected as big game in Colorado and, as such, CPW manages their population. CDA has management authority of black bears causing damage to agriculture. WS-Colorado gives CPW information on the take of all depredating black bears to help them determine population impacts from these activities. CPW sometimes requests WS-Colorado to take black bear when the need arises due to a damage situation. WS-Colorado also receives calls regarding black bear damage from individuals, but all control work is coordinated and contracted through CPW. WS-Colorado Specialists in Colorado responded to an average of 476 incidents annually in FY10-14 involving black bears, which is almost three times the average cited in the previous EA (WS 2005b). WS-Colorado recorded an annual average of $114,328 in damage due to black bears in FY10-14, which is on par with the damage reported in the previous EA (WS 2005b). Damages from black bears was mostly to livestock ($96,713 annually), but also included human health & safety, crops, bee hives, feed, and structures.

Black bears can be found throughout much of North America, including the Rocky Mountains. In Colorado black bears are found throughout the western two thirds of the state where highest population densities are found in the montane forests and cottonwood canyons of western Colorado (Fitzgerald *et al.* 1994). Black bears can live up to 25 years (Rogers 1976), and eat a variety of foods including grass, fruits, nuts, carrion, livestock, mammals, insects, bees (especially the larva) and garbage. Bears may overturn rocks and logs looking for grubs and insects or small rodents. Research indicates they may also be a more efficient predator of large game and livestock than was previously believed (Pederson, 1988). In Colorado, the annual mortality rate was 0.44 for cubs, 0.06 for yearlings, 0.15 for subadults, and 0.12 for adults. Female black bears reach reproductive maturity at approximately 3.5 years (Kohn 1982, Graber 1981). Following a 7-8 month gestation period, they may have one to five cubs (Rogers 1976, Alt 1981, Kolenosky and Strathearn 1987). Juvenile black bear annual mortality ranges between 20 and 70 percent, with orphaned cubs having the highest mortality (Kolenosky and Strathearn 1999). Natural mortality in adult black bears is approximately 10-20 percent per year (Fraser *et al.* 1982). Black bear density varies from $0.3/mi^2$ to $3.4/mi^2$ depending on habitat (Kolenosky and Strathearn 1999). In the southwestern U.S., black bear population densities have been documented at $1/mi^2$ (LeCount 1982). In Colorado, densities are considered to be low at $0.3\text{-}0.5/mi^{2.}$ (Fitzgerald *et al.* 1994). The ban on use of trailing dogs, spring hunting, and baiting, may have temporarily increased the population, but CPW manages black bears intensively, so increased hunter harvest in the fall season probably offset much of this increase. CPW previously estimated the bear population at 10,000-12,000 in 1991, but using new methods of estimating bear populations, the most recent CPW estimate is 17,000-20,000 (CPW 2015). Black bears occupy about 50% of Colorado, and we believe that 17,000 is a conservative but reasonable population estimate.

2.2.1.5 Raccoon. Raccoons are managed as a furbearer in Colorado, and CPW is responsible for oversight of raccoon management. CDA has authority for damage to agricultural resources. Raccoons are abundant throughout North America, except Canada and the Rocky Mountains and Great Basin regions. They are typically associated with riparian and forested habitats, but have become increasingly common in urban areas. In Colorado, they are found most abundantly in suburban and urban areas, along waterways and in forests in the less arid portions of Colorado; they sometimes can be found a long

distance from water in a variety of habitats including desert scrub. Since the 1940s, raccoon populations throughout the U.S. have increased, likely as a result of adapting well to man-made habitats. Raccoons are found throughout most of Colorado. Raccoon densities vary considerably, depending on habitat suitability. Twichell and Dill (1949) reported one of the highest densities where 100 raccoons were removed from a winter tree den area on 101 acres of a waterfowl refuge in Missouri (a local density of 634/mi^2). Other studies have found raccoon densities that ranged from 9.3/mi^2 to 80/mi^2 (Yeager and Rennels 1943, Urban 1970, Sonenshine and Winslow 1972, Hoffman and Gottschang 1977, and Rivest and Bergerson 1981). Densities in Colorado average towards the lower end of this range over large tracts of land: 1.3-8.3/mi^2 (Fitzgerald *et al.* 1994). Colorado probably has some ideal habitat areas with large numbers of raccoons, but their density is probably low statewide. CPW believes that 135,000 raccoons is a conservative but reasonable population estimate for Colorado, using the lowest density figure statewide (1.3/mi^2) (A. Holland, CPW, pers. com. 2/15/2015). Sportsman harvest for raccoons has averaged 2,845 annually in recent years. This is much lower than historic hunter harvest, which averaged 8,037 annually (Table 8; CPW 2014d).

Raccoons are one of the most omnivorous of animals, feeding on carrion, garbage, birds, mammals, insects, crayfish, mussels, other invertebrates, a wide variety of grains, various fruits, other plant materials, and most or all foods prepared for human or animal consumption (Sanderson 1999). WS-Colorado recorded an average of 224 incidents of raccoon damage, resulting in $5,650 of damage annually in FY10-14. Raccoons caused damage to crops, livestock, and property, and threatened human health & safety.

2.2.1.6 Feral Dog. Feral and free-roaming dogs are not common in Colorado, and they seldom cause damage. However, damage from feral dogs can be locally significant. Such dogs can kill livestock and poultry, and WS-Colorado recorded an average of 11 incidents, resulting in $3,563 in damage annually in FY10-14. Most of this damage was to livestock, although threats to human health & safety were also recorded (Tables 5 and 9). Feral and free-roaming dogs have also been known to prey on native wildlife such as elk, deer, and upland game, but no such incidents were recorded by WS-Colorado in FY10-14. Responsibility for dog control rests with county and municipal authorities. WS-Colorado primarily responds to requests for controlling dogs that come from local authorities (*e.g.*, county sheriff, municipal police, or local health department), or from CPW WS-Colorado works with local authorities to transfer custody of collared and free roaming dogs for return to the owner or adoption. Because many of these local authorities have animal control officers, WS-Colorado receives relatively few calls concerning free-roaming or feral dogs and, thus, WS-Colorado records only reflect minor damage for them. Feral dogs are not part of the native environment, and left abandoned in the wild are generally considered ecological pests.

2.2.1.7 Mountain Lion. The majority of mountain lion incidents involve depredation of livestock, pets, and, potentially, but rarely, people. Mountain lions were responsible for an average of over $49,700 damage (16% of all predator damage) to livestock, wildlife, and human health & safety in an average of 123 incidents annually, as recorded by WS-Colorado in FY10-14 (Table 9). Lions killed an average of 128 hoofed stock annually in FY10-14, as well as three pets and one zoo animal within this five-year timeframe. Lions were also responsible for an average of four human health & safety incidents each year. In addition, mountain lion predation on other wildlife species such as bighorn sheep and mule deer has created concern in some western states.

Mountain lions have an extensive distribution across western North America including Colorado, occupying about two thirds of the state (Fitzgerald *et al.* 1994). This species is known by several other names including panther, puma, catamount, and cougar. Mountain lions inhabit many habitat types in Colorado from desert to alpine environments, indicating a wide range of adaptability. They are closely associated with deer, elk, and other large hoofed mammal herds because they rely on these species for food. CPW

manages mountain lions as a big game species in Colorado, and is responsible for compensating livestock losses. CDA has authority for the management of livestock losses to lions. They issue depredation permits when needed per Colorado regulations, but permits are not required prior to take of mountain lions threatening livestock. WS-Colorado has been contracted by CPW to assess damage and provide mountain lion damage management for them as needed.

Female mountain lions typically breed for the first time between 22 and 29 months of age (Ashman *et al.* 1983) but initial breeding may be delayed until a territory has been established (Hornocker 1970). Mountain lions breed and give birth year round but most births occur during late spring and summer following about a 90 day gestation period (Ashman *et al.* 1983, Seidernsticker *et al.* 1973, Robinette *et al.* 1961). One to six offspring per litter is possible, with an average of two or three.

Mountain lion density is primarily dependent on prey availability and intraspecific (among members of the same species) competition. Prey availability is directly related to the habitat quality of the prey species and this directly influences a mountain lion's nutritional health and reproduction and mortality rates. Studies indicate that as available prey increases, so do lion populations. But because mountain lions are territorial animals, the rate of population increase tends to decrease as lion density increases, even though the prey availability continues to increase. As the mountain lion population density increases, the mortality rate from intraspecific strife, cannibalism, and dispersal into marginal quality, unoccupied habitats also increases. Shaw (1981) presented evidence that livestock such as sheep and calves provide a supplemental prey base that supports mountain lions through seasonal declines in their primary prey. This allows an artificially high population level to be reached, especially during times of low wild prey availability. Although the relationship of the mountain lion to its prey can help mountain lion populations to increase, intraspecific competition is a greater factor in determining peak density for a particular site. They typically do not reach the high density levels observed in a number of other wildlife species (Oregon Department of Fish and Wildlife 1993).

Published mountain lion densities, based on a variety of population estimating techniques, range from a low of about 1/100 mi^2 (McBride 1976, Hemker *et al.* 1984) to a high of 24/100 mi^2 (Johnson and Strickland 1992). The average density estimate for western states has been estimated at 7.5/100 mi^2 (Johnson and Strickland, 1992). Cunningham *et al.* (1995) determined that mountain lion densities were about 75% higher in the portion of their study area which was subject to greater depredation control and sport hunting. Their estimates of density ranged from 4-7/100 mi^2. However, studies that followed mountain lions for at least 12 months found a wider range of densities: 1.3-13/100 mi^2. In Colorado, mountain lions were estimated to have a density of 4-10/100 mi^2, which is within the range of the estimates for lions followed for at least 12 months. Using 7 mountain lions/100 mi^2 (the average density for Colorado), and considering that mountain lions occupy approximately 2/3 of Colorado, CPW believe that 4,850 is a conservative but reasonable estimate of the population of mountain lions in Colorado (A. Holland, CPW, pers. com., 2/15/2015). This estimate is in agreement with CPW's estimate of 4,500-5,000 mountain lions (CPW 2004).

2.2.1.8 Bobcat. CPW is responsible for the management of bobcats, which are designated as furbearers. CDA has authority over the management of bobcats which depredate on livestock. WS-Colorado works with CDA and CPW to provide PDM to reduce bobcat damage, especially to livestock. WS-Colorado provides CPW with information on take for population management purposes. WS-Colorado recorded an annual average of 32 incidents of bobcat damage, resulting in losses of $342 in Colorado in FY10-14 (Table 9). Damage caused by bobcats was almost exclusively to livestock, especially domestic fowl and lambs. Threats to property, natural resources, and human health & safety were less commonly recorded.

Bobcats are found throughout much of North America, excluding much of Canada and portions of the eastern U.S. They are most abundant in western States. Bobcats are typically associated with rimrock and chaparral habitat, but can be found in other habitats such as forests. They are found statewide in Colorado, but have their highest densities in western and southeastern Colorado. Bobcats reach reproductive maturity at approximately 9 to 12 months of age and may have one to six kittens following a two-month gestation period (Crowe 1975, Koehler 1987). They may live up to 14 years, but annual mortality can be as high as 47% (Rolley 1985). Bobcat population densities range between 0.1/mi^2 and 7/mi^2 according to published estimates (Rolley 1999). Using the low density estimate (0.1/ mi^2) as the average for all of Colorado, CPW believes that 10,000 bobcats is a conservative but reasonable estimate of the population in Colorado (A. Holland, CPW, pers. com. 2/15/2015). CPW estimates that sportsmen harvest an annual average of 1,588 bobcats in Colorado in recent years (Table 8; CPW 2014d).

2.2.1.9 Badger. Badgers are classified as furbearers in Colorado and managed by CPW. Badgers are found throughout most of the western States and are found throughout much of Colorado at moderate densities. Badgers occur in most habitat types in Colorado. They prefer open habitats and avoid densely wooded areas, although they will enter forest margins. Badgers occur in grasslands, meadows in subalpine and montane forests, alpine tundra, and semi-desert shrublands (Fitzgerald *et al.* 1994). Their distribution is commonly associated with fossorial (below ground) prey such as prairie dogs (*Cynomys spp*.) and ground squirrels. Published sustainable yield rates range from 18% to 33% (Cook 1986). Density estimates range from 1/mi^2 to 13/mi^2 (Messick 1999). CPW believes that 52,000 badgers is a conservative but reasonable estimate of the population in Colorado, using the lowest published density estimate of 1/mi^2, and considering that approximately half of the State provides suitable habitat (A. Holland, CPW, pers. com., 2/15/2015). In FY10-14, WS-Colorado recorded an annual average of 14 incidents of damage from badgers, with losses of $178. CPW estimates that sportsmen harvested an annual average of 253 badgers in Colorado in recent years (Table 8; CPW 2014d). WS-Colorado occasionally takes badgers, most often for the protection of property (*e.g.*, rangeland, pasture, and cropland damage) or human health & safety (*e.g.*, threat of wildlife strikes to aircraft).

2.2.1.10 Feral Cat. Feral cats are fairly common throughout Colorado, and primary responsibility for feral cat control rests with county and local authorities, such as local law enforcement and health departments. WS-Colorado primarily responds to requests from these local authorities to target feral cats, but occasionally targets feral cats at airports. WS-Colorado receives few such requests, and has documented an annual average of 12 incidents of damage or damage threat due to feral cats in FY10-14. WS-Colorado personnel are authorized to control feral cats to protect livestock, poultry, natural resources, and human health & safety when requested by the proper authority. Feral cats are not part of the native environment, and left abandoned in the wild are generally considered ecological pests. They are very efficient predators of native wildlife and competitors to native predator species.

2.2.1.11 Opossum. CDA manages opossum damage to agriculture. CPW manages the opossum and damage to non-agricultural related resources. Hunting seasons for them are currently closed. The opossum is native to three river basins in eastern Colorado and have expanded their range in these areas in the late 1900s most likely as a result of agriculture. They have also been introduced elsewhere in Colorado such as in Grand Junction (Fitzgerald *et al.* 1994). They are often associated with riparian areas and inhabit deciduous woodlands, cottonwood forests, pinyon-juniper woodlands, farmlands, old fields, grasslands, marshlands, agricultural and forested edges, and desert plains. Opossums have also been reported in mountainous areas. Opossums are omnivorous and have a wide-ranging diet. Females breed in their first year, and produce potentially two litters per year in Colorado. They may have as many as 25 young per litter, but average between six and nine. Most opossums die in their first year, and turn-over is expected by their third year. Opossums populations can fluctuate dramatically. The opossum is

protected as a furbearer in Colorado, but few are harvested by sportsmen. In recent years, CPW estimates an average of 45 opossums were harvested annually by sportsmen (Table 8; CPW 2014d). WS-Colorado records few incidents of damage from opossums, and no incidents were recorded in FY10-14. Opossums occupy about 7% of the state and their density ranges from 1.3/mi^2 to 20.2/mi^2 with an average of 10.1/mi^2 (Seidensticker *et al.* 1999). Using the low density estimate of 1.3/mi^2, CPW believes that a statewide population of approximately 9,500 opossums is conservative but reasonable (A. Holland, CPW, pers. com. 2/15/2015).

2.2.1.12 Weasels. Both long-tailed and short-tailed weasels are found in Colorado and CPW has management authority over weasels, which are classified as furbearers. The long-tailed weasel is more common and found in much of the continental U.S. including all of Colorado (Fitzgerald *et al*. 1994). They are found in a wide variety of habitats, usually brushy and rocky, and typically in close association with water. Long-tailed weasel densities are estimated at 1/mi^2 over large areas, including non-preferred habitats. Densities as high as 98/mi^2 have been reported in high quality habitats (Fagerstone 1999). Using the most conservative estimate, Colorado is estimated to have approximately 104,000 long-tailed weasels (A. Holland, CPW, pers. com. 2/15/2015).

The short-tailed weasel is found mostly in northern North America and is found in the high country (above 6,000 ft.) of central Colorado covering about 40% of the State in mixed coniferous forest and alpine tundra associated with moist areas (Fitzgerald *et al*. 1994). Published densities for short-tailed weasels vary from 10/mi^2 to 16/mi^2 in preferred habitats (Fagerstone 1999). Assuming that preferred habitat covers approximately 10% of their range (the portion which is near water), and using the lowest published density of 10/mi^2, CPW believes that 40,000 short-tailed weasels is a conservative but reasonable estimate of their population in Colorado (A. Holland, CPW, pers. com. 2/15/2015).

Both of these weasel species primarily feed on small mammals and some birds. Historic sportsman harvest is estimated at an annual average of 187 long-tailed weasels and 31 short-tailed weasels; however, no sportsman harvest of either species has been recorded in recent years (Table 8; CPW 2014d). WS-Colorado has historically received few damage complaints for weasels, which have invariably been for the long-tailed weasel, and most always for poultry predation. WS-Colorado did not record any incidents of damage from either weasel species in Colorado in FY10-14.

2.2.1.13 Feral Domestic Ferret. Domestic or European ferrets are frequently sold as pets and may be intentionally released into the wild or escape captivity. Nationwide, WS-Colorado records only a few incidents of ferret damage annually. Once feral, they feed on small rodents, rabbits, and potentially poultry to survive. Feral ferrets are not part of the native environment, and left abandoned in the wild are generally considered an ecological pest. They are very uncommon in the wild, but they are sometimes encountered. WS-Colorado did not record any incidents of damage from feral ferrets in FY10-14.

2.2.1.14 Marten. Although widespread in North America, pine marten populations suffered declines in localized areas due to over-exploitation for furs and loss of habitat from lumbering operations and other activities. CPW is responsible for regulating take of this furbearer. Historical sportsman harvest of pine marten in Colorado has been estimated at 1,885 animals annually, which is an indication of their abundance. However, in recent years, estimated sportsman harvest has been much lower: 327 animals annually (Table 8; CPW 2014d). Marten occur in spruce-fir forests and marginal alpine habitat where they feed on small mammals, particularly red squirrels (*Tamiasciurus douglasii*), birds, insects and mast. They climb and spend much of their time in trees, usually avoiding open areas. Males and juveniles appear the most susceptible to trapping (Strickland and Douglas 1999). In Colorado, martens are fairly abundant in the high country, primarily in central and western Colorado, in about 20% of the State (Fitzgerald *et al*. 1994). Density ranges from 1/mi^2 to 5/mi^2 (Strickland and Douglas 1999). Using the lowest published density,

CPW believes that 20,000 is a conservative but reasonable estimate of the marten population in Colorado (A. Holland, CPW, pers. com., 3/15/2015). Trappers harvested an annual average of 1,885 martens from 1987 to 1994 indicating their relative abundance. Typically the only damage that marten cause is from raiding mountain cabins. WS-Colorado did not record any damage from martens in FY10-14.

2.2.1.15 Mink. CPW is the agency responsible to oversee the management of mink, which are classified as furbearers in Colorado. Mink are found across much of northern North America and in scattered areas of Colorado (Fitzgerald *et al*. 1994). Mink have never been very abundant in Colorado. They are associated with lakes, streams, and marshes and are typically found within a half mile of these riparian habitats. They feed on small mammals, birds, eggs, fish, insects, and amphibians and are especially prevalent where crayfish and muskrat (*Ondatra zibethicus*) are abundant. Published mink densities range from 8.5-22/mi^2 in wetland habitat, and 2.5-6 per mile of stream shoreline, but methods of estimating their density have varied greatly and have inherent inaccuracies (Eagle and Whitman 1999). In northwestern Colorado, mink density was estimated at 1.7/mi^2 over large areas (McKean and Burkhard 1978 *cited in* Fitzgerald *et al*. 1994). Because Colorado has low densities of mink statewide, and because CPW does not have density data for the rest of Colorado, CPW believes that a conservative but reasonable estimate is 90,000 mink [half of the reported density (0.85/mi^2) over the entire state] (A. Holland, CPW, pers. com. 2/15/2015). Considering that mink are essentially aquatic, another estimate can be made using information on densities in differing wetland habitats. A conservative but reasonable estimate would be 2.5 mink per mile of perennial stream and 8.5/mi^2 of lakes and other perennial impoundments (the lowest reported densities). Colorado has approximately 31,470 miles of perennial (year-round) rivers and streams, and 260 mi^2 in perennial bodies of water including the larger reservoirs and lakes (D. Litke, USGS, pers. comm. 2001). Colorado has many more wetlands that would likely support mink, so these numbers are very conservative. With these conservative assumptions, the mink population is estimated to be about 80,000, a similar estimate to that derived above. Historic sportsman harvest has been estimated at 324 mink annually, but in recent years sportsman harvest has been much lower: 8 mink per year (Table 8; CPW 2014d). Damage from mink is usually associated with poultry and fish predation, but WS-Colorado has not recorded any damage from mink in FY10-14.

2.2.1.16 Ringtail. Ringtails are managed as furbearers by CPW. They are found in most of southern and western Colorado at lower elevations in about 60% of the State. Ringtails occupy rimrock, desert, and rocky ridge habitats in close association with water, and feed on small mammals, birds, lizards, insects, and mast. Historic sportsman harvest in Colorado has been estimated at 168 ringtails, but harvest has been much lower in recent years: 28 per year on average (Table 8; CPW 2014d). Published ringtail densities vary greatly from 0.2/mi^2 to 51.8/mi^2, but many of these were determined prior to 1950, when densities may have been different. Estimates from a Utah study in the late 1970s, with habitat similar to some areas in Colorado where ringtails occur, were reported as 3.9-7.5/mi^2 (Kaufmann 1999). Using the lowest reported density estimate of 0.2/mi^2, Colorado would have an estimated 12,500 ringtails which is likely very conservative (A. Holland, CPW, pers. com., 2/15/2015). Because of their habitat choice and secretive nature, ringtails seldom become a problem, but have been known to become a nuisance in and around human habitations. WS-Colorado did not record any damage from ringtails in Colorado in FY10-14.

2.2.2 Effects on Non-target Species Populations, Including T&E Species

A common concern among members of the public and wildlife professionals, including WS-Colorado personnel, is the possible impact of PDM methods and activities on non-target species, particularly T&E species, and the effects of aerial predator management overflights on wildlife. WS-Colorado follows SOPs which include measures intended to reduce the effects of PDM on non-target species populations, especially T&E species. These SOPs are detailed in Chapter 3. The

effectiveness of PDM methods to capture target species, yet reduce capture of non-target species may vary widely depending on local circumstances at the time of application (*e.g.*, target and non-target species may or may not be similar in weight, and may or may not occupy the same area). Some PDM methods may be more or less effective or applicable depending on experience of the user, weather conditions, time of year, biological considerations, economic considerations, legal and administrative restrictions, or other factors.

2.2.2.1 Nontarget Species Taken by WS in PDM and Potential Non-targets. During FY10-14, WS-Colorado took 12 different non-target species, averaging seven animals per year (Table 10). Most non-target species taken during PDM (8 of 12 species, and 28 of 33 total animals) are other predator species that were not targeted during a specific operation or were not the specific individual targeted, but were on the cooperative agreement as a target species. Information on these target predator species was discussed in Section 2.2.1. Other than predators, non-target take in FY10-14 included one domestic dog, one porcupine (*Erethizon dorsatum*), two desert cottontails (*Sylvilagus audubonii*), and one common raven (*Corvus corax*). The dog and the cottontails were released. The dog is discussed in Chapter under Public Safety and Pets. Desert cottontails are very abundant throughout eastern Colorado, and are known to cause problems. For example, cottontails attract raptors to airports, which threaten public safety and property. Further, in 2012, Colorado sportsmen harvested an estimated 57,859 cottontails (eastern, desert, and mountain cottontails combined; CPW, 2014a). Cottontails are clearly very abundant in Colorado, and the non-target take of two animals over five years is negligible, especially because the take was non-lethal. Porcupines are found in the western 3/4 of Colorado (Fitzgerald *et al*. 1994), and are locally abundant in many areas. In 1989, sportsmen harvested 4,625 porcupines in Colorado, giving an indication of their abundance. The non-target take of one porcupine over the course of five years is negligible compared to sportsman harvest. Common ravens are abundant throughout much of Colorado. As a predatory bird species, they occasionally cause damage to agricultural resources, and as such, they are targeted by WS-Colorado and non-federal entities for lethal control. From FY10 through FY14, WS-Colorado lethally took 220 common ravens, as covered under a separate EA (WS 2013). The non-target take of one common raven over five years is negligible compared to their abundance and targeted take.

Table 10. All nontarget animals taken by WS-Colorado during PDM from FY10 through FY14 on all land classes in Colorado.

	Total FY10-FY14		Average FY10-FY14	
Species	**Killed**	**Freed**	**Killed**	**Freed**
Badger	1	2	0	0
Feral Cat	1	13	0	3
Domestic Dog	0	1	0	0
Red Fox	1	0	0	0
Swift Fox	3	0	1	0
Mountain Lion	0	1	0	0
Mink	0	1	0	0
Porcupine	1	0	0	0
Desert Cottontail	0	2	0	0
Raccoon	1	0	0	0
Common Raven	1	0	0	0
Striped Skunk	4	0	1	0
Total*	13	20	3	4

*Totals may not exactly match the numbers due to rounding.

WS-Colorado has the potential of capturing other non-target species as well. Species that are of similar or more weight and size compared to the targeted species can be accidentally taken with several of the PDM methods used. Species such as white-tailed jackrabbits (*Lepus townsendi*), black-tailed jackrabbits, mule deer, and yellow-bellied

Table 11. Federal listed threatened and endangered mammals and birds in Colorado and the potential for Wildlife Services predator damage management activities to have an effect on these species.

SPECIES	Scientific Name	Status	Locale	Habitat	Diet**	PDM
MAMMALS						
Preble's Meadow Jumping Mouse	*Zapus hudsonius preblei*	T	Central-North central	W	Gi	0
New Mexico Meadow Jumping	*Zapus hudsonicus luteus*	E	Las Animas	GW	Gl	0
Black-footed Ferret*	*Mustela nigripes*	NEP	Statewide	R	S	-, 0, +
Canada Lynx	*Lynx canadensis*	T	West, Central Mountains	F	Sl	-, 0, +
BIRDS						
Gunnison Sage-Grouse	*Centrocercus minimus*	T	Central-Westcentral	R	Gl	-, 0, +
Whooping Crane	*Grus americana*	NEP	East	R	Gis	0
Piping Plover	*Charadrius melodus*	T	East	W	I	-, 0, +
Least Tern (Interior Population)	*Sterna antillarum*	E	East	W	Al	-, 0, +
Yellow-billed Cuckoo (Western pop.)	*Coccyzus americanus*	T	West	F	I	0
Mexican Spotted Owl	*Strix occidentalis lucida*	T	West	F	S	0
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	E	Southwest	F	I	-, 0, +
FISHES						
Greenback CutthroatTrout	*Oncorhynchus clarki stomias*	T	Central	LSg	Al	0
Colorado Pikeminnow	*Ptychocheilus lucius*	E	West	Lg	A	0
Humpback Chub	*Gila cypha*	E	West	LSg	A	0
Bonytail Chub	*Gila elegans*	E	West	LSg	A	0
Razorback Sucker	*Xyrauchen texanus*	E	West	Lg	A	0
INVERTEBRATES						
Uncompahgre Fritillary Butterfly	*Boloria acrocnema*	E	Southwest	F	N	0
Pawnee Montane Skipper	*Pseudocopaeodes eunus obscurus*	T	Douglas/Jefferson/Park/Teller	G	N	0
PLANTS						
Mancos Milk-vetch	*Astragalus humillimus*	E	Montezuma	R	-	0
Osterhout Milk-vetch	*Astragalus osterhoutii*	E	Grand	R	-	0
Clay-loving Wild Buckwheat	*Eriogonum pelinophilum*	E	Delta/Montrose	R	-	0
Penland Alpine Fen Mustard	*Eutrema penlandii*	T	Lake/Park/Summit	RW	-	0
Colorado Butterfly Plant	*Gaura neomexicana var. coloradensis*	T	North Central	RW	-	0
Pagosa Skyrocket	*Ipomopsis polyantha*	E	Archuleta	FG	-	0
Dudley Bluffs Bladderpod	*Lesquerella congesta*	T	Rio Blanco	R	-	0
Knowlton Cactus	*Pediocactus knowltonii*	E	La Plata	R	-	0
Parachute Beardtongue	*Penstemon debilis*	T	Garfield	R	-	0
Penland Beardtongue	*Penstemon penlandii*	E	Grand	R	-	0
North Park Phacelia	*Phacelia formolusa*	E	Jackson/Larimer	R	-	0
DeBeque Phacelia	*Phacelia submutica*	T	Garfield/Mesa	R	-	0
Dudley Bluffs Twinpod	*Physaria obcordata*	T	Rio Blanco	R	-	0
Colorado Hookless Cactus	*Sclerocactus glaucus*	T	Delta/Garfield/Mesa/Montrose	R	-	0
Mesa Verde Cactus	*Sclerocactus mesae-verdae*	T	Montezuma	R	-	0
Ute Ladies'-tresses	*Spiranthes diluvialis*	T	Northwest-North central	RW	-	0

* - believed extirpated

**Diet - Capitals = large proportion of diet - Lower case = small proportion of diet.

STATUS
E - Endangered
T - Threatened
P – Proposed
NEP- Non-essential, experimental

HABITAT
F - Forests/riparian borders
G - Grassland/meadow
R - Range/sage/high desert
W - Wetland/marsh/sandbar
L - Lakes, Rivers
S - Springs/creeks/ponds
g – gravel bottom

DIET
A - Aquatic- fish/invertebrates/plants
G - Grains/grass/brush/seeds
L - Large Vertebrates
M - Mast/fruit & nuts
N - Nectar/sap
S - Small vertebrates (i.e. rodents, birds)
C- Carrion

PDM - Impacts
(-) - Negative
0 - none
(+) - Positive

marmots (*Marmota flaviventris*) have been previously been taken in Colorado or surrounding states, and could potentially be taken during future PDM. However, none were taken during FY10-14. This is at least partly due to increased selectivity of PDM methods used, such as pan-tension devices used on traps. Species with the highest potential to be taken as non-targets, with the exception of the T&E and candidate species presented in Table 11, are relatively common in Colorado, either locally or statewide.

Bald eagles are generalized predators/scavengers primarily adapted to edges of aquatic habitats. They feed primarily on fish (taken both alive and as carrion), waterfowl, mammalian carrion, and small birds and mammals. The bald eagle is a wide-ranging raptor found in all lower 48 contiguous states during some point in its life-cycle. It is a bird of aquatic ecosystems, frequenting estuaries, large lakes, rivers, reservoirs and some seacoast habitat. Bald eagles have been documented to nest in all 48 contiguous states including Colorado (USFWS 2014b), and their numbers continue to increase from a low

of about 500 nesting pairs in the mid-1960's to almost 10,000 pairs as of the date of delisting (USFWS 2014c). They are also now a very common winter resident in Colorado (population estimated at 700-900) with many living on lakes and rivers throughout the State. PDM has a potential for negatively impacting bald eagles. WS-Colorado has taken no non-target bald eagles in Colorado over the last 5 years.

2.2.2.2 Potential T&E Species Impacts. Special efforts are made to avoid jeopardizing T&E species through biological evaluations of the potential effects of WS-Colorado PDM activities, and the establishment of special restrictions or measures to reduce the potential for take. Colorado has 5 mammals, 9 birds, 5 fishes, 2 invertebrates, and 16 plants which are federally listed as T&E species (Table 11). The State of Colorado lists an additional 3 mammals, 2 birds, 9 fish, and 1 amphibian as T&E species. The bald eagle was delisted in 2007 due to recovery, and is therefore not included in this discussion.

The USFWS, consulted under Section 7 of the ESA, issued BOs on the species that WS-Colorado had the likelihood to adversely affect (USFWS 2009, 2011). WS-Colorado abides by the reasonable and prudent measures and alternatives, and terms and conditions established in the BOs which reduce the potential for take. A new biological assessment to evaluate the impacts of predator damage management activities on federal listed threatened and endangered species as well as non-essential experimental wildlife species was conducted in 2016.

Table 11 shows federal listed mammals, birds, fish, invertebrates and plant species in Colorado. WS-Colorado PDM has the potential to have an adverse effect on 6 of these species of mammals and birds and a positive effect on 6 mammal or bird species. PDM will have no effect on listed invertebrates, fishes or plants. Additionally, several mammal and bird species including the Preble's meadow jumping mouse, whooping crane, western yellow-billed cuckoo, Eskimo curlew, southwestern willow flycatcher, and Mexican spotted owl will be unaffected by PDM will therefore not be considered further in this EA. Also fish, invertebrates, and plants unaffected by PDM will not be discussed further in this EA. This section provides background information on those species that potentially could be affected, positively or negatively, by some aspect of PDM.

2.2.3 Impacts on Public Safety and Pets

The use of chemical drugs and toxicants by WS-Colorado is regulated by EPA under FIFRA, CDA Pesticide Control Laws, and WS Policies and Directives. We believe the risk to humans from these PDM methods is low. Under several of the alternatives proposed in this EA, WS-Colorado would use sodium cyanide in the M-44 device and carbon monoxide produced from the gas cartridge used for fumigating coyote, skunk, and fox dens. WS-Colorado used 122 M-44s and 18 large gas cartridges from FY10-FY14, for an average of 24 M-44s and 4 gas cartridges per year. In the prior EA, we reported a five-year average of 209 M-44s and 9 gas cartridges used annually from FY00-FY04 (WS 2005b). Based on a thorough Risk Assessment, WS concluded that when WS chemical methods including those referenced above are used in accordance with label directions, they are highly selective for the target individuals or populations. WS use of these pesticides in PDM would have negligible impacts on the public safety and pets and do not represent a risk to the public, threatened and endangered species, non-target wildlife populations or the environment (EPA 2009).

On the other hand, public health and safety may be jeopardized by not having a full array of PDM methods for responding to complaints involving threats to human health and safety such as direct physical attacks on humans from predators, disease transmission, and airstrike hazards. Predators have been responsible for attacks on humans and WS has responded to attacks from coyotes and bears in FY11-15. Sometimes predator attacks can be fatal, but rarely. For example, in 1991, a mountain lion killed a jogger near Idaho Springs, Colorado. More recently, in August of 2009, WS responded to a human fatality in Ouray County, Colorado due to a black bear attack. Large predators also represent a significant strike risk to aircraft at airports, and numerous coyotes have been struck by aircraft. This can result in damage and injuries to people. Finally, zoonotic diseases

(diseases shared among animals and humans), such as rabies, can pose a significant threat to humans. WS often uses several PDM methods to capture offending animals, depending on the situation. Firearms, traps, snares, or chemical toxicants may be used to take an offending animal and eliminate further encounters. PDM methods that may pose a slight public safety risk may be used effectively to eliminate a recognized public safety risk.

Additionally, it has been found that without the services provided by WS, people will often resort to the use of unwise or illegal methods to resolve predator problems. This has been demonstrated many times and records of arrests involving people trying to protect their resources are replete.

2.2.4 Effects on Sociocultural Resources

Some members of the public may be concerned that WS-Colorado PDM activities could conflict with recreational activities such as hunting and fishing and non-consumptive uses, such as wildlife viewing and photography.

Aesthetics is a philosophy dealing with the nature of beauty or the appreciation of beauty. Therefore, aesthetics is subjective in nature and is dependent on what an observer regards as beautiful. Wildlife generally is regarded as providing economic, recreational and aesthetic benefits (Decker and Goff 1987) and the mere knowledge that wildlife exists is a positive benefit to many people. There may be some concern that the proposed action or alternatives would result in the loss of aesthetic benefits to the public, resource owners or neighboring residents. An example of concerns pertaining to aesthetic impacts are concerns that the noise (e.g., from aircraft) or viewing evidence of PDM activities would adversely impact aesthetic enjoyment of activities such as hiking on public lands.

Native American cultural practices: Native American tribes such as the Southern Utes tribe use natural resources for food, income and cultural practices. This Section also addresses potential for each of the alternatives to impact tribal uses of and relationships with wildlife resources and natural ecosystems.

2.2.5 Effects of PDM, Especially Aerial Predator Management Activities, on the Use of Public Lands for Recreation

Recreation encompasses a wide variety of outdoor entertainment in the form of consumptive and non-consumptive uses. Consumptive uses of public lands include activities such as hunting, fishing, and rock-hounding. Non-consumptive uses include activities such as bird watching, photography, camping, hiking, biking, rock climbing, winter sports, and water sports. Recreationists are members of the general public that use public lands for one of the above or other activities. Some members of the public believe that WS-Colorado PDM activities conflict with recreation on public lands. In addition, some individuals believe their recreational experiences on public lands are impaired by knowing that any lethal PDM actions are occurring on these lands. Others feel that they are being deprived of the aesthetic experience of viewing or hearing coyotes or other predators because of WS-Colorado PDM actions. On the other hand, some believe that PDM is wholly acceptable. PDM can help bolster certain species populations of T&E species and big game, and eliminate individual predators that are a threat to human health and safety.

2.2.6 Humaneness and Ethical Perspectives

Many people, including WS-Colorado, are concerned with the humane treatment of animals. This section reviews the varying perspectives on this issue relative to the proposed management actions for each alternative.

Humaneness and animal welfare as it relates to killing or capturing wildlife is an important and very complex issue that can be interpreted in a variety of ways. Schmidt (1989) indicated that vertebrate pest damage management for societal benefits could be compatible with animal welfare concerns if "*the reduction of pain, suffering, and unnecessary death is incorporated in the decision making process.*" However, defining "pain" and "suffering" can be challenging. In fact, it has been noted that "*neither medical nor veterinary curricula explicitly address suffering or its relief*"

(California Department of Fish and Game 1991). Suffering has been described as a "*highly unpleasant emotional response usually associated with pain and distress.*" However, it has also been noted that suffering "*can occur without pain*" and that "*pain can occur without suffering*" (AVMA 1987). Suffering implies a duration of time; thus, an animal would experience "*little or no suffering where death comes immediately*" (California Department of Fish and Game 1991), such as from a well-placed gunshot. Defining pain is an even greater challenge. Wild mammals clearly experience pain, but detecting such pain can be difficult. Pain experienced by individual animals from the same stimulus probably ranges from little or no pain to significant pain (California Department of Fish and Game 1991). The American Veterinary Medical Association (AVMA) has also noted that "*individuals can differ in their perceptions of pain intensity as well as in their physical and behavioral responses to it*" (AVMA 2013). Altered physiology and behavior can be indicators of pain, and identifying the causes that elicit pain responses in humans would "*probably be causes for pain in other animals*" (AVMA 1987).

Best Management Practices for Trapping furbearing animals were developed by the states to increase humaneness and efficiency of catching wild furbearing animals (AFWA 2006). The testing process scientifically evaluated traps and trapping systems for capturing furbearers in the United States. Evaluations are based on animal welfare, efficiency, selectivity, practicality and safety. Trauma scales were used to develop a level of animal welfare performance for traps are presented as guidelines in ISO (International Organization for Standardization) Document 10990-5. WS-Colorado follows the Best Management Practices for trapping using approved traps to minimize the effects traps may have on captured wild animals.

2.3 ISSUES NOT CONSIDERED FOR COMPARATIVE ANALYSIS

The environmental consequences of these issues were found to have the least impacts under the current program alternative. Even though these issues are not analyzed in this EA, some of these issues are still considered in determining SOPs to reduce potential impacts. Following are the issues that were sufficiently discussed and show little or no change. Subsequently, these will not be addressed in this EA, except where SOPs are developed to minimize impacts of these issues.

2.3.1 Livestock losses should be an accepted cost of doing business (a threshold should be reached before providing PDM service).

Some persons feel that livestock producers should expect some level of loss as a cost of doing business, and that WS should not initiate any management actions until economic losses reach some predetermined "threshold" level. Although some losses of livestock and poultry can be expected and tolerated by livestock producers, WS has a legal responsibility to respond to requests for wildlife damage management, and it is program policy to aid each requester to minimize losses. If damage management efforts are not initiated soon after a damage problem is detected, damage may escalate to excessive levels before the problem is solved. WS uses the Decision Model (Slate et al. 1992) to determine appropriate strategy.

2.3.2 No PDM at taxpayer's expense (PDM should be fee based).

Some persons feel that wildlife damage management should not be provided at the expense of taxpayers or that it should be fee based. A common argument for public funded wildlife damage management is that the public should bear responsibility for damage to private property caused by pubic wildlife. WS was established by Congress as the agency responsible for providing wildlife damage management to the people of the United States. Funding for WS come from a variety of sources in addition to federal appropriations. Such nonfederal sources include State general appropriations, local government funds (county or city), livestock associations, Indian tribes, and private funds which are all applied toward program operations. Federal, state, and local officials have decided that PDM should be conducted by appropriating funds. Although not required by law, the WS-Colorado program currently requests cooperative local government or private funding to cover about 50% of the program's management services are, in essence, "fee based" to a relative high degree for a federal program. Additionally, wildlife damage management is an appropriate sphere of activity for government programs, since wildlife management is a government responsibility.

2.3.3 The appropriateness of manipulating wildlife for the benefit of hunters or recreation.

Some individuals feel is this not appropriate to manipulate one wildlife species for the benefit of another wildlife species, or for the benefit of hunters or recreation. This is a matter of individual perception and perspective. The jurisdiction for managing most resident wildlife in the state rests with CPW which, under state law, can request WS assistance in achieving its management objectives. American Indian Tribes have jurisdiction for management of resident wildlife species on tribal lands and could also request such assistance. WS would not conduct PDM specifically for wildlife protection unless requested by an agency or tribe with such management authority.

2.3.4 WS's removal of coyotes exacerbates the livestock depredation problem because the coyote population reduction results in compensatory reproduction.

Although it is well supported that coyote reproduction increases as population size decreases (Connelly and Longhurst 1975), WS is unaware of any data that would substantiate the speculation that unexploited coyote populations pose less risk to livestock than exploited populations. On the contrary, research on lamb and sheep losses with restricted or no PDM indicate coyote control is effective in reducing losses. This is supported by a review of the Government Accounting Office (GAO 1990) which concluded that "according to available research, localized lethal controls have served their purpose in reducing predator damage (GAO 1990).

2.3.5 Cumulative Effects on Wildlife Populations from Oil and Gas Development, Timber Harvesting, Land Development, and Grazing.

A few public comments have been received during public review of prior versions of this EA that expressed concerns about cumulative impacts on the wildlife species that WS-Colorado impacts with PDM due to other activities such as oil and gas development, timber harvesting, other land development actions such as residential subdivision development, and grazing. WS-Colorado has no authority to affect decisions of other entities that engage in or approve such actions. Thus, they are not related or connected to WS-Colorado actions. The effects of such actions by other agencies and entities are part of the existing environmental baseline, and those effects neither increase nor decrease as a result of WS-Colorado PDM activities (see additional discussion about grazing impacts below).

Adverse impacts on some wildlife can result from land management and development activities. Housing developments in rural areas have been recognized as having adverse effects on wildlife by diminishing habitat (Gill 1999). Oil and gas development can adversely affect certain wildlife species by reducing the amount of available habitat for them. Road building and establishment of well pads (sites where wells are drilled to pump oil or gas out of the ground) reduce habitat directly by removing vegetation that animals use for food and cover. Timber harvest can benefit some wildlife species while negatively affecting others (USFS 1998). For example, deer and elk generally benefit from the creation of openings in large expanses of mature forest. Roads established to support oil and gas development and timber harvesting further indirectly reduce the amount of habitat "effectively available" to certain species because of animals' fear of using areas where humans are traveling; this is considered the "displacement effect" caused by roads. Wildlife species identified as being affected in this way include mule deer and elk.

The following discussion is provided to explain what potential, if any, WS-Colorado PDM actions have for contributing to cumulative effects on wildlife species and the environment that have resulted from non-WS related actions by others.

Where these activities occur on public lands, impact analysis is generally required under NEPA. Thus, our analysis focuses on public lands (BLM and USFS) where such activities occur, because there is sufficient data and analysis to effectively assess the potential for cumulative impacts. The BLM and USFS approve and regulate oil and gas development, timber harvesting, and grazing on public lands and have evaluated the potential for cumulative effects on numerous wildlife species because of their land management decisions for those types of activities. We reviewed BLM and USFS EIS documents for areas within Colorado to determine the species identified as being

potentially impacted by land management activities (including oil and gas development, timber harvesting, and livestock grazing) and for which restrictions or mitigation measures have been established to minimize such impacts. These species are listed in Table 15. We refer the reader to those agencies and analyses to determine in more detail the extent of impacts of such activities on wildlife in specific areas. Then we made a determination of whether WS-Colorado PDM, including aerial predator management, has any real potential for contributing to or causing significant adverse impacts on any of those same wildlife species. The potential for WS-Colorado PDM activities, including aerial predator management, to affect these species is also included in Table 15.

In an EIS (BLM 1991a) covering oil and gas leasing and development in 5 BLM RAs in Colorado, the BLM stated that indirect impacts on some wildlife species would be from the loss of 17,900 acres of habitat over a 20-year period because of ground surface disturbance which is minor compared to the 5.1 million acres of federal oil and gas mineral estate in the 5 RAs evaluated. Other impacts were qualitatively discussed but we could find no quantitative measures of such effects described. The BLM's Records of Decision for oil and gas leasing and development in the 5 RAs adopted a number of mitigation measures described in the EIS to protect wildlife habitat for the purposes of preventing substantial adverse effects on wildlife populations. The mitigation measures included habitat improvement efforts and stipulations or conditions on leases such as "Conditions of Approval", "No Surface Occupancy", and "Timing Limitations", each designed specifically to protect important wildlife habitat. The BLM concluded that cumulative impacts on wildlife from implementing their proposed oil and gas development proposed action would be insignificant (BLM 1991a) and has subsequently reported that less than one percent of the total acreage managed by BLM experiences surface disturbance from oil and gas activity (BLM 2005). Therefore, it appears that BLM has implemented effective mitigation measures to avoid significant adverse effects on wildlife from oil and gas development on BLM lands on the 5 RAs.

WS-Colorado PDM activities have not contributed, and are not expected to contribute, to adverse effects on most of the wildlife species affected by BLM and USFS land management decisions (Table 15; see Chapter 4 for analyses). This is partly because oil and gas development and timber harvesting typically do not affect the same wildlife resources that WS-Colorado PDM actions affect, and when they do, the effects are generally indirect and insignificant. Moreover, most of the impacts of these activities are due to habitat destruction or fragmentation, whereas WS-Colorado PDM has no effect on habitat. The only exceptions, with potential for cumulative impacts, are predator species targeted by WS-Colorado PDM, specifically coyotes, mountain lions, and black bears.

Coyotes, are directly affected by WS-Colorado PDM activities, but we found no mention of any concerns for the species in most BLM and USFS evaluations (cited above). Only one EIS (BLM 1999a) cited a potential impact to coyotes, stating that small predators, including coyotes, would be impacted by oil and gas development because of habitat disturbance resulting in reductions of small mammal populations that are their primary source of prey. However, there is ample evidence in the scientific literature that coyote populations are not adversely impacted to any substantial degree by such land management actions. Coyotes are one of the most opportunistic, adaptable, and widely distributed predators in North America (Bekoff and Wells 1986). They have adapted to human land development (Howell 1982, Loven 1995), and have even expanded their range to more densely populated eastern states over the past several decades (Hill *et al*. 1987, Moore and Parker 1992). Thus, it is doubtful that coyote populations have indeed been negatively impacted to any significant degree by land management actions such as oil and gas development and timber harvesting, and we are aware of no studies that show potential for significant effect on them by such activities. Moreover, oil and gas development does not typically eliminate enough vegetation or disturb a high enough percentage of the ground surface area to remove substantial amounts of small mammal habitat (BLM 1999a). Timber harvesting probably benefits coyotes by creating more open areas and "edge" habitat between wooded and open areas, and early successional stage areas that are generally conducive to supporting a variety of small mammal species that would serve as coyote and other small carnivore prey. More importantly and with more relevance here, the analysis in Chapter 4 herein shows that coyote populations in the state have been relatively

stable and are expected to continue to be so despite any cumulative effects from all types of activities (related or not related to WS-Colorado PDM activities). Thus, there are no significant cumulative impacts on the coyote population in Colorado.

Mountain lions and black bears are the only other species that WS-Colorado directly affects with PDM, and which have been identified in at least one other agency's NEPA analysis as potentially being affected by these activities. Without explaining how or why, BLM (1991a) stated that potential significant impacts from oil and gas activities on mountain lion and black bear populations would most likely be restricted to localized areas. BLM (1999a) provided further explanation of potential effects on mountain lions and stated that indirect effects would be related to reductions in their principal prey species, primarily deer and elk, which may result from habitat loss that could occur as a result of oil and gas development. The most important type of habitat loss identified by BLM (1999a) was the loss of deer and elk winter range[5]. Indeed, deer populations have been decreasing over the past 8 years, and habitat loss is thought to be a key factor. However, to our knowledge, mountain lion populations have not exhibited a concomitant decrease. In fact, our analysis suggests that mountain lion populations are increasing, or at least stable (see Chapter 4). This is consistent with the conclusions of the BLM (1991a), in that they stated that any effects on mountain lions would most likely be limited to localized areas; their impacts were not expected to significantly affect mountain lions statewide. In addition WS-Colorado coyote removal activities on deer winter range areas could provide some positive or beneficial effect on deer by removing coyotes that can cause winter mortality or could otherwise cause added harassment stress on wintering deer (Mackie *et al.* 1976, Gese and Grothe 1995). We conclude that there is no cumulative impact on mountain lions due to the actions of WS-Colorado PDM, gas & oil exploration, and timber harvest, and we expect no cumulative impact on mountain lions due to these actions in the future.

2.3.6 Livestock Losses Are a Tax "Write Off". \

Some people believe that livestock producers receive double benefits because producers have a partially tax funded program to resolve predation problems while they also receive deductions for livestock lost as a business expense on tax returns. However, this notion is incorrect because the Internal Revenue Service tax code (Internal Revenue Code, Section 1245, 1281) does not allow for livestock losses to be "written off" if the killed livestock was produced on the ranch. About 77% of predation occurs to young livestock (lambs, kids, and calves) in Colorado. Additionally, many ewes, nannies, and cows added as breeding stock replacements to herds from the lamb, kid, and calf crop, and if lost to predation they cannot be "written off" since they were not purchased. These factors limit the ability of livestock producers to recover financial losses. Producers do not receive double benefits from having a federal program to manage wildlife damage and collect federal tax deductions for predation losses.

2.3.7 Effects of Livestock Grazing on Riparian Areas and Wildlife Habitat as a "Connected Action" to WS's PDM Activities.

Some people have suggested that livestock grazing is "connected" to WS-Colorado PDM action, which implies that it either is an "interdependent part" of WS-Colorado PDM and depends on such PDM for its justification (*i.e.*, that it is "automatically triggered" by WS-Colorado PDM), or that it "cannot and will not proceed" unless WS-Colorado PDM occurs (40 CFR 1508.25). Both of these assertions are false. Livestock grazing in Colorado occurs on many private property areas, as well as on about 98% of BLM and USFS identified grazing allotments, without any WS-Colorado PDM actions conducted on those allotments in a given year. Therefore, livestock grazing is not automatically triggered by WS-Colorado PDM, and it clearly can and does "proceed" in the absence of WS-Colorado PDM assistance.

Although some persons may view WS-Colorado PDM actions as causing "indirect" effects on rangeland and riparian areas by facilitating the continuation of livestock grazing in such areas,

[5] Harsh winters with deep snow are frequently limiting factors in deer and elk populations, and lower elevation areas where these species can find adequate forage to meet their survival energy needs and reproductive nutrition requirements are critical to maintaining desired population levels in many areas of the western U.S.

such livestock grazing does currently take place, and there is no reason to think it will not continue to take place, even without assistance from the WS-Colorado program. For example, grazing occurs on about 98% of the BLM and USFS grazing allotments in the State without assistance from WS-Colorado on those allotments. Thus, the overwhelming majority of livestock grazing activity on federal public federal lands in Colorado is not receiving any WS-Colorado PDM assistance. Regulation or restriction of livestock grazing is outside the scope of decisions that WS-Colorado has authority to make. Thus, livestock grazing on all land ownership classes where it now occurs (private, State and federal lands), and whatever impacts there might be from such grazing, are part of the environmental baseline, whether or not WS-Colorado conducts any PDM activities.

Some public commenters have further asserted that WS-Colorado PDM to protect livestock cannot or will not proceed unless livestock grazing is occurring. Such an assertion is a tautology. If there were no livestock in this country, there would be no reason to use PDM protect livestock from predators. Just as there would be no reason to conduct PDM if there were no predators of livestock. Normally, PDM activities will occur wherever livestock producers experience predation losses, whether it is on private, state, or federal lands, and whether or not WS-Colorado is involved. Because federal agencies do not have the authority to regulate private land livestock grazing, such grazing and its effects are part of the existing human environment, and such private land livestock grazing is quite common and extensive.

Currently, livestock producers that request WS-Colorado PDM actions in Colorado must cover at least 50% of WS-Colorado's costs for providing the PDM service. Even if some livestock producers went out of business from the lack of receiving any PDM assistance and subsequent predation losses, livestock grazing may continue on those lands. Such producers may sell those ranches, including, any associated federal grazing permits, to other producers who may have better economic ability to withstand predation losses (*e.g.*, the purchasing producer has more cash to put toward operating expenses and does not have to pay as much in financing costs to borrow funds - this means a better "bottom line" for the new producer and better financial ability to remain in business even with some levels of predation loss). However, it is also possible that other such producers that go out of business may sell their properties to land developers, which can then lead to reductions in wildlife habitat because of rural land subdivision and residential housing construction. When that occurs, the inability to obtain adequate PDM services could have the unintended consequence of leading to reductions in wildlife species that formerly lived on, or otherwise depended on, the habitat that was lost to development. Loss of habitat because of human population growth and expansion of housing into traditional habitat areas has been a major concern cited by CPW in evaluating causes of long term declines in mule deer numbers since the middle part of the last century (Gill 1999).

Whether livestock grazing should occur on public lands (BLM and USFS) is outside the scope of this EA. The only livestock grazing activities that are subject to NEPA requirements are those that are authorized by federal land management agencies to occur on federal lands. The BLM and USFS prepare NEPA documents covering their authorizations of livestock grazing on public lands and we refer the reader to those agencies for further information and analysis of the environmental effects of grazing, including riparian areas. As stated earlier, PDM methods used by WS-Colorado have no direct effect on riparian areas, rangeland, or other types of habitat. Therefore, WS-Colorado PDM activities do not contribute to any cumulative impact on riparian areas or other habitat areas that are being affected or have been affected by livestock grazing.

However, livestock grazing does not have to be occurring on such lands to potentially result in the occurrence of PDM activities on those lands for the protection of livestock. This is because predators often have large home ranges, and will travel from an area of one land ownership where livestock may not be present into another area of land ownership where livestock are present in order to prey on the livestock. PDM could take place on public lands for the purpose of protecting livestock on nearby private lands.

Like livestock grazing and its impacts on the environment, PDM by nonfederal entities is part of the environmental baseline for the human environment in the absence of any federal PDM assistance and does not have to comply with the requirements and provisions of NEPA. However, such PDM actions by private or nonfederal parties could result in unacceptable and harmful impacts. For example, evidence suggests that some private entities will resort to illegal chemical pesticide uses in attempts to resolve real or perceived wildlife damage problems (USFWS 1996, Texas Department of Agriculture 2003, Porter 2004). We believe that professional assistance by a federal government agency operating under strict federal and state laws and government policies and guidelines is less likely to result in unintended adverse effects on the environment in general, and more specifically on nontarget wildlife, and human health and safety than would private entities.

It is certainly reasonable to assume that PDM by State or private entities would occur in the absence of assistance by WS-Colorado. This means that even if someone asserts that WS-Colorado PDM for livestock protection is "connected" to public land grazing, WS-Colorado has no ability to affect the environmental outcome because most such grazing will continue to occur on public lands anyway, and at least some level of PDM will most likely occur also, in the absence of any action by WS-Colorado. Thus, even if WS-Colorado decided to select a "no WS program" alternative, such a decision would have virtually no meaningful effect in changing the environmental baseline with respect to the impacts of grazing and/or PDM actions. Federal land management laws all contain clauses protecting the rights of the States to maintain jurisdiction over the management of resident wildlife species.[16] It is our understanding that, unless regulated or restricted by the BLM or FS, authorized Colorado State agencies such as the CPW and CDA (or even private entities acting in accordance with State wildlife laws) could theoretically be authorized to control predators on BLM and FS lands in the absence of any involvement by WS-Colorado.

2.3.8 Potential Effects on Wildlife from the Mere Presence of WS Personnel Conducting PDM.

Public comments to prior versions of this EA have raised the concern that the mere presence of WS-Colorado personnel in the field during the spring months has the potential to cause harmful disturbance to wildlife, and could potentially cause some animals to be separated from their mothers or might cause the abandonment of nest sites. Professional wildlife biologists believe there is no basis for this speculation, especially considering the short duration WS-Colorado personnel spend in any particular area. There are fewer than 35 WS-Colorado field personnel in Colorado, which is only a tiny fraction of many thousands of public recreationists and other public land users that enter public lands in any one year as part of the existing human environment. WS-Colorado abides by all area closures imposed by State or federal land or wildlife management agencies to protect sensitive wildlife species. We rely upon annual coordination with those same agencies to alert us to areas where this is of particular concern. In general, few if any such concerns have been raised by the responsible agencies because WS-Colorado personnel only work in a small proportion of the land area and spend little time in any particular area.

2.3.9 Concerns that WS Employees Might Unknowingly Trespass.

Public comments to prior versions of this EA have raised the concern that WS-Colorado employees could trespass onto private property or across State boundaries both on the ground and in the air. WS-Colorado is aware that it is sometimes difficult to determine land ownership and boundary lines, and WS-Colorado field employees make diligent efforts to ensure that they do not enter properties where they do not have permission. Landowners who request assistance from WS-

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[16] Multiple Use and Sustained Yield Act of 1960, 16 U.S.C. § 528 ("MUSYA") (stating that nothing in the act "shall be construed as affecting the jurisdiction or responsibilities of the several States with respect to wildlife and fish on the national forests"); Federal Land Planning Management Act, 43 U.S.C. § 1732(b) (emphasizing that "nothing in this Act shall be construed as * * * enlarging or diminishing the responsibility and authority of the States for management of fish and resident wildlife"). The National Forest Management Act of 1976 explicitly incorporated the MUSYA. 16 U.S.C. § 1604(e)(1). The Wilderness Act provides that "nothing in this Chapter shall be construed as affecting the jurisdiction or responsibilities of the several States with respect to wildlife and fish in the national forests." 16 U.S.C. § 1133(d)(7).

Colorado typically provide WS-Colorado representatives with very specific information not only about the property boundaries of their own land, but about the boundaries of neighboring lands as well. WS-Colorado aerial predator management activities are typically conducted with the aerial crew in radio contact with a WS-Colorado representative on the ground who knows the property boundaries of the area being worked. Therefore, we do not expect that inadvertent trespass incidents would rise to the level of presenting any significant environmental effects.

2.3.10 Concerns that the Proposed Action May Be "Highly Controversial" and Its Effects May Be "Highly Uncertain," Both of Which Would Require That an EIS Be Prepared

The failure of any particular special interest group to agree with every act of a Federal agency does not create a controversy, and NEPA does not require the courts to resolve disagreements among various scientists as to the methodology used by an agency to carry out its mission (*Marsh vs. Oregon Natural Resource Council*, 490 U.S. 360, 378 (1989)[6]). As was noted in the 1996 FONSI, "*The effects on the quality of the human environment are not highly controversial. Although there is some opposition to PDM, this action is not highly controversial in terms of size, nature, or effect*." If in fact a determination is made through this EA that the proposed action would have a significant environmental impact, then an EIS would be prepared.

2.3.11 Concerns that Killing Wildlife Represents "Irreparable Harm"

Public comments to prior versions of this EA have raised the concern that the killing of any wildlife represents irreparable harm. Although an individual predator or multiple predators in a specific area may be killed by WS-Colorado PDM activities, this does not in any way irreparably harm the continued existence of these species. Wildlife populations experience mortality from a variety of causes, including human harvest and depredation control, and have evolved reproductive capabilities to withstand considerable mortality by replacing individuals that are lost. Colorado's historic and current populations of big game animals, game birds, furbearers, and unprotected predators, which annually sustain harvests of thousands of animals as part of the existing human environment, are obvious testimony to the fact that the killing of wildlife does not cause irreparable harm. Populations of some of these species are in fact much higher today than they were several decades ago (*e.g*., elk and black bears), in spite of liberal hunting seasons and the killing of hundreds or thousands of these animals annually. The legislated mission of CPW is to preserve, protect, and perpetuate all the wildlife of the State. Therefore, CPW would be expected to regulate the killing of protected wildlife species in the State to avoid irreparable harm. Our analysis in Chapter 4 shows that the species WS-Colorado takes in PDM actions are expected to sustain viable populations. Thus, losses due to human-caused mortality are not "irreparable."

2.3.12 Global Climate Change/Greenhouse Gas Emissions

The State of the Climate in 2012 report indicates that since 1976, every year has been warmer than the long-term average (Blunden and Arndt 2013). Global surface temperatures in 2012 were among the top ten warmest years on record with the largest average temperature differences in the United States, Canada, southern Europe, western Russia and the Russian Far East (Osborne and Lindsey, 2013). Impacts of this change will vary throughout the United States, but some areas will experience air and water temperature increases, alterations in precipitation and increased severe weather events. The distribution and abundance of a plant or animal species is often dictated by temperature and precipitation. According to the EPA (2013), as temperatures continue to increase, the habitat ranges of many species are moving into northern latitudes and higher altitudes. Species adapted to cold climates may struggle to adjust to changing climate conditions (e.g., less snowfall, range expansions of other species).

APHIS recognizes that climate change is an ongoing concern and may result in changes in species range and abundance. Climate change is also anticipated to impact agricultural practices. The combination of these two factors over time is likely to lead to changes in the scope and nature of wildlife-human conflicts in the state. Because these types of changes are an ongoing process, the EA has developed a dynamic system including mitigations and standard operating procedures that allow the agencies to monitor for and adjust to impacts of ongoing changes in the affected

[6] Court cases not given in Literature Cited section.

environment. WS-Colorado would monitor activities conducted under this analysis in context of the issues analyzed in detail to determine if the need for action and associated impacts remain within parameters established and analyzed in this EA. WS-Colorado would supplement the analysis and/or modify program actions in accordance with applicable local, State and federal regulations including the NEPA if substantive changes in the potential environmental effects of program actions warranting revised analysis are identified. Established SOPs also include reporting all take to the USFWS and CPW and CDA annually as appropriate for review of project-specific and cumulative impacts on wildlife populations. Coordination with agencies that have management authority for the long-term wellbeing of native wildlife populations and review of available data on wildlife population size and population trends enables the program to check for adverse cumulative impacts on wildlife populations, including actions by WS-Colorado that could jeopardize the long-term viability of WS-Colorado actions on wildlife populations. Monitoring would include review of federally-listed T/E species and consultation with the USFWS, as appropriate, to avoid adverse impacts on T/E species. As with any changes in need for action, WS-Colorado would supplement the analysis and/or modify program actions in accordance with applicable local, State and federal regulations including the NEPA, as needed, to address substantive changes in wildlife populations and associated impacts of the PDM program. In this way, we believe the proposed action accounts for is responsive to ongoing changes in the cumulative impacts of actions conducted in Colorado in accordance with the NEPA.

The CEQ has advised federal agencies to consider whether analysis of the direct and indirect greenhouse gas (GHG) emissions from their proposed actions may provide meaningful information to decision makers and the public (CEQ 2014). Based on their review of the available science, CEQ advised agencies that if a proposed action would be reasonably anticipated to cause direct emissions of 25,000 metric tons or more of CO2-equivalent GHG emissions on an annual basis the agencies should consider that a quantitative and qualitative assessment may be meaningful to decision makers and the public (CEQ 2014). APHIS has assessed the potential GHG impacts from the national APHIS-WS program and current and proposed actions in context of this guidance.

The average person in a home produces four metric tons of carbon dioxide equivalents (CDEs includes CO2, NOx, CO and SOx) annually (EPA 2010). Nationwide, APHIS-WS has 170 district and State Offices and this includes district offices with only one staff person. Each State Office would likely produce fewer CDEs annually than the average home because little electricity is used at night and on weekends.

APHIS-WS vehicles are used for a multitude of wildlife management projects, including current Colorado PDM Program activities. APHIS-WS cannot predict the fuel efficiency of each all-terrain vehicle (ATV) used in the field nor can it predict how often an ATV would be used. However, if a conservative estimate of 20 miles per gallon is used and consideration is given to total mileage being substantially less than the mileage calculated for normal vehicular use, the effects of ATVs on air quality would be negligible. APHIS-WS also cannot predict the fuel efficiency of each vehicle in the national program. However, APHIS-WS used the Federal Highway Administration (FHWA) estimated average combined fuel economy of cars and light trucks of 21.5 miles per gallon (mpg) in the discussion of alternatives. To establish baseline data on the National WS program, WS calculated the CDEs from its current fleet of passenger vehicles (1,665 leased and owned vehicles) using the average vehicle miles traveled per year as calculated by FHWA (2010)[7]. APHIS used the ratio of CO_2 equivalents (CDEs) to total greenhouse gas emissions for passenger vehicles to complete the calculation.[8] Current APHIS vehicle use for all wildlife management programs can contribute approximately 8,058 metric tons (MT) of CDEs each year.[9]

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[7] 11,493 miles per vehicle per year

[8] 0.985

[9] (8.92 × 10-3 metric tons/gallon of gasoline) x (19,135,845 miles traveled by APHIS-WS) x (1/21.5 mpg) x (1/0.985)

Nationwide, APHIS-WS either owns or leases ten different types of helicopters; their average fuel consumption is 24.88 gallons per hour (gph). Helicopters with this average fuel consumption emit approximately 0.24 MT/hr of CO_2 emissions.[10] APHIS-WS also owns or leases six different types of aircraft. Nationwide, APHIS-WS flew 10,426 hours (helicopter and fixed wing combined) of agency-owned aircraft in FY 2013 and flew an additional 4,225 hours under contract aircraft. If all flight hours were attributed to fixed-wing planes, the estimated CO_2 emissions would be 1,612 MT/year. If all flight hours were attributed to helicopters, the estimated CO_2 emissions would be 3,516 MT/year. Combining vehicle, aircraft, office and ATV use for FY 2013 and potential new vehicle purchases, the range of CDEs is likely to be 10,350 – 12,254 MT or less per year, which is below the CEQ's suggested reference point of 25,000 MT/year.[11]

One commenter suggested that WS should consider greenhouse gas emissions associated with livestock production as part of the emissions associated with the WS program. We do not concur that these emissions should be attributed entirely or in part to WS activities. The existence of the WS program is not essential to the survival of the livestock production industry and factors other than WS have been identified as the primary drivers for trends in the livestock industry. In a comparison of parts of the country with differing levels of coyotes and coyote predation on livestock (Berger 2006) concluded that government support of the predation management had not prevented declines in the sheep industry and that production costs and market prices explained most of their model variations in sheep numbers. These findings are not surprising given that conflicts with predators are not spread out evenly among producers and that many producers have little or no issues with wildlife predation on their livestock. Additionally, livestock producers can and do take measures on their own to address predation on livestock without involvement of the WS program. Consequently, although WS actions are beneficial to individual producers, the size and extent of the livestock production industry as a whole is not dependent upon WS.

WS understands that climate change is an important. The WS program would continue to participate in ongoing federal efforts to reduce greenhouse gas emissions associated with program activities including compliance with Executive Order 1369 – planning for federal sustainability in the next decade. Given the information above, none of the alternatives proposed is anticipated to result in substantial changes that would impact national APHIS-WS greenhouse gas emissions. Consequently, WS-Colorado program activities likely to result from the proposed action would have a negligible effect on atmospheric conditions including the global climate.

CHAPTER 3: ALTERNATIVES

WS-Colorado's alternatives must encompass the varied and diverse needs of PDM and be applicable throughout Colorado. The varied nature and diversity of requests for PDM assistance requires WS-Colorado to be diverse, dynamic, and flexible. In previous EA's (WS 1997b, 1999a, 2005b), four alternatives were determined to be relevant by WS-Colorado, cooperating agencies, and the public for conducting PDM activities in Colorado: (1) continue the current Federal PDM program, the Proposed Action; (2) no Federal PDM program; (3) technical assistance only; and (4) lethal PDM for corrective control only. This EA will revisit these alternatives for consideration.

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[10] Conklin and deDecker Aviation Information (https://www.conklindd.com/CDALibrary/CO2Calc.aspx) fixed-wing aircraft. Average fuel consumption rates for fixed wing piston engine aircraft is 12.9 gph (FAA 2005). Average CO_2 emissions for piston engine aircraft are 0.11 MT/hr (Conklin and de Decker 2015). Less than one percent each of NOx, CO, SOx, and other trace components are emitted from aircraft engine emissions (FAA 2005).

[11] CEQ issued a memorandum to heads of federal agencies and departments on February 28, 2011, providing draft guidance on when and how to analyze the environmental impacts of greenhouse gas emissions and climate change under NEPA. A suggested 25,000 metric tons of carbon dioxide equivalent emissions from the proposed action would trigger the need for a quantitative analysis.

3.1 ALTERNATIVES ANALYZED IN DETAIL

3.1.1 Alternative 1 - Continue the Current Federal PDM Program (the "Proposed Alternative" and the "No Action Alternative")

The "No Action" alternative is a procedural NEPA requirement (40 CFR 1502.14(d)), and is a viable and reasonable alternative that could be selected. It serves as a baseline for comparison with the other alternatives and, as a result, receives an in-depth analysis. As defined by CEQ, the "No Action" alternative in this EA is to continue the current program as conducted under the current EA (WS 2005c).

Under the current program, the majority of predator damage incidents recorded by WS-Colorado, about 76%, come from livestock and other agricultural producers associated with both private and public lands. WS-Colorado also records incidents of predator damage to protect property, natural resources, and human health and safety. Since the publication of the prior EA (WS 2005c), we have seen a significant increase in requests for PDM assistance to protect human health and safety, which has decreased the percentage of agricultural damage incidents from 90% to 76%. Incidents of predator damage or threats to human health and safety now comprise almost 18% of total incidents. Much of this change reflects an increased focus nationwide on aviation safety. Whereas birds cause most wildlife-aircraft strike hazards, mammals, including predators, also pose such hazards, and this is reflected in the increased number of predator damage incidents recorded by WS-Colorado.

WS-Colorado provides PDM assistance to livestock and other resource owners within the fiscal constraints of the program. The current PDM program on private lands is governed by WS policy and specific private property agreements for each property, specifying methods to be used and species to be targeted. Whereas the majority of producers run livestock on private land, many of them graze their livestock on or adjacent to public lands for some portion of the year. These livestock can encounter depredation from predators that originate from public lands. As such, PDM is provided by WS-Colorado personnel on public, private, state, Tribal, and other lands, where agreements for PDM are in place.

Current program activities on federally-administered and owned lands (BLM and USFS) are defined specifically in WPs, and WS-Colorado follows all laws and regulations that have been determined to apply to PDM on these lands. WS-Colorado provides information on proposed PDM activities to the cooperating agencies (BLM and USFS). These agencies are responsible for reviewing proposed actions to assess their compatibility with established RMPs or LRMPs. It is the land management agency's responsibility to clearly show where a proposed action would likely conflict with land use plans. Maps are used to delineate areas where PDM restrictions or limitations are needed in order to avoid conflicts with other land uses. The WP and WS Decision Model (Slate *et al*. 1992) provide further site-specific planning mechanisms to evaluate and monitor PDM activities in each area.

3.1.1.1 Planned Control Areas. Planned control areas are areas where WS-Colorado is actively working or plans to work to limit predator damage. Planned activities are those which are anticipated to occur based on historical needs. However, PDM may or may not be conducted in these areas because needs vary from year to year and site to site. WS-Colorado cannot predict where losses will occur or where livestock will be grazed. PDM is most concentrated in areas where livestock are most abundant, and during times when they are most vulnerable to predators (*e.g.*, during calving and lambing). Requests for assistance in reducing property damage and threats to human health and safety are intermittent, and thus, even less predictable. The exception is threats to aviation safety, which are intermittent temporally, but well-defined spatially.

Wildlife Services has long-standing statewide programs to protect livestock from predation and occasionally is requested to conducted PDM projects to protect native

wildlife from predation. Livestock, especially sheep and cattle, are depredated by coyotes, black bears, mountain lions, golden and bald eagles, red foxes, bobcats, and feral or free ranging dogs. Smaller livestock, such as poultry and domestic waterfowl are reported to be depredated by swift fox, red fox, red-tailed hawks, skunks, raccoons, bobcats, black bears, and mountain lions. Less abundant livestock including alpacas, horses, and goats are depredated by coyotes, feral or wild dogs, mountain lions and black bears. Wildlife Services has been requested to protect threatened or endangered species (e.g. Gunnison sage grouse, black-footed ferret, piping plovers, least terns) from predation. Other wildlife species we have been requested to protect are species of management concern that are declining in abundance locally (e.g. mule deer). We have also been consulted about predation on other wildlife species in local situations due to mountain lion predation on big horn sheep and coyote and mountain lion predation on elk. Less frequently, Wildlife Service is requested to assist homeowners and local communities and governments when wild predators depredate companion animals or attack or threaten to attack people. We have become involved when coyotes, red fox or mountain lions kill pet dogs and cats. WS-Colorado has also become involved when wild carnivores, especially bears, lions and coyotes, have attacked or threatened humans.

WS-Colorado conducts PDM to protect livestock from predation statewide on public, private and tribal lands. For the federal fiscal years (FYs) 2010 to 2015 (FY 2011 = October 1, 2010 to September 30, 2011), WS-Colorado had agreements (Work Initiation Documents) in place to conduct livestock protection by managing predation on 4.958 million acres of land or 7.4% of the Colorado land area. Private land comprises 2.967 million acres or 60% of land where WS-Colorado conducts PDM for livestock protection. Other land types where PDM is conducted by WS-Colorado for livestock protection include 197,771 acres of state lands, 2,541 acres of tribal lands and 1.791 million acres of Bureau of Land Management or Forest Service lands. Colorado can be divided into three different regions based on the primary livestock protected, land types worked, and density and species diversity of predators (Table 12).

Table 12. Counties by regions of Colorado where predation management activities were conducted by WS-Colorado to protect livestock or wildlife species of management concern from predation during federal Fiscal Year 2010 – 2014.

West Slope		Northeast	Southeast	
Archuleta	Larimer	Arapahoe	Baca	Lincoln
Delta	Mesa	Cheyenne	Crowley	Otero
Dolores	Moffat	Elbert	Douglas	Prowers
Eagle	Montrose	Morgan	El Paso	Pueblo
Garfield	Ouray	Morgan	Fremont	Teller
Grand	Pitkin	Washington	Huerfano	
Gunnison	Rio Blanco	Weld	Kiowa	
Gunnison	Routt		Las Animas	
Hinsdale	San Juan			
Jackson	San Miguel			
La Plata				

3.1.1.1a West Slope. PDM for livestock protection on the West Slope primarily protects sheep from coyote, black bear and mountain lion predation. Sheep are primarily raised on range that requires moving every few days to new grass to graze. Additionally, some ranches raise cattle, goats, alpacas, horses and donkeys. An annual average of 9.2 staff years were spent by field employees reducing predation on livestock and wildlife species of management concern. Wildlife Services expends the greatest effort protecting livestock from January to May using aerial predator damage management to remove coyotes from grazing and lambing grounds on the West Slope. Corrective management action to

protect newborn lambs is most intensive during mid-April to early June. Management tools used by Wildlife Services for corrective management action includes aerial predator damage management, calling and shooting, decoy dogs to attract and shoot territorial coyote pairs, and trapping with foot hold traps, snares and M-44's[12]. Livestock producers use guard dogs, herders, range riding, habitat management (e.g., brush removal), husbandry and shooting to protect livestock during this period. After June, predation on livestock from coyotes generally declines due to removal of territorial coyote pairs around the lambing and grazing grounds, and coyotes switching to newly available deer fawns, rabbits and their young, rodents and other wildlife for food. While coyote predation on lambs and sheep declines, bear predation accelerates greatly during the summer on the West Slope. Lion predation on lambs and sheep occurs less often than bear or coyote predation. Bear and lion predation corrective action usually requires using hounds to track, tree or corner depredating animals. Shooting with night-vision is another common method to remove bears and lions killing livestock on the West Slope. Ranches or grazing allotments on the West Slope may be all private land, a mix of public and private land or all public land. Ranches and grazing allotments on the West Slope tend to be large, covering thousands or tens of thousands of acres due to the need to graze lands lightly to avoid excessive grazing. This form of livestock production keeps large tracts of habitat intact.

3.1.1.1b Southeastern Colorado. Livestock protection activities in southeastern Colorado primarily protect calves from coyote predation. An annual average of 1.2 staff years were spent by field employees reducing predation on livestock. Wildlife Services expends the greatest effort protecting cattle from February to May using aerial predator damage management to remove coyotes from calving grounds in southeastern Colorado. Also, there are several types of bird production operations raising domestic chickens, ducks, geese, ostriches and other small farm animals (e.g., rabbits) that are depredated by coyotes, red fox, bobcat and raccoons. Corrective management action to protect newborn calves is most intensive during March through April. Management tools used by Wildlife Services for corrective management action includes aerial predator damage management, calling and shooting, shooting, decoy dogs to attract and shoot territorial coyote pairs, and trapping with foot hold traps, snares and M-44's[1]. Livestock producers use guard dogs, range riding, grazing pastures with less predation, fencing and shooting to protect livestock during this period. Some smaller livestock producers can pen livestock at night to reduce predation. Bird and small animal production ranches generally using fencing, night penning, bringing animals in at night, cage traps, husbandry and shooting to manage predation by coyotes, foxes, bobcats and raccoons. Bear and lion predation on livestock is common in southeastern Colorado but less frequent than the West Slope. Ranches and grazing allotments in southeastern Colorado often are entirely private land. Some ranches or grazing allotments are a mix of private or public land. Public-land-only ranches or grazing allotments are uncommon. Ranches and grazing allotments in southeastern Colorado tend to be smaller, covering several hundred to several thousand acres. A few ranches are larger covering tens of thousands of acres, but these are uncommon.

3.1.1.1c Northeastern Colorado. Livestock protection activities in northeastern Colorado primarily protect calves from coyote predation. However, there is a mix of livestock raised in northeastern Colorado, including sheep on range or pasture, alpaca on pasture, and various livestock in feedlots. An annual average of 0.75 staff years were spent by field employees reducing predation on livestock. Wildlife Services expends the greatest effort protecting cattle and sheep from February to May using aerial predator damage management to remove

[12] Use of foot hold traps, snares and M-44's for livestock protection is limited to private land only.

coyotes from calving and lambing grounds in northeastern Colorado. Corrective management action to protect newborn calves and lambs is most intensive during March through April. Management tools used by Wildlife Services for corrective management action includes aerial predator damage management, calling and shooting, shooting, decoy dogs to attract territorial coyote pairs, and trapping with foot hold traps, snares and M-44's[1]. Livestock producers use guard dogs, range riding, grazing pastures with less predation, fencing, habitat management, husbandry and shooting to protect livestock during this period. Some smaller producers can pen livestock at night to reduce predation. Bear and lion predation on livestock is uncommon in northeastern Colorado, but it does occur. Ranches and grazing allotments in northeastern Colorado often are entirely private land. Some ranches or grazing allotments are a mix of private or public land. Public-land-only ranches or grazing allotments are much less common. Ranches and grazing allotments in northeastern Colorado tend to be smaller, covering several hundred to several thousand acres. There are also some small livestock producers raising a few animals for personal use or specialty markets (e.g., wool, food). There are a few ranches covering more than 10,000 acres, but these are uncommon.

3.1.1.1d Protecting Aquaculture Resources. Aquaculture also occurs in Colorado. Requests for assistance for predation on food fish are less common. However, WS-Colorado has been requested by producers to provide technical assistance on farm raised trout, catfish and other food fish. Predation on farm raised fish is generally from meso-carnivores or migratory birds.

3.1.1.1e Wildlife species generally involved in planned work. WS-Colorado works with, or could potentially work with, several species of wildlife that depredate livestock. The species that WS-Colorado could possibly encounter during PDM includes a few state managed mammals and a handful of migratory birds. These "possible" species include carnivorous and omnivorous predatory mammals (canids, felids, black bear, raccoon, mustelids, opossum, and feral dogs and cats) and a small number of birds (gulls and raptors). The abundance of PDM operations for many of these "possible" species to protect livestock or wildlife species of management concern varies widely. From FY2011 to FY2015, WS-Colorado conducted PDM activities (direct control and technical assistance) involving 11 different predatory species: coyote, black bear, mountain lions, red fox, swift fox, striped skunk, raven, feral cat, crow, badger, raccoon and bobcat.

3.1.1.1f Methods used to abate predation on livestock and other agricultural animals. Livestock producers implement most non-lethal methods and a few lethal methods to protect their livestock or farm raised fish. WS-Colorado is often requested to abate predation when specialized skills are required or legal limitations exist. Whereas WS-Colorado uses non-lethal methods where appropriate or for demonstration, we often implement lethal methods to abate predation where producers are unable to resolve, special skills are required or legal restraints limit methods producers may use. There are a number of methods used to capture or kill predatory species depredating livestock. These methods are explained later in this chapter.

3.1.1.1g Protecting Wildlife from Predation. PDM to protect wildlife species of management concern or threatened or endangered legal status involves several species of predators in Colorado, but especially coyote, black bear and red fox. Predator damage management activities are for the protection of livestock and some wildlife (e.g., mule deer, Gunnison's sage grouse, black-footed ferret, piping

plover, least tern) in Colorado. Requests to protect wildlife species of management concern are less frequent and may not occur every year.

3.1.1.1h Protect human safety and life from predation. Infrequently predatory wildlife species attack, injury or threaten people. Most wildlife-people interactions that threaten human safety occur in spring and summer. Sometimes these attacks are predicated on other people feeding wildlife resulting in unnaturally high numbers of wild animals in close proximity to people and the wild animals have not fear of people. These dangerous situations happen most often with black bears. Other wildlife species that attack, injure or threaten people are coyotes and mountain lions. Less frequently, these threats to human safety involve red fox or raccoon, often because someone conditioned these animals by feeding anthropogenic food. WS-Colorado works closely with CPW to alleviate these threats. The State of Colorado has developed policies and procedures to address wildlife threats to people and how the threat will be resolved. WS-Colorado follows these policies and procedures.

3.1.1.2 Unplanned/Emergency Control Areas. Unplanned and emergency PDM may be provided in areas where no PDM is scheduled with the exception of areas designated as restricted. The restricted zones are identified by WS, cooperators, or cooperating agencies. These may be specific named areas (*e.g.*, Trailhead X or Campground Y), or generic areas denoted on WP maps (*e.g.*, using a color scheme). In either case, these areas are avoided during WS-Colorado PDM activities. Where unanticipated local damage problems arise which threaten human health and safety or property, WS-Colorado may take immediate action to eliminate or curtail the problem, provided the proposed control area is not located within a designated restricted activity zone. Emergency PDM activities are handled on a case-by-case basis, as the need arises. WS-Colorado notifies the cooperating agency as soon as practicable after the emergency action commences or the work is performed.

3.1.1.3 IWDM. WS has been conducting WDM in the United States for more than 100 years. Over these years, WS has modified WDM activities to reflect societal values and minimize impacts to people, wildlife, and the environment. Such changes have involved research and development of new field methods, and the implementation of effective strategies to resolve wildlife damage. The most effective approach to resolving wildlife damage is to integrate the use of several methods simultaneously or sequentially. Integrated wildlife damage management (IWDM) is the implementation and application of safe and practical methods for the prevention and control of damage caused by wildlife, based on local problem analysis, and the informed judgment of trained personnel. IWDM is applied by WS Specialists and WS Biologists (WS Directive 2.105) to reduce damage through the WS Decision Model (Slate *et al.* 1992).

The philosophy behind IWDM is to implement effective management techniques in a cost-effective manner while minimizing potentially harmful effects on humans, wildlife (target and nontarget), and the environment. IWDM draws from the largest possible array of options to create a combination of techniques appropriate for the specific circumstances. IWDM may incorporate cultural practices (*e.g.*, animal husbandry), habitat modification, animal behavior (*e.g.*, harassment and frightening devices), local population reduction, or any combination of these, depending on the characteristics of the specific damage problem. Consideration is given to the following factors before selecting or recommending control methods and techniques:

- Species responsible for damage
- Magnitude, geographic extent, frequency, and duration of the problem
- Status of target and nontarget species, including T&E species
- Local environmental conditions
- Potential biological, physical, economic, and social impacts

- Potential legal restrictions
- Costs of control options
- Prevention of future damage

Within the scope of IWDM methods, WS personnel may provide technical assistance and/or operational damage management. Technical assistance includes demonstrations on the proper use of some management devices; information on animal husbandry, wildlife habits, habitat management, and animal behavior modification; and advice on available PDM techniques. Technical assistance may be provided following an on-site visit or verbal consultation with the requestor. Generally, several management strategies are described to the requestor for short- and long-term solutions to damage problems. Technical assistance does not constitute a direct federal action; it is simply advice on methods that could be used by resource owners to resolve a problem.

Operational damage management assistance is implemented when the problem cannot be resolved through technical assistance. The initial investigation defines the nature and history of the problem, extent of damage, and the species responsible for the damage. The professional skills of WS personnel are often required to resolve problems effectively, especially if the use of restricted pesticides is warranted or if the problem is complex. WS considers the biology and behavior of the damaging species and other factors using the WS Decision Model (Slate *et al.* 1992). The recommended strategies may include any combination of preventive and corrective actions that could be implemented by the requester, WS, or other agency personnel, as appropriate.

3.1.1.4 Preventive Damage Management. Preventive damage management is the application of PDM strategies before damage occurs, often based on historical problems and data. Most nonlethal methodologies, whether applied by WS-Colorado or resource owners, are preventive. For example, fencing is often used to exclude predators from livestock pastures in order to prevent damage from occurring. Unfortunately, most nonlethal PDM techniques are only effective for a short time before wildlife habituate to them (Pfeifer and Goos 1982, Conover 1982) and are generally only practical for small areas (Arhart 1972, Rossbach 1975, Shirota *et al.* 1983, Schmidt and Johnson 1984, Mott 1985, Dolbeer *et al.* 1986, Graves and Andelt 1987, Tobin *et al.* 1988, Bomford 1990). When requested, WS-Colorado personnel may provide technical assistance and/or operational damage management in order to prevent losses from occurring. For example, in areas where substantial lamb or calf depredations have historically occurred on lambing or calving grounds, WS-Colorado may provide information about livestock guarding animals, fencing or other husbandry techniques, or if appropriate, conduct lethal PDM before lambing or calving begins. The rationale for conducting preventive damage management is similar in principle to holding controlled hunts for deer or elk in areas where agricultural damage has been a historical problem. By reducing the number of deer near agricultural fields, or the number of coyotes near a herd of sheep or before sheep begin grazing in an area, the likelihood of damage can be reduced (Wagner 1997).

3.1.1.5 Corrective Damage Management. Corrective damage management is the application of PDM to stop or reduce current losses. As requested and appropriate, WS-Colorado personnel in Colorado may provide technical assistance and/or operational damage management to prevent additional losses. For example, in areas where verified and documented lamb depredations are occurring, WS-Colorado may provide information about livestock guarding animals, fencing or husbandry techniques, or conduct operational damage management to stop the losses.

3.1.1.6 Research to abate loss to livestock or natural resources. Research is conducted by federal and state wildlife agencies and universities to identify solutions to wildlife damage to valued resources. Valued resources could be livestock, pets, people or wildlife species of management concern, such as threatened or endangered species.

Sometimes species of management concern are species that are now common (e.g., mule deer, greater sage grouse) but population trend data show declines that could be indicators of future concerns. Research may focus on causes of population decline and try to determine if a species is declining due to predation, habitat, nutrition, weather, human disturbance, fire, or other effects. Research may be funded by WS, CPW, a university or other entity.

3.1.1.7 Methods Available for Use. A wide range of methods is used by WS-Colorado personnel in PDM, and strategies are based on applied IWDM principles as described above. These methods can be classified into three general strategies: resource management, physical exclusion, and wildlife management. Within each strategy, specific methods or tactics are available for PDM, including many which are specific to particular species. Below is a list of methods considered by WS-Colorado for PDM.

Resource Management
- Habitat Management
- Animal Husbandry Techniques
- Guard Animals
- Modification of Human Behavior

Physical Exclusion
- Fencing
- Netting

Wildlife Management
- Frightening Devices
- Chemical Repellents
- Capture Methods (lethal and nonlethal)
- Immobilization/Euthanasia
- Chemical Medications
- Chemical Toxicants

Technical assistance is most often provided by WS-Colorado for the use of resource management and physical exclusion methods, and potentially a few wildlife management techniques such as harassment and cage traps. This may require on-site instruction on the use of some PDM techniques (for example harassment techniques). WS-Colorado operational damage management efforts can include any of the PDM methods, but primarily involve site-specific, “hands-on” wildlife management techniques which are difficult for much of the public to implement, or involve safety concerns when being implemented by the public. Some techniques suggested for use by resource owners, or by other entities or individuals, may not be considered by WS-Colorado if they are biologically unsound, legally questionable, or ineffective.

3.1.1.7a Resource Management. Resource management practices are appropriate when the potential for depredation can be reduced without significantly increasing the cost of production, or diminishing the ability to achieve land management and production goals. Many of these techniques can require the producer to devote significant time and initial expense towards implementing, but can be very effective (Knowlton *et al*. 1999, Conover 2002, Mitchell *et al*. 2004). Changes in resource management are usually implemented by producers, but WS-Colorado may also be involved. WS-Colorado has the potential for using the following resource management techniques in PDM.

<u>Habitat Management</u>. Localized habitat management is often an integral part of PDM. The type, quality, and quantity of habitat are directly related to the wildlife produced or attracted to an area. Habitat can be managed to not produce or attract certain wildlife species. Habitat management includes the elimination of cover used by particular predators at specific sites. Limitations of habitat management as a method of reducing predator

damage are determined by the characteristics of the species involved, the nature of the damage, economic feasibility, and other factors. Legal constraints may also exist which preclude altering particular habitats. Most habitat management recommended by WS-Colorado in PDM is aimed at reducing wildlife aircraft strike hazards at airports (*e.g.*, managing brush and grass cover at airports to reduce field rodent populations which are a prey-base attractant), or reducing cover for predators near lambing or calving pens and grounds to reduce predation. The latter is particularly important in PDM because predators are more likely to be successful if the area is conducive to ambush, or allows the predator to approach prey under the cover of dense brush. Removal or thinning of the brush can discourage predator activity as well as predator success (*i.e.*, depredation losses). Also, opening the area allows for better monitoring of livestock, and increases the efficacy of shooting (discussed later). WS-Colorado generally does not modify habitats nor recommend any sort of habitat modifications where T&E species are known or thought to occur.

Animal Husbandry Techniques. This general category includes modifications in the level of care and attention given to livestock, shifts in the timing of breeding and births, selection of less vulnerable livestock species to be produced, and the introduction of human custodians (herders) to protect livestock. The level of care or attention given to livestock may range from daily to seasonal. Generally, as the frequency and intensity of livestock handling increase, so does the degree of protection (Robel *et al*. 1981). In operations where livestock are left unattended for extended periods, the risk of depredation is greatest. The risk of depredation can be reduced when operations permit nightly gathering, so that livestock are unavailable during the hours when predators are most active. It also possible to reduce predation of sheep by concentrating sheep in smaller areas (Sacks and Neale 2002). Additionally, the risk of depredation is usually greatest with immature livestock. This risk diminishes as age and size increase, and can be minimized by holding expectant females in pens or sheds to protect births and by holding newborn livestock in pens for the first 2 weeks. Shifts in breeding schedules can also reduce the risk of depredation by altering the timing of births to coincide with the greatest availability of natural prey, or to avoid seasonal concentrations of predators. The use of herders can also provide some protection from predators, especially those herders accompanying bands of sheep on open range where they are highly susceptible to predation.

Range riding is a technique for livestock producers to monitor their herds of livestock, especially on open range. The technique also provides additional information about wildlife, predators and non-predators, in the area and the herd. While the effectiveness of the technique to reduce predation through human presence is unproven (Parks and Messmer 2016), some producers believe the intangible benefits justify the effort and cost. Some producers or their herders in Colorado use horses or ATVs to ride the range and large pastures to monitor livestock, detect predators and monitor livestock use of forage to make more informed decisions when to move livestock to new grazing areas.

Every year livestock producers consider where predation occurred in the past and where predation is currently occurring to plan where to lamb, calve, graze or bed their animals. This technique of managing livestock activities is referred to as “risk mapping” (Treves et al. 2011). The

purpose is to avoid hazards, such as predation that is likely to occur as some locations due to habitat or known animal presence. Examples of known animal presence is locations where elk are calving or mule deer are fawning which are likely to attract black bears that depredate elk calves and deer fawns. If would be prudent in these instances to avoid known calving and fawning areas. Likewise, bedding livestock near thick heavy brush provides cover for bears, mountain lions and coyotes that could more easily sneak up and attack bedded or sleeping livestock killing them. Risk mapping is a standard technique used by all producers and herders that is designed to reduce risk, but it does not stop predation.

Predators can also be opportunistic in scavenging carcasses to obtain nutrition. During some times of the year when natural food supplies are low and predator energy needs are high some predators (e.g., coyotes, black bears, red fox) will search livestock production areas for carcasses. It would be prudent to remove food resources, such as dead livestock, when possible to avoid attracting predators. Also, these food resources provide nutrition that would support local predators who would breed increasing potential future livestock predators. Caracass removal would aid in reducing predator attractants and food supplies that would support local predators.

Guard Animals. Guard animals are used in PDM to protect a variety of resources, primarily livestock, and can provide adequate protection at times. Guard animals (*e.g.*, dogs, burros, and llamas) have proven successful in many sheep and goat operations. The effectiveness of guarding animals may not be sufficient in areas where there is a high predator density, where the resource (sheep foraging on open range) is widely scattered, or where the guard animal-to-resource ratios are less than recommended. In addition, some guard animals intended for protection against small to medium size predators like coyotes may be prey to larger predators like mountain lions and black bears. WS-Colorado often recommends the use of guard dogs, but does not have an operational guard dog program.

Modification of Human Behavior. WS-Colorado often tries to alter human behavior to resolve potential conflicts between humans and wildlife. For example, WS-Colorado may talk with residents of an area to eliminate the feeding of wildlife that occurs in parks, recreational sites, or residential areas to reduce damage by certain predators such as coyotes and bears. This includes inadvertent feeding due to improper disposal of garbage, or leaving pet food outdoors where wildlife can feed on it. Many wildlife species adapt well to human settlements and activities, but their proximity to humans may result in damage to structures or threats to public health and safety. Eliminating wildlife feeding and handling can reduce potential problems. However, many people who are not directly affected by problems caused by wildlife enjoy wild animals and engage in activities that encourage their presence.

Another example of human behavior modification is providing educational information to people with exaggerated fears of predators. WS-Colorado receives calls about species such as large carnivores which are not causing damage. Their mere presence is perceived as a threat to the callers even though the animal is in its natural habitat. WS-Colorado personnel provide educational information and reassurance about these species.

3.1.1.7b Physical Exclusion. Physical exclusion methods restrict the access of wildlife to resources. These methods can provide effective prevention of wildlife damage in many situations.

Fencing. Fences are widely used to prevent damage from predators. Exclusionary fences constructed of woven wire or multiple strands of electrified wire can be effective in keeping predators from some areas such as an airport. The size of the wire grid and height of the fence must be able to keep the predators out. In addition, an underground apron about 2 feet below ground and 2 feet out (*i.e.*, fencing in the shape of an "L" going outward) makes a fence more predator-resistant. The underground apron keeps out burrowing predators which might otherwise dig crawl holes under the fence. But fencing has limitations. Even an electrified fence is not always wildlife-proof, and the expense of the fencing can often exceed the benefit. In addition, if large areas are fenced, any wildlife being excluded must then be removed from the enclosure. Some fences inadvertently trap, catch, or affect the movement of nontarget wildlife and may not be practical or legal in some areas (*e.g.*, restricting access to public land, or interfering with wildlife migration).

Netting. Netting consists of placing wire nets (*e.g.*, chicken wire) or heavy duty plastic, around or over high value resources likely to be damaged. Netting is typically used to protect areas such as livestock pens, fish ponds and raceways, and structures. Complete enclosure of ponds and raceways to exclude all predatory wildlife such as minks and raccoons typically requires wire mesh secured to frames or supported by overhead wires. Gates and other openings must also be covered. Complete enclosure of areas with netting can be very effective at reducing damage by excluding all problem species, but can be costly.

3.1.1.7c Wildlife Management. This strategy includes altering target predator behavior, removing specific individuals from the population, reducing local population densities, or extirpating exotic species populations. Some specific techniques used or recommended by WS-Colorado are discussed below.

Frightening Devices. Frightening devices are used to repel predators from an area where they are a damage risk (*e.g.*, airport, livestock bedding areas). The success of frightening methods depends on an animal's fear of, and subsequent aversion to, offensive stimuli (Shivik and Martin 2001). A persistent effort is usually required to effectively apply frightening techniques, and the techniques must be sufficiently varied to prolong their effectiveness. Over time, animals often habituate to commonly used scare tactics and ignore them (Dolbeer *et al*. 1986, Graves and Andelt 1987, Bomford 1990). In addition, animals frightened from one location may become a problem at another. Scaring devices, for the most part, are directed at specific target species and operated by private individuals or WS-Colorado Specialists working in the field. However, several of these devices, such as scarecrows and propane exploders, can be automated.

Harassment and other methods to frighten animals are probably the oldest methods of combating wildlife damage (*e.g.*, scarecrows). These devices may be either auditory or visual, and provide short-term relief from damage. A number of sophisticated techniques have been developed to scare or harass wildlife from an area, but simple auditory devices (electronic distress sounds, alarm calls, propane cannons, and pyrotechnics) are the most popular. Other methods include harassment

with visual stimuli (*e.g.*, flashing and/or bright lights, scarecrows, human effigies, balloons, mylar tape, and wind socks), vehicles, or people. Some methods such as the Electronic Guard use a combination of stimuli (siren and strobe light). These are used to frighten predators from the immediate vicinity of the damage-prone area. As with other PDM efforts, these techniques tend to be more effective when used collectively in a varied regime rather than individually. However, the continued success of these methods frequently requires reinforcement by limited shooting (discussed below).

Other frightening methods in use are rubber bullets and "bean bags" that are shot from shotguns. Rubber bullets and bean bags do not kill or pass through an animal, but are intended to hurt them enough to change their behavior. Rubber bullets and bean bags have been used mostly for nuisance predators (*e.g.*, "garbage can bears"). When a predator learns to associate raiding a garbage can or other nuisance activities with the sting of being shot, they may learn to avoid that activity in the future. Rubber bullets or bean bags are used target-specifically.

Chemical Repellents. Chemical repellents are nonlethal chemical formulations used to discourage or disrupt particular wildlife behaviors. Chemical repellents are categorized by their delivery mechanism: olfactory, taste, and tactile. Olfactory repellents must be inhaled to be effective. These are normally gases, or volatile liquids and granules, and require application to areas or surfaces to be protected. Taste repellents are compounds (*e.g.*, liquids, dusts, granules) that are normally applied to trees, shrubs, and other materials which are likely to be eaten or gnawed by the target species. Tactile repellents are normally thick, liquid-based substances which are applied to areas or surfaces to discourage travel of wildlife by causing irritation such as to the feet. Most chemical repellents are nontoxic to target species, nontargets, and the environment. However, most repellents are ineffective or are short-lived in reducing or eliminating damage caused by wildlife. These are infrequently used by WS-Colorado. The only repellents available for predators are unrestricted chemicals such as tobacco dust (*e.g.*, F&B Rabbit and Dog Chaser®) and capsaicin from hot pepper (*e.g.*, Hot Sauce®, Miller®) which are sold over-the-counter to the general public to repel dogs and cats from areas where they are not wanted (*e.g.*, flower beds, gardens). WS-Colorado did not used any repellents in PDM during FY10-14, and does not anticipate their use in the future.

Capture or Take Methods. Several methods are available to capture or take offending predators. The suitability and efficacy of any technique will depend on a variety of factors. Capture/take methods used or recommended by WS-Colorado include foot-hold traps, quick-kill traps, cage traps, net-guns, snares, catch-poles, denning, shooting, and aerial predator management. These are discussed below.

> Foot-hold Traps are versatile and used by WS-Colorado for capturing many predator species on private lands. Traps placed in the travel lanes of the target animal, using the animal's movement patterns to determine trap placement rather than attractants, are known as *"blind sets."* More frequently, traps are placed as *"baited"* or *"scented"* sets. These trap sets use an attractant consisting of visual attractants (*e.g.*, feathers) or olfactory attractants (*e.g.*, fetid meat, urine, or musk) to attract the animal. In some situations a "draw station," such as a carcass, animal

parts, or a large piece of meat, is used to attract target predators. In this approach, one to several traps are placed in the vicinity of the draw station. In order to protect scavenging birds, including eagles, WS program policy prohibits the placement of traps closer than 30 feet to a draw station or visible bait, with the exception of traps placed for bears, mountain lions, or raptors (bear and lion sets are selective for large heavy animals, and raptor sets are specifically intended to capture these birds). Advantages of the foot-hold trap are: (1) they can be set under a wide variety of conditions; (2) some targets can be translocated after capture; (3) nontarget captures can usually be released; (4) trap placement and bait selection can minimize nontarget take; (5) animals much larger than the target species can usually pull themselves free from smaller foot-hold traps without injury; and (6) pan-tension devices can reduce the probability of capturing nontarget animals smaller than the target species (Turkowski *et al*. 1984, Phillips and Gruver 1996). In accordance with WS policy, WS-Colorado foot-hold traps use pan-tension devices, and have padded jaws to reduce injury. Disadvantages of using foot-hold traps include difficulty keeping them in operation during rain, snow, or freezing weather, and a lack of selectivity where nontarget species are of a similar or slightly heavier weight. The use of foot-hold traps also requires more time and labor than some other methods. But overall, they are indispensable in resolving many depredation problems.

Before foot-hold traps are employed, their limitations must be considered. Amendment 14 to the Colorado Constitution limits the use of use foot-hold traps. Under this Amendment, foot-hold traps can be used only on private lands, and only with a 30 day exemption authorized by CPW. Only one such exemption per parcel of land may be claimed in a calendar year. The use of foot-hold traps is prohibited on public lands. Another limitation to foot-hold traps is the possibility of injury to target and nontarget animals. Also, livestock and nontarget animals may be captured even with pan-tension devices, selective trap placement, and selective baiting. Furthermore, weather, and the skill of the user often determines the success or failure of the foot-hold trap in preventing or stopping wildlife damage. Target predators can also become “trap-wise”; they learn to detect and avoid or subvert foot-hold traps. Trap-wise predators are very difficult to capture, and generally require the use of a different technique. This is a good example of the importance of an IWDM approach. Finally, foot-hold traps may affect a few T&E species in Colorado which could be captured unintentionally. As such, WS-Colorado takes several measures to minimize the amount and severity of such take. These include: (1) pan-tension devices, (2) daily trap checks, (3) padded jaws, and (4) selective use of attractants (*e.g.*, baits made with fish oil, anise oil, catnip, and fresh meat, or visual attractants such as pieces of fur, feathers, shiny metal, or fabric are generally attractive to bobcats). Also, the known or likely presence of such T&E species in an area is generally a contraindication for the use of foot-hold traps by WS-Colorado.

Quick-Kill Traps come in a wide variety of styles and sizes; the most common are Conibears®. The Conibear® consists of a pair of rectangular wire frames that close like scissors when triggered,

killing the captured animal with a quick body blow. Such quick-kill traps have the added features of being lightweight and easily set. However, quick-kill traps, depending on where they are placed, could impact nontarget species. Furthermore, Amendment 14 to the Colorado Constitution, and subsequent interpretations passed in Colorado SB 97-052, prohibit the use of quick-kill traps on public land, and restricts their use on private land. These traps are rarely used by WS-Colorado in PDM, but may occasionally be used for smaller predators, such as mink. WS policy prohibits the use of quick-kill traps with a jaw spread exceeding 8 inches (*e.g.*, 330 Conibears®) for land sets.

Cage Traps come in a variety of styles and sizes which target different species. The most commonly known cage traps used in the current WS-Colorado program are box traps. Box traps are usually cuboid, and made with wood or heavy gauge wire mesh. These traps are used to capture animals alive and can be used where many lethal or more dangerous tools would be too hazardous. For example, box traps are well suited for use in residential areas. Cage traps usually work best when baited with foods attractive to the target animal. They are used to capture animals ranging in size from mice to deer, but are better suited for smaller animals. However, large cage traps do work well for capturing bears and suburban mountain lions, provided the traps can be transported by vehicle to the damage sites. Cage traps are mostly ineffective for coyotes.

Cage traps have a few drawbacks. Some individual target animals avoid cage traps. Some nontarget animals become “trap happy” and purposely get captured in order to eat the bait, making the trap unavailable to catch target animals. These behaviors can make a cage trap less effective. Cage traps must be checked frequently to ensure that captured animals are not subjected to extreme environmental conditions; an animal may die quickly if the cage trap is placed in direct summertime sunlight. Another potential problem with the use of cage traps is that some animals will become injured while fighting to escape. However, most nontarget species can be released un-harmed.

Net Guns of various sizes have occasionally been used by WS to catch target predators from aircraft or on the ground. These shoot from a “rifle with prongs,” go about 20 yards, and wrap around the target animal. This technique is mostly used in research to capture animals which will be sampled or equipped with radio-telemetry devices. These might also be used to capture species such as wolves or lynx for management purposes (*e.g.*, re-introduction or returning them to appropriate habitat) with an applicable permit.

Snares made of wire or cable are among the oldest existing PDM tools. They can be used effectively to catch most species, but are most frequently used to capture coyotes, fox, mountain lions and bears. They are much lighter and easier to use than foot-hold traps and are not generally affected by inclement weather. Neck-snares, commonly referred to simply as “snares”, can be effectively used wherever a target animal moves through a restricted lane of travel (*e.g.*, “crawls” under fences, trails through vegetation, or den

entrances). When an animal moves forward into the loop formed by the cable, the loop tightens and the animal is held. Neck-snares may be employed as either lethal or live-capture devices depending on how or where they are set. Neck-snares are usually lethal, but “stops” (devices to keep the snare loop from tightening to the extent that it would kill the animal) can be attached to the cable to make the snare a live-capture device.

The foot- or leg-snare is a spring-powered nonlethal device, activated when an animal places its foot on the trigger. Foot-snares can used effectively to capture large predators such as mountain lions and black bears. Additionally, several foot-snare designs have been developed to capture smaller predators such as coyotes and bobcats.

Snares can incorporate a breakaway feature to release nontarget wildlife and livestock if the target animal is significantly smaller than these potential nontargets (Phillips 1996). The size and placement of the snare can afford some species-selectivity, but they are generally not considered to be species-specific. As such, snares should be set in locations where the likelihood of capturing nontarget animals is minimized. In some situations, using snares to capture wildlife is impractical due to the behavior or morphology of the animal, or characteristics of the particular location of the wildlife damage situation. With the passage of Amendment 14 to the Colorado Constitution, and subsequent interpretations passed in Colorado SB 97-052, the use of snares has been prohibited on public land, and restricted to limited situations on private land.

Catch-poles can be used to capture an animal by hand (typically diseased, injured, or entrapped animals) or safely handle predators to remove them from traps. The device consists of a hollow pipe with an internal cable or rope that forms an adjustable noose at one end. The free end of the cable or rope extends through a locking mechanism on the end opposite the noose. By pulling on the free end of the cable or rope, the size of the noose is reduced sufficiently to hold an animal. WS-Colorado uses catch poles infrequently, primarily to remove live animals from traps without danger to or from the captured animal.

Denning is the practice of seeking out and excavating the dens of depredating coyotes or red fox, and destroying the young, adults, or both in order to stop or prevent livestock depredation. The use of denning is fairly limited, because dens are often difficult to locate, and den use by the target animal is restricted to 2 to 3 months during the spring. But denning can be very effective, because coyote depredations on livestock and poultry often increase in the spring and early summer due to the increased food requirements or raising pups (Till and Knowlton 1983, Till 1982, Till 1992). The removal of pups often stops depredations, even if the adults are not taken. Another common use of denning is to euthanize the pups after the adults have been taken near a den site. Such young pups would otherwise starve. Using this method, pups are either removed from dens and then shot in the head, or, more commonly, killed in the den with a carbon monoxide-producing fumigant (discussed below under chemical methods).

Den hunting for adult coyotes and their young is often combined with calling and shooting and aerial predator management. Denning is labor intensive with no guarantee of finding the den of the target animal. Denning is very target-specific and is most often used in open terrain where dens are comparatively easy to find.

Shooting is conducted with rifles, shotguns, and air guns, and is very selective for the target species. Shooting is limited to locations where it is legal and safe to discharge firearms. Shooting is rarely used as the sole PDM method in a control operation because opportunities to shoot target animals are random and unpredictable. This is especially problematic for nocturnal species. However, shooting is frequently performed in conjunction with calling, particularly for coyotes, bobcats, and red fox. Vocal calls, handheld mouth-blown calls, and electronic calls can be used to mimic target species (*e.g.*, coyote howls or raccoons fighting) or prey species (*e.g.*, injured jackrabbit or chicken) vocalizations. Trap-wise coyotes are often vulnerable to calling. Target animals are often called into close range by the WS Specialist which makes shooting much more effective. Shooting may also be used in conjunction with hunting dogs as described below.

Shooting in conjunction with night vision equipment is sometimes used in areas where traditional methods are unsuccessful or where chronic livestock depredation occurs. Most livestock predators are nocturnal and are easier to take at night. This method is especially effective in high-daytime-use public areas, where many PDM methods would be unsafe during daylight hours.

Lethal reinforcement through shooting is often necessary for successful frightening programs (see the discussion on Frightening Devices above), though this is most often used for flocking birds as opposed to predators.

Aerial Predator Management is the shooting of target animals from an aircraft, typically using a shotgun. This method is commonly used for coyote and red fox damage management on all land classes where authorized and deemed appropriate. It is especially effective in removing offending coyotes which have become trap-wise, and/or are not susceptible to calling and shooting. Local depredation problems (particularly lamb and calf depredation by coyotes) can often be resolved quickly through aerial predator management. Aerial predator management is species-specific and can be used for immediate damage relief if weather, terrain, and cover conditions are favorable. This method may be used to target specific offending predators in order to reduce or stop damage, or to temporarily reduce local coyote or fox populations in lambing and calving areas with a history of predation. Aircraft may also be used to search for predator dens.

Cain *et al.* (1972) rated aerial predator management as *"very good"* in safety, efficacy in solving depredation, and lack of adverse environmental impacts. Connolly and O'Gara (1987) documented the efficacy of aerial predator management in taking confirmed sheep-killing coyotes. Wagner (1997) found that aerial

predator management may be an especially appropriate tool as it reduces risks to nontarget animals and minimizes contact between damage management operations and recreationists. Wagner (1997) also found that aerial predator management 3 to 6 months prior to sheep-grazing was cost-effective when compared with areas without aerial predator management.

Aerial predator management is generally conducted during winter and early spring because it is safest and most effective. Safe and effective aerial predator management requires good visibility, and relatively clear and stable weather. Warm conditions limit the effectiveness of aerial predator management because heat reduces coyote activity, and visibility is greatly hampered by vegetative ground cover. High air temperature also influences air density, which hinders low-level flight safety. Additionally, because aerial predator management is often used to protect lambing and calving grounds, predator removal just prior to this timeframe is generally most effective.

Fixed-wing aircraft are useful over flat and gently rolling terrain. However, due to their maneuverability, helicopters have greater utility and are more effective over brush covered ground, timbered areas, steep terrain, or broken land, where animals are more difficult to spot. In broken timber or deciduous ground cover, aerial predator management is more effective in winter when snow cover improves visibility or in early spring before the leaves emerge. Aerial predator management is most effective when ground support crews can direct aircraft by radio to the general location of animals which have been located by eliciting coyote howls using sirens, calls, or recorded coyote howls. WS aircraft guidelines have been implemented to ensure that aerial predator management programs are conducted in a safe and environmentally sound manner, and in accordance with all Federal and State laws. Pilots and aircraft must be certified under established WS program procedures. Only properly trained and certified WS employees are approved as aerial predator management crew members. Aerial predator management is generally perceived by the public as being more desirable than poisons, because it is selective and results in quick death. However, there is an inherent risk to aerial predator management crews. Aerial predator management has a negligible effect on the environment.

Hunting Dogs are frequently used in PDM to locate, pursue, or decoy target animals. WS uses trailing/tracking, decoy, and trap-line companion dogs. Training and maintaining suitable dogs requires considerable skill, effort, and expense. There must be sufficient PDM requests for dogs in order to make the effort of training worthwhile.

Tracking Dogs or trailing dogs are commonly used to track and “tree” target wildlife species such as black bears, mountain lions, bobcats, and raccoons. Though not as common, they sometimes are trained to track coyotes (Rowley and Rowley 1987, Coolahan 1990). Dogs commonly used are different breeds of hounds such as blue tick, red-bone, and Walker. They become familiar with the scent of the animal they are to track and follow, and the dogs

strike (howl) when they detect the scent. Tracking dogs are trained not to follow the scent of nontarget species. WS Specialists typically find the track of the target species at fresh kills or drive through the area of a kill site until the dogs strike. WS Specialists then put their dogs on the tracks of the predator. If the track is not too old, the dogs can follow the trail and "tree" the animal. The animal usually seeks refuge up a tree, in a thicket on the ground, on rocks or a cliff, or in a hole. The dogs stay with the animal until the WS Specialist arrives and dispatches, chemically immobilizes, or releases the animal, depending on the situation. A possibility exists that dogs could switch to a fresher trail of a nontarget species while pursuing the target species. This can occur with any animal that they have been trained to follow, and can also occur with an animal that is similar to the target species. For example, dogs on the trail of a bobcat could switch to a lynx, if they cross a fresher lynx track. As such, tracking dogs could potentially have an impact on nontarget species, including T&E species, but this risk can be minimized greatly by WS Specialists looking at the track prior to releasing the hounds, and calling the dogs off a track if it is determined that they have switched tracks. Inadvertently treeing a nontarget animal can cause stress in the animal, but it is non-lethal, and generally causes no direct long-term harm.

Decoy Dogs are frequently used in coyote damage management in conjunction with calling. Dogs are trained to locate, lightly engage, and lure coyotes into close shooting range for WS Specialists. Decoy dogs are especially effective for territorial pairs of coyotes. Decoy dogs are typically medium-sized dogs such as small Labradors and mountain curs that are trained to stay relatively close to the WS Specialist.

Trap-line Companion Dogs often accompany WS Specialists in the field while they are setting and checking equipment. They are especially effective in finding sites to set equipment by alerting their owners to areas where coyotes or other predators have traveled, urinated, or defecated; these are often good locations for sets. Trap-line companion dogs stay with the WS Specialists and generally have no effect on nontarget animals.

Translocation is the capturing of an animal with one of the nonlethal take methods previously discussed, and releasing the animal at a different location, which is far enough away that the animal is not expected to return. WS-Colorado typically does not recommend translocation of common or dangerous wildlife. However, translocation is an important method for wildlife management, especially for the propagation of T&E or sensitive species, and WS-Colorado may occasionally translocate predators as requested by CPW or USFWS. These agencies would establish the policies and make most decisions relating to wildlife translocation, taking into account population goals for the various species.

Chemical Immobilization and Euthanasia Drugs are important tools for managing wildlife. Under certain circumstances, WS-Colorado personnel are involved in the capture of animals where the safety of the animal, personnel, or the public are at risk, and

chemical immobilization can reduce these risks. For example, chemical immobilization has often been used to take black bears, mountain lions, coyotes, and raccoons in residential areas where public safety is at risk. WS-Colorado employees that use immobilizing drugs are certified for their use and follow the guidelines established in the APHIS-WS Field Operational Manual for the Use of Immobilization and Euthanasia Drugs. Telazol® (a mixture of tiletamine and zolazepam) and a mixture of Ketamine and Xylazine are the two immobilizing agents generally used by WS-Colorado with predators. These are typically used in urban, recreational, and residential areas where the safe removal of a problem animal is most easily accomplished with a drug delivery system (*e.g.*, darts from rifle, pistol, blow gun, or syringe pole). Immobilization is usually followed by release (*e.g.*, after radio collaring a mountain lion for a research study), translocation, or euthanasia. Euthanasia is usually performed with drugs such as Beuthanasia-D® or Fatal-Plus® which contain forms of sodium phenobarbital. Euthanized animals are disposed of by incineration or burial to avoid secondary hazards. Drugs are monitored closely and stored in locked boxes or cabinets according to WS policies, and Department of Justice or Drug Enforcement Administration guidelines. Most immobilization and euthanasia drugs are controlled substances which can only be used under license from the U.S. Department of Justice's Drug Enforcement Administration. The use of immobilizing drugs requires close proximity to the target animal, so there is no issue with nontarget take.

Chemical Medication Drugs are used by WS nationally to treat animals which are infected with a disease or other malady, to prevent the spread of disease (*e.g.*, rabies), or to treat an animal which has been chemically immobilized. WS-Colorado is involved in disease surveillance, monitoring, and management programs to minimize the spread of diseases and reduce the potential for infection of humans, agriculture, and other wildlife. This may warrant medicating wildlife through injections, or via oral or topical applications. Oral treatments, if not administered directly by a tube, are often disguised in baits acceptable to the target animal. Risk assessments on drugs being used in the field are completed prior to their use. This includes potential side-effects to T&E species found in the range of their use. For example, WS uses an oral rabies vaccine which is a genetically-engineered recombinant vaccinia-rabies glycoprotein vaccine (Raboral V-RG® MERIAL, Inc.). It is currently licensed for use in raccoons in the United States and Canada and approved for experimental use in gray fox and coyotes in Texas. It is not currently used by WS-Colorado, and is unlikely to be used in the future, but it could be. The vaccine has been extensively evaluated in the laboratory for safety in more than 50 vertebrate species with no adverse effects, regardless of inoculation route or dose. If used in Colorado to reduce the spread of rabies, it should have no adverse effects on nontarget species.

Chemical Pesticides are widely used because they are often very effective at reducing or stopping damage. Although some pesticides are specific to certain taxonomic groups (*e.g.*, birds *vs.*

mammals), pesticides are typically not species specific, and their use may be hazardous to nontarget species unless they are used with care by knowledgeable personnel. The proper placement, size, type of bait, and time of year are keys to selectivity and successful use of pesticides for PDM. EPA pesticide registration requires rigorous testing to determine potential effects on humans and the environment including risks to nontarget species. When a pesticide is used according to its EPA-registered label, it poses minimal risk to people, the environment, and nontarget species. WS-Colorado personnel are required by policy to adhere to label requirements including any literature that accompanies the label, regardless of whether it is attached to the product. WS-Colorado personnel who use these chemicals must be certified by CDA as chemical applicators and are required to adhere to all certification requirements set forth by FIFRA and CDA. Suitable pesticides for controlling predator damage are limited; sodium cyanide and large gas cartridges are the only two pesticides currently used by WS-Colorado in PDM. Amendment 14 to the Colorado Constitution prohibits the use of pesticides on public lands and restricts them to a 30-day time period on private lands.

Sodium Cyanide (EPA. Reg. No. 56228-15) is used in the M-44 device, a spring-activated ejector device developed specifically to kill coyotes and other canids. The M-44 is a mechanical device that ejects sodium cyanide powder into the mouth of an animal that pulls up on it with its teeth. The M-44 is made of four parts and is set with special pliers. It is selective for canids, which are members of the dog family, due to their feeding behavior (scavenging) and because the attractants used are relatively canid-specific. When properly used, the M-44 presents little risk to humans and the environment, and provides an additional tool to reduce predator damage. The M-44 device consists of: (1) a capsule holder wrapped with fur, cloth, or wool; (2) a capsule containing 0.8 gram of powdered sodium cyanide; (3) an ejector mechanism; and (4) a 5-7 inch hollow stake. The hollow stake is driven into the ground, the ejector unit is cocked and placed in the stake, and the capsule holder containing the cyanide capsule is screwed onto the ejector unit. A fetid meat or other suitable bait is spread on the capsule holder. An animal attracted by the bait will try to pick up or pull the baited capsule holder. When the M-44 device is pulled, a spring-activated plunger propels sodium cyanide into the animal’s mouth. Toxicity may occur when swallowed, inhaled as a dust, or absorbed through the skin. When it comes in contact with carbon dioxide or acids, it forms hydrogen cyanide gas (HCN). HCN is highly and quickly toxic by contact, ingestion, or inhalation of vapors. HCN is an asphyxiant which prohibits the use of oxygen at the molecular level, affecting all cellular activities and functions in the body. The characteristic response to HCN is a rapid loss of consciousness and cessation of breathing, except with the mildest of exposures. After ingestion of a large dose of sodium cyanide, the target species may become unconscious within a few seconds. Breathing is rapid at first, but soon becomes slow and gasping. Convulsions may follow, but in severe poisoning cases, especially if untreated, coma and death may occur within a few minutes. M-44 users carry an antidote kit while setting out or checking the devices, which consists of six amyl nitrite pearls. WS-Colorado personnel must be certified to

use the M-44. The EPA label for the M-44 includes 26 use restrictions. Although the M-44 is selective for canids, WS nationally has taken some nontargets other than canids on rare occasions.

Large Gas Cartridges (EPA. Reg. No. 56228-21) are fumigant devices that emit gases to take burrowing wildlife and reduce damage associated with them. These are very efficient, but often expensive. In PDM, WS-Colorado only uses gas cartridges in coyote, fox, and skunk dens. When ignited, the cartridge burns in the den of an animal and produces large amounts of carbon monoxide, a poisonous gas which is colorless, odorless, and tasteless. The combination of oxygen depletion and carbon monoxide exposure rapidly and humanely kills the animals in the den. Carbon monoxide euthanasia is recognized as "acceptable with conditions" by the American Veterinary Medical Association (AVMA 2013). The conditions suggested by AVMA relate to applicator safety and adequate dosage to ensure what they describe as "loss of consciousness without pain…." WS-Colorado personnel are properly trained in personal safety before they use this method, and the large gas cartridges used by WS-Colorado are specifically formulated by WS's Pocatello Supply Depot to produce adequate carbon monoxide for fumigation of dens. WS-Colorado' use of large gas cartridges is not considered euthanasia, but the acceptability of the active agent for euthanasia supports the humaneness of this tool. WS-Colorado only uses gas cartridges in dens that show signs of active target animal use. Therefore, these are mostly very target-specific and will have no effect on nontarget species.

3.1.2 Alternative 2 - No Federal WS PDM

This alternative would terminate the federal WS-Colorado PDM program. Information on future developments in nonlethal and lethal management techniques developed by WS's research branch would not be as readily available to producers or resource owners. PDM assistance, including use of most methods used by WS-Colorado under Alternative 1 (Table 12A), would unlikely be provided by the Colorado Department of Agriculture, CPW, or county agencies. These government agencies would likely provide technical assistance for most predation conflicts. CPW, or their agents, mayprovide direct control of predation incidents involving human safety caused by black bears or mountain lions. PDM likely would be provided by livestock producers, resource managers, private organizations, or private contractors to protect livestock, threatened or endangered wildlife or wildlife species of management concern. However, WS-Colorado anticipated that PDM would be available at a reduced level since predator management is costly and has many state and federal regulatory requirements that limit the use of some methods, especially the more effective methods (Table 12A). Aerial predator management would not be available on public lands but could be used on private lands. The use of M-44's by private individuals would be prohibited. The use of trained hounds to decoy coyotes or bay and hold black bears or mountain lions would require trained hounds few individuals have and additional permits by CPW. Foot traps and snares would be prohibited on federal and state public lands. Thermal imagers and night vision improve the effectiveness of shooting or calling and shooting and these tools would be cost prohibitive to most private individuals. However, these methods would often be applied by persons with less or no training or experience, which might result in the use of unsafe, ineffective, environmentally unsound, or even illegal methods.

Table 12A. Lethal predator damage management methods available for use by Wildlife Services-Colorado or private individuals or businesses in Colorado.

	Wildlife Services			Private		
Method	Federal Public Lands	State Public Lands	Private lands	Federal Public Lands	State Public Lands	Private lands
Aerial predator management	Yes	Yes	Yes	No	?	Yes
M-44	No	Yes	Yes	No	No	No
foot traps	N[1]	Yes	Yes	No	No	Yes
snares (body or neck)	N[1]	Yes	Yes	No	No	Yes
shooting	Yes	Yes	Yes	Yes	Yes	Yes
thermal imager	Yes	Yes	Yes	Maybe[2]	Maybe[2]	Maybe[2]
night vision	Yes	Yes	Yes	Maybe[2]	Maybe[2]	Maybe[2]
cage trap	Yes	Yes	Yes	Yes	Yes	Yes
dogs (decoy, bay or tree)	Yes	Yes	Yes	Yes[3]	Yes[3]	Yes[3]

1. Method may be used to protect human health or safety, federal threatened or endangered species or research.
2. Cost may be prohibitive with thermal imagers cost about $13,000 and up. Night vision costs can be prohibitive and are more variable based on "generation" and a starting range of $500 to $3,000.
3. Private individuals may use dogs for bear or mountain lion damage management if permitted as an agent of Colorado Parks and Wildlife or livestock producer.

3.1.3 Alternative 3 - Technical Assistance Only

This alternative would allow WS-Colorado to provide technical assistance with PDM techniques, such as guard dogs, frightening devices, harassment, fencing, exclusion, animal husbandry, modification of human behavior, habitat modification, cage traps, foot-hold traps, neck snares, and chemical methods available for the public. WS-Colorado would also loan equipment used for nonlethal control. WS-Colorado would only assist in lethal PDM activities in emergency situations when it was necessary for public safety. PDM assistance, including use of most methods used by WS-Colorado under Alternative 1 (Table 12A), is unlikely to be provided by the Colorado Department of Agriculture, CPW, or county agencies. Information and training on lethal control methods would not be provided or used by WS-Colorado. Individuals experiencing predator damage would still have access to nonlethal and some lethal PDM methods as allowed under applicable state, federal and tribal laws. PDM likely would be provided by private resource owners and managers, private organizations, or private contractors, albeit at a reduced level since predator management is costly and has many state and federal regulatory requirements that limit the use of some methods, especially the more effective methods (Table 12A). Aerial predator management would not be available on public lands but could be used on private lands. The use of M-44's by private individuals would be prohibited. The use of trained hounds to decoy coyotes or bay and hold black bears or mountain lions would require trained hounds few individuals have and additional permits by CPW. Foot traps and snares would be prohibited on federal and state public lands. Thermal imagers and night vision improve the effectiveness of shooting or calling and shooting and these tools would be cost prohibitive to most private individuals.

Producers, land managers, and other government agencies would implement the various non-lethal and lethal PDM measures on their own. Lethal PDM methods would likely be applied by persons with less or no training or experience. CPW would likely implement lethal PDM to protect human safety when harm is caused by black bears and mountain lions. Producers, private contractors and resource managers would likely implement lethal PDM to protect livestock, threatened and endangered species or species of management concern, albeit at levels reduced to WS-Colorado since predator management is costly and has many state and federal regulatory requirements. Private contractors would be able to provide aerial predator management on private land but not

public federal grazing allotments. The technical assistance provided by WS-Colorado might help some resource owners to safely implement PDM, but others might use unsafe, ineffective, environmentally unsound, or even illegal methods.

3.1.4 Alternative 4 - Lethal PDM Methods Used Only for Corrective Control

This alternative would allow lethal PDM only where depredation on livestock or other damage from predators has occurred. Incumbent in this alternative is WS-Colorado verification of the loss and the species responsible. Lethal control by WS-Colorado would be limited to an area near the loss to maintain the integrity of the corrective-only situation. The full variety of mechanical and chemical control methods described for Alternative 1 would be available once damage has been verified by WS-Colorado.

Producers, land managers, and other government agencies could still implement any nonlethal or lethal methods they determine to be practical and effective, for corrective or preventive control. Consequently, these methods would often be applied in preventive control situations by persons with little or no training or experience. This might result in the use of unsafe, ineffective, environmentally unsound, or even illegal methods.

3.2 STRATEGIES CONSIDERED BUT NOT ANALYZED IN DETAIL WITH RATIONALE

Several other strategies were considered but not analyzed in detail. These were excluded from our analysis due to problems associated with their implementation as described below.

3.2.1 Compensation for Predator Damage Losses

The compensation alternative would require the establishment of a system to reimburse resource owners for predation or other losses. Currently, CPW compensates ranchers for black bear and mountain lion livestock losses, but often also captures the offending animal because typically become repeat offenders. This alternative for all losses associated with predators has been eliminated from further analysis because no federal law currently exists to authorize such action. WS-Colorado has no authority to establish a compensation program. Under such an alternative, WS-Colorado would not provide any direct control to reduce predator damage because losses would be compensated when damage was verified to be caused by predators. Drawbacks for this concept include:

- It would require larger expenditures of Federal money and manpower to investigate and validate all losses, and determine and administer appropriate compensation.
- It would be difficult, if not impossible, to assess and confirm losses in a timely manner for all requests; thus, many losses would not be verified and would go uncompensated.
- Compensation would decrease the incentive to livestock and other resource owners to limit predation or damages with PDM strategies such as improved animal husbandry practices and fencing.
- Not all resource owners would rely completely on a compensation program, and PDM activities including the use of lethal PDM methods would likely continue as permitted by state law.

3.2.2 Bounties

Bounties are the payment of funds for killing predators in a given area. Bounties have not been supported by Colorado State agencies (CPW and CDA) or most wildlife professionals for many years (Latham 1960). WS-Colorado concurs, because bounties are generally not effective in abating damage, especially over a wide area such as the State of Colorado. Bounty systems have other inherent problems also. For example, the location and timing of the take are arbitrary and

unregulated. As such, many animals would be taken in areas without livestock, and during periods when predator removal may not be effective at reducing damage. Abuse is also common with bounty systems; many animals could come from places outside the bounty area. Finally, WS-Colorado does not have the legal authority to establish a bounty program, and would rely on the State or Counties to implement bounties. Therefore, this alternative has been eliminated from further analysis.

3.2.3 Eradication and Long Term Population Suppression

An eradication alternative would direct all WS-Colorado efforts toward total long term elimination of coyotes and perhaps other predator species in entire cooperating areas or larger defined areas in Colorado. The eradication of predator species is not a desired goal of state or federal agencies. Some landowners would prefer that some species of predators be eradicated, especially those that have become abundant and caused damage without intervention from wildlife agencies (International Association of Fish and Wildlife Agencies 2004). However, eradication as a general objective for PDM will not be considered by WS-Colorado in detail because WS-Colorado, CPW, CDA, USFWS, BLM, USFS, and most members of the public oppose eradication of any native wildlife species. Additionally, the eradication of a native species or local population would be extremely difficult, if not impossible to accomplish, and cost-prohibitive in most situations.

Suppression would direct WS-Colorado efforts toward managed reduction of certain problem populations or groups. In localized areas where damage can be attributed to predation by specific groups, CPW has the authority to increase hunting seasons and hunter tag quotas. If a large number of requests for WDM are generated from a localized area, WS-Colorado would consider suppression of the local population or groups of the offending species, if appropriate. However, it is not realistic, practical, or allowable under present WS policy to consider large-scale population suppression. Typically, WS-Colorado activities in Colorado are conducted on a very small portion of the area inhabited by the problem species, and therefore, eradication or long term population suppression is unrealistic. This alternative has been eliminated from further analysis.

3.2.4 The Humane Society of the United States Alternative

The Humane Society of the United States has proposed an alternative which requires that: 1) "permittees evidence sustained and ongoing use of nonlethal/husbandry techniques aimed at preventing or reducing predation prior to receiving the services of WS"; 2) "WS employees use or recommend as a priority the use of appropriate nonlethal techniques in response to a confirmed damage situation"; 3) "lethal techniques are limited to calling and shooting and ground shooting, and used as a last resort when use of husbandry or other nonlethal PDM methods have failed to keep livestock losses below an acceptable level"; and 4) "[WS] establish higher levels of acceptable loss thresholds on public lands than for private lands".

The major components of this proposed alternative have been analyzed in detail in the alternatives contained in this EA and through court rulings. The Humane Society of the United States alternative would not allow for a full range of IWDM techniques to resolve wildlife damage. In addition, WS is charged by law to protect American agriculture, despite the cost of PDM. Further, in the case *Southern Utah Wilderness Society et al. vs. Hugh Thompson et al. U.S. Forest Service* (Civil No. 92-C-0052A 1993), the court clearly stated that, "The agency need not show that a certain level of damage is occurring before it implements a *WS* Program. . . . Hence, to establish need for *WS*, the forest supervisors need only show that damage from predators is threatened." Thus, judicial precedence was set and found that it is not necessary to establish a criterion, such as percentage of loss of a herd, to justify the need for PDM provided by WS. Proactive (preventive) and reactive (corrective) control actions are therefore justified by a reasonable determination of the threat of damage by predators. The alternatives selected for detailed analysis in this EA encompass a reasonable range as required by NEPA, and include some of the suggestions in this proposal. It is believed that inclusion of this alternative would not contribute new information or options for consideration and analysis; hence, this alternative has been eliminated from further analysis.

3.2.5 No PDM Within any Public Lands, including Wilderness or Proposed Wilderness

This alternative would not allow WS-Colorado to conduct any PDM on public lands in Colorado; however, it would not prevent other entities from conducting PDM in these areas. WS-Colorado does not have the legal authority to determine what activities will or will not occur on public lands; this authority belongs to the respective land management agencies. If these land management agencies determine that PDM will be allowed on public lands, including in certain WAs, PDM activities will likely occur there regardless of whether WS-Colorado or some other entity (*e.g.*, producers or contractors) conducts them. In the absence of WS-Colorado conducting PDM, they may be conducted by persons with little or no training or experience, which might result in the use of unsafe, ineffective, environmentally unsound, or even illegal methods in WAs. Directly related to Wilderness Areas, under the current WS-Colorado program, the amount of PDM that occurs in wilderness areas is minor, and the effects of the No Action Alternative (the Current Program; Alternative 1) would not be notably different from the effects of a "No Control in Wilderness Areas" alternative. The minor amount of PDM that is conducted by WS-Colorado in wilderness or proposed wilderness areas conforms to legislative and policy guidelines applicable to WS-Colorado, and WS-Colorado meets annually with these land management agencies to review work plans that delineate what, when, why, and where PDM would be conducted in WAs. SOPs specific to this issue are listed in Section 3.3. This alternative has been eliminated from further analysis.

3.2.6 Nonlethal Control Only

This alternative would not allow the use of lethal methods by WS-Colorado, as described under the proposed action (Alternative 1), to relieve damage caused by predators. Resource owners or managers would still have the option of implementing lethal control measures, and WS-Colorado would continue to recommend lethal and nonlethal methods, but would only use nonlethal methods operationally. However, few nonlethal methods used in PDM are practical for implementation by WS-Colorado personnel. Most nonlethal methods are put into use by the resource owner (Knowlton *et al.* 1999). Many of these methods (*e.g.*, fencing and guard dogs) require significant time to implement and have a high initial cost (Mitchell *et al.* 2004). Beyond the additional effort and costs, these methods are not always effective at reducing damage, and potentially have side-effects (*e.g.*, concentrating livestock can cause damage to pasture areas) (Knowlton *et al.* 1999).

A few public commenters consider this to be the Alternative of choice and cite literature such as Mitchell *et al*. (2004) indicating that nonlethal can be very effective. However, Mitchell *et al.* (2004) and others such as Knowlton *et al.* (1999) indicate that, although certain nonlethal methods have shown promise, further research is needed to determine their effectiveness and practicality. Additionally, most livestock producers already use nonlethal methods to reduce predation. NASS (1998) reported survey data suggesting that 80 percent of Colorado sheep producers employed one or more nonlethal predator control measure: 44% used guard dogs, 44% used predator resistant fencing, 41% used night penning, 38% used shed lambing, 16% used herding/gathering or moving of livestock, and 8% used nonlethal frightening methods. Andelt (1992) reported that about 1/3 of sheep producers using guard dogs indicated that the use of dogs did not reduce their reliance on other predator control techniques or on predator control agencies.

Nonlethal methods are an important part of the mix of current strategies used for meeting PDM needs in the State, but they have not kept losses low enough to satisfy many producers. In addition, this Alternative would not prevent producers from conducting lethal PDM on their own. In fact, we expect that many producers would reject WS nonlethal assistance in favor their own lethal control means if WS-Colorado were to adopt this Alternative. This would likely result in lethal PDM methods being applied by persons with little or no training or experience, which might entail the use of unsafe, ineffective, environmentally unsound, or even illegal methods. Finally, a nonlethal-only Alternative would be very similar to the Technical Assistance Only Alternative, because the majority of nonlethal methods are put into practice by resource owners. Consequently,

the inclusion of this Alternative would not add significantly to the analysis in this EA, and it has been eliminated from further analysis.

3.2.7 Translocation Rather Than Killing Problem Wildlife

This Alternative would require that no predators were intentionally killed, but that they were instead captured live, and released at a distant location ("translocated"). Translocation is appropriate in some situations, and WS-Colorado will continue to translocate wildlife in these limited situations in coordination with CPW and/or USFWS, and in consultation with the appropriate land management agency or manager associated with proposed release sites. For example, translocation is warranted and appropriate for species whose populations are at very low levels (*e.g.*, kit fox or other T&E species), when suitable release sites are available, and when the additional money required for translocation can be obtained. However, translocation is not appropriate in all situations, and a requirement to translocate all damaging predators would not be prudent. The predator species that often cause damage problems in Colorado are relatively abundant (*e.g.*, coyotes, red fox, black bears, and mountain lions) or are not native (*e.g.*, feral cats and feral dogs). For these species, translocation is not necessary for the maintenance of viable populations, and the drawbacks of translocation outweigh the benefits. The drawbacks of translocating wildlife include:

- threat of increased damage at the release site, which in some cases could require payment of damage compensation claims
- risk of the spread of diseases, such as rabies and distemper
- difficulty in finding appropriate release sites, especially when the animals were captured because they caused damage (such animals are likely to cause additional damage at the release site)
- stress to the animal, including capture stress, transport stress, and competition for territory and resources at the release site, all of which can lead to poor outcome
- high rates of return to the site of capture, especially when release sites are not distant enough
- poor survival rates among translocated animals
- loss of many of the most effective methods of removing damaging wildlife, including shooting, aerial predator management, and all other lethal methods; this would significantly decrease WS-Colorado's efficacy in solving predator damage problems
- increased logistics and cost, including transportation to the release site which must be far enough from the capture site to discourage return

In fact, the American Veterinary Medical Association, the National Association of State Public Health Veterinarians, and the Council of State and Territorial Epidemiologists oppose the translocation of mammals due to the potential for disease transmission to a healthy local population. This is particularly true for small mammals such as raccoons or skunks (Center for Disease Control 1990). Translocation of wildlife is also discouraged by APHIS-WS policy (WS Directive 2.501) for all of the reasons listed above. Moreover, such an Alternative would not be remarkably different from a "Nonlethal Control Only Alternative", which has been eliminated from further analysis, or a Technical Assistance Only Alternative (Alternative 3). The Translocation Only alternative is impractical, and would not significantly add to the analysis in this EA, so it has been eliminated from further analysis.

3.2.8 Management Techniques Not Considered for Use in IWDM

3.2.8.1 Mountain Lion Sport Harvest Alternative.

This Alternative would require that CPW offer sport-harvest of mountain lions whenever and wherever damage management is required, prior to WS-Colorado involvement. CDA and CPW have the authority to determine the most appropriate means of removing depredating lions, and they have indicated that this is not

feasible as the sole first-line method of mountain lion damage management, because hunters will not reliably take the target individual, nor reliably produce the quick response which is often required. CPW currently allows the take of certain depredating lions or populations through sport hunting and will likely continue to do so, but it is unlikely that they will use this as their first line of action in all cases. Moreover, WS-Colorado has no legal authority to impose such a requirement on CPW, so it's consideration as an Alternative in this EA would not be prudent. This alternative has been eliminated from further analysis.

3.2.8.2 Immunocontraceptives or Sterilization Should Be Used Instead of Lethal PDM.

Fertility control agents for mammals can be grouped into three categories: surgical sterilization, chemical contraception (including hormone implantation), and immunocontraception (contraceptive vaccines). These techniques all require that each individual animal receive either single, multiple, or possibly numerous treatments to successfully prevent conception. These methods were not analyzed in detail in the EA because such a requirement would unduly limit our available PDM methods, which would significantly decrease WS-Colorado's efficacy in solving predator damage problems. In addition, surgical sterilization would need to be performed by a licensed veterinarian, which would be extremely labor intensive and expensive, and there are currently no Federal or State approved chemical contraceptives or immunocontraceptives available for use in PDM.

As alternative methods are developed, fertility control may prove to be a practical tool in some circumstances (DeLiberto *et al*. 1998), but it is unlikely to be used as the sole method of PDM over large areas, such as the State of Colorado. Bromley and Gese (2001a, 2001b) conducted studies to determine if surgically sterilized coyotes would maintain territories and pair bond behavior characteristics of intact coyotes, and if predation rates by sterilized coyote pairs would decrease. Their results suggested that behaviorally, sterile coyote pairs appeared to be no different than intact pairs except for predation rates on lambs. Reproductively intact coyote packs were 6 times more likely to prey on sheep than were sterilized packs (Bromley and Gese 2001b). They believed this occurred because sterile packs' food demands were lower (they did not have to feed pups). Therefore, sterilization could be an effective method to reduce lamb predation if enough alpha (breeding) pairs could be captured and sterilized. However, they also concluded that a more effective and economical method of sterilizing coyotes was needed to make this a practical management tool on a larger scale (Bromley and Gese 2001b).

GonaCon™, a contraceptive vaccine developed by WS-NWRC, was registered by the Environmental Protection Agency (EPA) for use in white-tailed deer (*Odocoileus virginianus*) on 29 September 2009 (EPA registration #56228-40). In 2013, the EPA expanded the approved use of GonaCon to include wild/feral horses and burros. However, GonaCon is not currently approved for any predator species, and we know of no other approved chemosterilant or contraceptive vaccine available for use in predators. Furthermore, the scientists who developed many of the available fertility control tools have stated that such tools will not be applicable "for all management situations", and "will probably have a limited use, primarily in urban/suburban areas" (Fagerstone *et al.* 2006). We concur. Whereas fertility control agents may be useful in some PDM scenarios if products become available in the future, they will certainly not be applicable in all situations. For all of these reasons, this alternative has been eliminated from further analysis.

3.2.8.3 Lithium Chloride as an Aversive Agent.

Lithium chloride has been tested as a taste aversion agent to condition coyotes to avoid livestock, especially sheep. Despite extensive research, the efficacy of this technique remains unproven (Conover *et al.* 1977, Sterner and Shumake 1978, Burns 1980, 1983, Burns and Connolly 1980, 1985, Horn 1983, Johnson 1984). In addition, lithium chloride is currently unregistered by EPA or CDA, and therefore cannot be used or recommended for this purpose. This alternative has been eliminated from further analysis.

3.2.9 Non-lethal Methods Implemented Before Lethal Methods

This alternative would require that non-lethal methods or techniques described in Chapter 3 be applied to all requests for assistance to reduce damage and threats to safety from predatory mammals and birds. If the use of non-lethal methods fails to resolve the damage situation or reduce threats to human safety at each damage situation, lethal methods would be employed to resolve the request. Non-lethal methods would be applied to every request for assistance regardless of severity or intensity of the damage or threat until deemed inadequate to resolve the request. This alternative would not prevent the use of lethal methods by other entities or by those persons experiencing predatory mammal or bird damage but would only prevent the use of those methods by WS-Colorado until non-lethal methods had been employed.

Those persons experiencing damage often employ non-lethal methods to reduce damage or threats prior to contacting WS-Colorado. Verification of the methods used would be the responsibility of WS-Colorado. No standard exists to determine requester diligence in applying those methods, nor are there any standards to determine how many non-lethal applications are necessary before the initiation of lethal methods. Thus, only the presence or absence of non-lethal methods can be evaluated. The proposed action (Alternative 1) and the technical assistance only alternative (Alternative 3) are similar to a non-lethal before lethal alternative because WS-Colorado would use or recommend non-lethal methods before lethal methods (WS Directive 2.101). Adding a non-lethal before lethal alternative and the associated analysis would not contribute additional information to the analyses in the EA.

The purpose of the EA is to resolve deer damage to agriculture, property, human health and safety and natural resources. Requiring a landowner or manager to implement non-lethal methods before lethal methods may not resolve the deer damage. Moreover, the state has management authority over deer and would make determinations based on state law and regulations about requirements landowners and managers must abide to manage deer.

3.3 WS SOPs INCORPORATED INTO PDM TECHNIQUES

An SOP (Standard Operating Procedure) is a set of standardized instructions intended to achieve specific, predictable results, and avoid unwanted results. In the case of wildlife damage management, SOPs serve to prevent, reduce, or compensate for negative impacts that otherwise might result from an action, and can cover any aspect of that action. The current WS program, in Colorado and nationwide, uses many such SOPs. Relevant SOPs are incorporated into all Alternatives analyzed herein, except the no federal program alternative (Alternative 2). Most SOPs are instituted to abate specific issues, but some are more general and relate to the overall program. SOPs include those recommended or required by regulatory agencies (*e.g.*, EPA), and these are listed where appropriate. Additionally, specific measures to protect resources such as T&E species that are managed by WS's cooperating agencies (USFWS and CPW) are included in the lists below.

3.3.1 General SOPs Used by WS in PDM

- WS complies with all applicable laws and regulations that pertain to working on federally managed lands.

- WS coordinates with Tribal officials for work on Tribal lands to identify and resolve any issues of concern with PDM.

- The use of PDM methods such as traps and snares conform to applicable rules and regulations administered by the State, as well as WS Directives.

- WS personnel adhere to all label requirements for toxicants and pesticides. EPA approved labels provide information on preventing exposure to people, pets, and T&E species, along with environmental considerations that must be followed. WS personnel abide by these restrictions.

- The WS Decision Model (Slate *et al.* 1992) is consistently used by WS employees when determining appropriate WDM methods. This Model is designed to identify effective wildlife damage management strategies as well as their impacts.

3.3.2 WS SOPs Specific to the Issues

The following is a summary of the SOPs used by WS-Colorado that are specific to the issues listed in Chapter 2 of this document.

3.3.2.1 Effects on Target Predator Species Populations.

- PDM is directed toward localized populations or individual offending animals, depending on the species and magnitude of the problem, and not an attempt to eradicate any native wildlife population in a large area or region.

- WS-Colorado Specialists use specific trap types, lures, and placements that are most conducive to capturing the target animal with the least amount of injury, consistent with WS Directives 2.101, 2.105, 2.450, and 2.455.

- Decisions to kill problem bear, mountain lions, foxes, bobcats, coyotes, raccoons, opossums, and striped skunks damaging agricultural resources are made by WS-Colorado under the authority of CDA. All other species are controlled under CPW authority. Decisions to translocate any species is coordinated with the CPW. CPW is notified in a timely manner of all take for big game species such as black bear and mountain lion.

- WS-Colorado will use Best Management Practices for Trapping by using approved foot-hold, restraining, and kill traps to capture predatory animals.

3.3.2.2 Effects on Non-target Species Populations, Including T&E Species.

- WS-Colorado personnel are trained to select the most appropriate method(s) for taking problem animals with little impact on non-target species.

- WS-Colorado personnel work with research programs such as the WS National Wildlife Research Center to continue to improve the selectivity of management devices.

- Traps and snares are not set within 30 feet of exposed carcasses (*i.e.*, "draw stations") in order to prevent the unintentional capture of scavenging birds such as bald eagles and ravens. The only exception to this policy is for the capture of target mountain lion, black bear, or raptors (bear and lion sets are selective for large heavy animals due to pan-tension devices, and raptor sets are specifically intended to capture these birds).

- Pan-tension devices for foot snare triggers and foot-hold traps are used by WS-Colorado, as appropriate, throughout Colorado to reduce the capture of non-target wildlife that weigh less than the target species.

- Breakaway snares, designed to break open and release when tension is exerted by a larger nontarget animal such as deer, antelope or livestock, have been developed and are being refined. These snares will be implemented into the WS-Colorado program as appropriate.

- Non-target animals captured in foot-hold traps or foot snares are released at the capture site unless it is determined by WS-Colorado Specialists that the animal is not capable of self-maintenance.

- PDM activities are directed at towards individual problem animals, or local populations, to resolve damage problems associated with them.

- When working in an area that has T&E species or has the potential for T&E species to be exposed to PDM methods, WS-Colorado personnel will know how to identify sign of the target and T&E species (*e.g.*, bobcat *vs* lynx), and apply PDM methods accordingly.

3.3.2.2a Measures to Reduce the Potential Take of Specific T&E Species

Kit Fox. WS-Colorado follows CPW's guidelines for minimizing the potential to take kit fox in their range as defined in CPW's regulations. In kit fox range, WS-Colorado uses pan-tension devices on foot-hold traps, and snares with stops or an 11+" loop. Traps and snares are checked daily, and the use of M-44s is not allowed. If WS-Colorado targets a kit fox because of damage, CPW will be notified to determine if it should be translocated.

Canada Lynx. WS-Colorado abides by the December 7, 2009 BO obtained from the USFWS (USFWS 2009). Currently, WS-Colorado has been provided general habitat maps and guidance from CPW for this purpose. CPW conducted a predictive analysis of habitat used by lynx in Colorado and found lynx strongly associated with spruce-fir forests at high elevations (above 9,000 feet) with deep snow during winter months (Ivan et al. 2011). The maps that CPW develops provide a good insight as to where lynx can be expected to occur (Ivan *et al.* 2011). The best winter habitat for lynx in Colorado was predicted to be the San Juan, Culebra, and Wet Mountain ranges in southern Colorado, Sawatch and West Elk mountain ranges along the Grand Mesa, and Park Range and Flat Tops in northern Colorado (Ivan et al. 2011). Summer habitat was similar to winter habitat with some stronger associations including the use of lodgepole pine and aspen habitat in the Sawatch Range of central Colorado and the use of the Medicine Bow and Front Range of northern part of Colorado (Ivan et al. 2011). We believe that PDM implemented by WS-Colorado continues to be the same as that identified in the 2009 BO. CPW has agreed to keep WS-Colorado informed of unusual lynx locations in Colorado so that WS-Colorado personnel can take steps to avoid their incidental capture. When WS-Colorado personnel conduct PDM in lynx habitat (primarily higher elevation areas of USFS NFs where they have been found), shooting will be the preferred method whenever it can be used practically and effectively to resolve a problem situation, because it poses virtually no risk of incidental lynx take. Further restrictions on WS-Colorado PDM methods to avoid lynx take that are now part of WS-Colorado SOPs while operating under the December 7, 2009 BO are as follows.

- All WS-Colorado personnel conducting PDM in or near lynx occupied habitat will be trained in identification of lynx and lynx sign, and snowshoe hare and their sign if conducting PDM in lynx habitat.

- No fetid baits or attractants will be used in coyote trap sets within lynx habitat.

- No neck snares may be used for capturing coyotes or bobcats within lynx habitat; neck snares for capturing lions, bears, and (if and when they occur in the state and WS-Colorado is authorized to capture them) wolves may be used within lynx habitat if they are equipped with "stops" (to prevent the snare loop from closing down below a size that could choke or otherwise hold a lynx).

- WS-Colorado may not use M-44 devices or large gas cartridges within lynx habitat.

- WS-Colorado must remove any tracking dog from trailing a lynx.

- WS-Colorado must immediately release any incidentally captured lynx after notifying the USFWS or CPW, if practical, unless the lynx has been injured and cannot be rehabilitated or safely released, at which point it may be euthanized after USFWS approval. If an injured lynx can be rehabilitated, it will be transferred to the USFWS or CPW, or a licensed wildlife rehabilitation center as directed by USFWS or CPW.

- WS-Colorado must report details of any trapped, lethally taken, lynx, and all lynx-related observations to the nearest USFWS office and CPW, and must make efforts to contact the USFWS when a lynx is captured alive to determine if the lynx should be radio-collared, or released immediately.

- WS-Colorado must notify appropriate CPW and USFWS offices within 24 hours if a lynx is killed and must assist in preserving and transporting the carcass to the appropriate agency for analysis.

River Otter. To avoid taking river otter, WS-Colorado does not trap along lake shores, streams, and rivers where river otter sign is found except with: a) padded-jaw foot-hold traps; b) Conibear® type traps less than 220 in size; or c) land or water set snares with a closure size of 16 inch circumference or larger.

In addition, padded-jaw traps and snares are not used in drowning sets; padded jaw traps and land set snares may only be set in accordance with the provisions of 33-6-205 CRS, 33-6-206 CRS, or 33-6-207 CRS; and water set snares and Conibear® traps may only be set in accordance with the provisions of 33-6-205, CRS, or 33-6-207 CRS.

Gray Wolf. WS-Colorado has adopted and implemented conservation measures outlined in 2016 to protect gray wolves. These measures would also protect Mexican gray wolves, should they wander into Colorado (WS 2016).

- WS-Colorado will contact USFWS's or CPW's Gray Wolf Coordinator to verify any WS-Colorado sightings of gray wolves in Colorado. Colorado has almost 7,000 captive wolf-dog hybrids, which could potentially could be one of these released into the wild.

- WS-Colorado will not use M-44s or neck snares in the "occupied gray wolf range or conservation areas." Occupied gray wolf range is defined as: (1) an area in which gray wolf presence has been confirmed by state or federal biologists

through interagency wolf monitoring programs, and USFWS has concurred with the conclusion of wolf presence, or (2) an area from which multiple reports judged likely to be valid by USFWS have been received, but adequate interagency surveys have not yet been conducted to confirm presence or absence of wolves. One conservation area has been identified in Colorado as the area south of the Wyoming border on Highway 13 to Craig, then east on Highway 40 to Steamboat Springs, then south on Highway 131 to Interstate 70, then east to Interstate 25, then north to the Wyoming border and finally west along the Wyoming border back to Highway 13. Wolves have been sighted occasionally over the last several years in this area.

- WS-Colorado will check all foot-hold traps and foot-hold snares at least once a day in areas known to be occupied by gray wolves. This monitoring may be conducted electronically.

- WS-Colorado may use break-away snares with stops that are checked at least once a day in areas known to be occupied by gray wolves. This monitoring may be conducted electronically.

- WS-Colorado will use night vision or thermal imaging when conducting calling-and-shooting at night in areas occupied by gray wolves.

- WS-Colorado will require that Specialists involved in aerial predator management and ground shooting in areas where gray wolves have been documented will receive additional training to differentiate wolves from coyotes. Further, no aerial predator management will occur in occupied gray wolf habitat from 01 September – 30 November.

- WS-Colorado will abide by all applicable reasonable and prudent alternatives, measures, and terms and conditions required as a result of findings in any ESA consultations between WS-Colorado and USFWS.

- WS-Colorado may assist the Wolf Recovery Team, CPW, or CDA in trapping wolves so that they can be examined. The use of immobilizing drugs to capture a wolf will only be conducted by WS-Colorado personnel certified in the use of these drugs.

- In the event that a wolf has been found to kill livestock in Colorado, WS-Colorado will verify and document the predation, obtain pertinent evidence such as photographs, and contact the USFWS Wolf Recovery Team. Should the Recovery Team determine that the offending individual(s) must be removed, it is likely that WS-Colorado would be asked by the Recovery Team to initiate PDM activities to abate damages caused by the offending wolf or wolves. This would be completed for USFWS under separate NEPA documentation and the appropriate permit.

Wolverine. Wolverines may have been extirpated from Colorado, and WS-Colorado has not taken any in the last few decades. If WS-Colorado personnel sight a wolverine, or verify tracks or other sign, we will notify CPW. In the immediate area of a wolverine identified by WS-Colorado or CPW, WS-Colorado may still use padded jaw foot-hold traps and snares with stops checked daily, but not M-44s. WS-Colorado will determine further measures that will reduce the potential for take with CPW if one is found.

California Condor. If a California condor is seen in Colorado outside of the designated experimental range in Arizona, WS-Colorado will contact the USFWS. Currently, M-44s are not used in a 5 mile corridor around the Colorado and San Juan Rivers from March 1

to October 1, because three condors were seen near Grand Junction in the summer of 1998 (USFWS 2001).

Burrowing Owl. WS-Colorado employees using gas cartridges to fumigate a coyote or red fox den will ensure that dens are occupied by the target species, and not by burrowing owls.

Plains Sharp-tailed Grouse, Lesser Prairie-chicken, and Gunnison's Sage-grouse. WS-Colorado will use pan-tension devices on foot-hold traps in habitat occupied by these grouse species to minimize their potential capture. Small predators of similar weight as these sensitive species will be live captured in cage traps in these areas.

3.3.2.2b Measures to Ensure Minimal Impacts from Aerial Predator Management Overflights.

WS-Colorado pilots will abide by the WS Aviation Policy Manual and Federal Aviation Regulations. Non-target wildlife will not be pursued and will be avoided whenever seen.

3.3.2.3 Impacts on Public Safety and Pets.

- Public safety zones are delineated and defined by location or on WP maps by BLM and USFS during the WP review phase, as changes make them necessary. The public safety zone is one-quarter mile, or other appropriate distance, around any residence or community, county, state or federal highway, or developed recreation site. PDM conducted on federal lands within identified public safety zones will generally be limited to activity aimed at the protection of human health and safety. However, a land management agency or cooperator could request PDM activities in the public safety zone for an identified need. Depending on the situation and applicable laws and regulations, WS-Colorado could provide the service. However, land management agencies would be notified of PDM activities that involve methods of concern such as firearms and dogs before these methods would be used in a public safety zone, unless specified otherwise in the WP and deemed appropriate.

- All pesticides used by WS-Colorado are registered with EPA and CDA. WS-Colorado employees will comply with each pesticide's directions and labeling, in addition to EPA and CDA rules and regulations.

- WS-Colorado Specialists who use restricted use chemicals (pesticides or drugs) are trained and certified by program personnel or other experts in the safe and effective use of these materials under EPA and CDA approved programs. WS-Colorado employees who use these chemicals participate in continuing education programs to keep abreast of developments and to maintain their certifications.

- M-44's are only used by those WS-Colorado personnel who are trained and have received state certification from CDA to use sodium cyanide. PDM activities that involve the use of these chemicals are conducted in accordance with CDA and EPA regulations as well as label restrictions and other SOPs related to protection of non-target or sensitive species.

- Conspicuous, bilingual warning signs (English and Spanish) alerting people to the presence of traps, snares, and M-44s are placed at major access points when they are set in the field.

3.3.2.4 Effects of PDM on Sociocultural Issues.

- WS-Colorado will consult with Native American tribes prior to conducting PDM on tribal lands.

3.3.2.5 Effects of PDM, especially Aerial Predator Management Activities, on the Use of Public Lands for Recreation.

- WS-Colorado will conduct PDM on SMAs only when and where requested by the land management entity. All PDM activities conducted in SMAs including WAs and WSAs would be in accordance with the MOUs between WS-Colorado and the land management agencies, and all enacted rules and regulations that are applicable to WS-Colorado.

- WS-Colorado personnel follow all laws and regulations applicable to WS-Colorado and use the WP guidelines while conducting PDM activities on public lands. The WPs include delineation of areas where certain methods may not be used during certain time periods when conflicts with recreational events may occur. If it were necessary to work in areas outside the planned area, the area manager or their representative would be contacted in a timely manner.

- WS-Colorado conducts PDM in accordance with all laws applicable to WS-Colorado associated with public lands and for the areas specified in BLM RMPs and USFS LRMPs. The land managing agencies review the WPs for consistency with their Plans.

- Vehicle access will be limited to existing roads, unless off-road travel is specifically allowed by the land managing agency and conforms with RMPs and LRMPs.

- PDM in WAs will be in accordance with Wilderness Policies and MOUs applicable to WS-Colorado PDM activities.

- WS-Colorado does not anticipate conducting PDM in National Parks. The potential exists that a request could come from the National Park Service or CPW for responding to a threat to human health and safety or for research purposes. If WS-Colorado conducts PDM in response to such a request, the work will be done according to a WP agreed to by NPS, which will specify any restrictions on methods or locations.

- Should any of BLM's existing WSAs be officially designated as Wilderness Areas in the future, PDM will be performed in accordance with the enacting legislation and Wilderness rules and regulations that pertain to WS-Colorado PDM.

3.3.2.6 Humaneness and Ethical Perspectives.

- Chemical immobilization and euthanasia procedures that do not cause pain or undue stress are used by certified personnel when practical and where safe.

- WS-Colorado personnel attempt to kill captured target animals that are slated for lethal removal as quickly and humanely as possible. In most field situations, a shot to the brain with a small caliber firearm is performed which causes rapid unconsciousness followed by cessation of heart function and respiration. A well placed shot to the head is in concert with the American Veterinary Medical Association’s definition of euthanasia (Kitchen *et al.* 1987, AVMA 2001, 2013).

In some situations, accepted chemical immobilization and euthanasia methods are used.

- Traps are set and inspected according to CDA or CPW regulations and WS policy.
- Research continues with the goal of improving the humaneness of PDM devices.

CHAPTER 4: ENVIRONMENTAL CONSEQUE\NCES

Chapter 4 provides the information needed for making informed decisions in selecting the appropriate alternative for meeting the purpose and the need for PDM in Colorado as identified in Chapter 1. This chapter analyzes the environmental consequences of each of the four alternatives discussed in Chapter 3, in relation to the four issues identified for detailed analysis in Chapter 2. The proposed action/no action alternative (Alternative 1) serves as the baseline for the analysis; each of the alternatives is compared to the proposed action for each issue to determine if real or potential impacts are higher, lower, or remain about equal.

The analyses in this Chapter are based on direct, indirect, and cumulative impacts. Direct impacts are caused by the action and occur at the same time and place. Indirect impacts are caused by the action and are later in time or farther removed in distance. Indirect impacts may include effects related to induced changes in population density, ecosystems, and land use changes. Cumulative impacts, as defined by CEQ (40 CFR 1508.7), are "impacts to the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions." Cumulative impacts may result from individually minor, but collectively significant, actions taking place over time

4.1 ISSUES ANALYZED IN DETAIL

As discussed in Chapter 2, the four issues to be analyzed in detail are: (1) effects on target predator species populations; (2) effects on non-target species populations, including T&E Species; (3) impacts on public safety and pets; (4) effects on sociocultural issues; (5) effects of PDM, especially aerial predator management activities, on the use of public lands for recreation; and (6) humaneness and ethical perspective. For each issue, the four alternatives are analyzed.

4.1.1 Effects on Target Predator Populations

To adequately determine the magnitude of impacts in relation to predators and their populations, both WS-Colorado take and cumulative take will be analyzed. While the primary purpose of the population impact analysis may be to prevent unintended reductions to the population, other intents are also met are considered. These include protection wildlife species populations for aesthetics, consumptive and non-consumptive uses, and for the benefits these species provide to functioning ecosystems. These benefits include ecological services. CPW provided estimates of sportsman harvest, but could not provide definitive estimates of population sizes for most species. WS-Colorado used the best available information to produce reasonable estimates of sportsman harvest within the timeframe of this EA (FY10-14). These data are presented and discussed in Chapter 2 (Table 8). Estimates of the predator populations were also made in Chapter 2.

As discussed in Chapter 2, an important consideration for the determination of "significant impact" under NEPA is the effect of a federal action on the environmental baseline. Because the State of Colorado has the authority to manage populations of resident wildlife species (with the exception of migratory and T&E species) as they see fit, the baseline for the environment with respect to state-managed wildlife species may be a stable, increasing, or declining population, as determined by state management agencies which represents the people of the State. Thus, a declining population of a resident wildlife species does not necessarily imply a "significant impact" as defined by NEPA; the decline may be condoned or desired by the State. For example, CPW may want to reduce a specific predator population. It is reasonable and proper to rely on the representative form of government within a state as the established mechanism for determining the collective desires or endorsements of the people of a State. WS-Colorado abides by this philosophy and defers to the collective desires of the people of the State of Colorado.

The analysis herein indicates predator populations are not being impacted to the point of causing a substantial decline. If at some point in the future they are negatively impacted, then such a decline would not constitute a "significant" impact as defined by NEPA, so long as the actions that cause

the decline are in accordance with the responsible management agency's goals and objectives, with applicable State law, and concomitantly, with the collective desires of the people of the State.

A "viable" population can exist at many levels between one that is at biological carrying capacity (the maximum number of a species that a particular habitat can support) and one that is at only a fraction of carrying capacity. Because rates of population increase are density dependent (*i.e.*, the population grows at a faster rate as the population is reduced in relation to carrying capacity), predator populations have the ability to recover from declines that might result from mistakes in management. History has born this out by the fact that efforts in the early half of the 20th century to eradicate some of the predator species being discussed (*e.g.*, coyotes, black bears, and mountain lions) failed to do so. However, the larger predators' numbers were most likely reduced substantially (Evans 1983). Density dependent rates of increase are a built-in mechanism of most wildlife populations that serve to reduce effects of population reductions whether by harvest, localized control, or non-man-induced mortality. This provides additional assurance that a viable population would be maintained in the State, even if a sustainable harvest rate is exceeded in the short term in areas where the objective is to maintain the population.

4.1.1.1 Alternative 1 - Continue the Current Federal PDM Program.

The methods used by WS-Colorado to take target predators under the current program were discussed in Chapter 3. They are the same as those that have been used in recent years and discussed in the prior EA (WS 2005). The methods used in each damage situation depend on the species causing the damage and other factors including location (public versus private lands), weather, and time of year. The methods include frightening devices, foothold traps, cage traps, neck and foot snares, shooting, calling and shooting, aerial predator management, net guns, hunting dogs, M-44s (sodium cyanide), and denning (gas cartridge). Other methods may be used, but most of these would be incorporated by the resource owner.

WS-Colorado conducts PDM annually for 7 primary predator species in Colorado, but could have the potential for dealing with several others (12 species in last 5 FYs -Table 1). These species are listed in Chapter 1 with general information about them and which agency has primary responsibility for responding to damage complaints involving them. The primary target species taken yearly in Colorado are coyotes, red fox, striped skunks, black bears, raccoons, mountain lions, and to a lesser extent, feral cats, badgers, and bobcats. Most other target predators, including feral dogs, swift fox, and opossum, are taken by WS-Colorado only occasionally, if at all. All target predators taken during FY10-14 by WS-Colorado are presented in Table 13. On average, coyotes represented 85% of this take, raccoons 4%, striped skunks 4%, red fox 3%, black bears 3%, mountain lions 0.5%, and all others 0.7%.

Table 13. All target predators killed by WS-Colorado for predator damage management during federal Fiscal Year 2010-14.

Species	FY10	FY11	FY12	FY13	FY14	Average
Coyote	2,648	3,192	1,781	2,032	1,598	2,250
Black Bear	56	74	84	44	101	72
Mountain Lion	11	16	10	17	7	12
Striped Skunk	92	142	115	109	30	98
Red Fox	129	104	95	77	34	88
Raccoon	93	136	110	126	92	111
Feral Dog	3	1	1	0	2	1
Bobcat	5	3	4	0	1	3
Feral Cat	2	4	14	11	3	7
Badger	3	13	14	6	1	7
Swift Fox	3	0	0	0	4	1
Opossum	0	0	0	1	0	0
Total	3,045	3,685	2,228	2,423	1,873	2,651

Table 14 summarizes the average WS-Colorado take and cumulative take of each predator species analyzed. This table also summarizes the analysis of potential impacts to the populations of these species. The potential impacts to each species is analyzed in more depth in the following sections.

Table 14. Overview of impact analyses of predator species targetted by WS-Colorado for predator damage management during federal Fiscal Year 2010-14.

Species	WS Take[α]	Sportsman Harvest[β]	Cumulative Take	Estimated Population	WS Take % of Pop.	Cumulative Take % of Pop.	Long-Term Sustainable Harvest Rate	Impact[γ]
Coyote	2,250	39,977	42,227	156,000	1.4%	27.1%	60%	Low
Red Fox	88	1,287	1,375	94,000	0.1%	1.5%	65%	Low
Gray Fox	0	607	607	36,000	0.0%	1.7%	25%	Low
Swift Fox	1	264	265	9,100	0.0%	2.9%	25%	Low
Striped Skunk	98	1,254	1,352	208,000	0.0%	0.7%	60%	Low
W. Spotted Skunk	0	0	0	26,500	0.0%	0.0%	Not Available	None
E. Spotted Skunk	0	ND	ND	2,650	0.0%	ND	Not Available	None
Hog-nosed Skunk	0	ND	ND	NEP	ND	ND	Not Available	None
Black Bear	72	979	1,051	17,000	0.4%	6.2%	20%	Low
Raccoon	111	2,845	2,956	135,000	0.1%	2.2%	49%	Low
Feral Dog	1	N/A	1	N/A	ND	ND	N/A	N/A
Mountain Lion	12	407	419	4,850	0.2%	8.6%	11%	Low
Bobcat	3	1,588	1,591	10,000	0.0%	15.9%	17%	Low
Badger	7	253	260	52,000	0.0%	0.5%	30%	Low
Feral Cat	7	N/A	7	N/A	ND	ND	N/A	N/A
Opossum	0	45	45	9,500	0.0%	0.5%	Not Available	Low
Long-tailed Weasel	0	0	0	104,000	0.0%	0.0%	Not Available	None
Short-tailed Weasel	0	0	0	40,000	0.0%	0.0%	Not Available	None
Feral Domestic Ferret	0	N/A	0	N/A	ND	ND	N/A	N/A
Marten	0	327	327	20,000	0.0%	1.6%	15%	Low
Mink	0	8	8	90,000	0.0%	0.0%	Not Available	Low
Ringtail	0	28	28	12,500	0.0%	0.2%	Not Available	Low

[α]WS Take is average annual lethal take, including nontarget take, during FY10-14.

[β]Sportsman Harvest is "Recent Harvest" from Table 5; see notes on Table 5 for details. Data from CPW 2014d.

[γ]see species sections for explanation of determination of impact

ND = not determined (data not avaliable); N/A = not applicable; NEP = no extant population in Colorado

4.1.1.1a Coyote Population Impact Analysis.

A population model developed by Pitt *et al*. (2001) assessed the impact of removing a set proportion of the coyote population in one year and then allowing the population to recover (referred to as “pulse removal”). In the model, all populations recovered within 1 year when <60% of the population was removed. The population recovered within 5 years when 60-90% of the population was removed. The authors stated that actual coyote populations would recover even more quickly than the model indicated, because the model made several conservative assumptions: (1) coyote territories were retained even at low densities, (2) animals would not move out of their territories to mate, (3) no animals moved in from surrounding areas (no immigration), and (4) natural mortality rates were not reduced at low population densities. Assumptions like these are generally necessary in order to simplify population models, but in this case, each assumption removes a biological function which would serve to help the population recover more quickly. Pitt *et al*. (2001) also evaluated the impact of removing a set proportion of the population every year for 50 years (“sustained removal”). When the removal rate was <60% of the population, the population size was the same as for an unexploited population. However, a shift in population structure was noted. For example, the population with 50% removal had fewer transient animals, a younger age structure, and higher reproduction. Sustained removal rates of >70% of the population resulted in removal of the entire population after 7 years, but the authors acknowledged that annual removal of 70% of the population would become increasingly difficult at low densities. Because of the model limitations described above, natural populations are probably able to withstand greater levels of sustained removal than their model indicated as well. An earlier model developed by Connolly and Longhurst (1975), and revisited by Connolly (1995), indicated that coyote populations could withstand an annual removal of up to 70% of their numbers and still maintain a viable population. Based on this research, we estimate the long-term sustainable harvest threshold for coyotes to be 60%. This means that the coyote population will not be negatively affected if less than 60% of the population is removed annually, and that any rate below 60% can be continued in perpetuity with no deleterious effect. Further,

harvest rates above 70% would also not affect the statewide population, as long as they are not continued long-term.

-Direct Impacts: Coyotes are the species most frequently targeted by WS-Colorado, primarily because they cause the most damage. In FY10-14, coyotes were responsible for 46% of the livestock losses recorded by WS-Colorado, and 42% of the value of all losses due to predators in Colorado. They were also responsible for the majority of predator damage incidents reported to WS-Colorado (75%). As a result, this species makes up the largest percentage of the WS-Colorado predator take (85%). The coyote population in Colorado was estimated to be 156,000 (A. Hollard, CPW, pers. comm. 2/10/2015). This estimate will be used to determine impacts (Table 15).

Table 15. Overview of coyote impact analysis.

Year	WS Take[α]	Sportsman Harvest[β]	Other Take[γ]	Cumulative Take	Estimated Population	WS Take % of Pop.	Cumulative Take % of Pop.	Long-Term Sustainable Harvest Rate	Impact
FY 2010	2,648	42,427	144	45,219	156,000	1.7%	29%	60%	Low
FY 2011	3,192	49,974	218	53,384	156,000	2.0%	34%	60%	Low
FY 2012	1,781	64,294	46	66,121	156,000	1.1%	42%	60%	Low
FY 2013	2,032	41,337	46	43,415	156,000	1.3%	28%	60%	Low
FY 2014	1,598	41,337	17	42,952	156,000	1.0%	28%	60%	Low
Average	**2,250**	**45,847**	**94**	**48,191**	**156,000**	**1.4%**	**31%**	**60%**	**Low**

[α]WS Take is all lethal take, including nontarget take.

[β]Sportsman Harvest not available for all years, so prior year's estimate was used. Average is from the five most recent years with available data. See text for specifics. Data from CPW 2014d.

[γ]Other take includes aerial shooting by private individuals.

WS-Colorado took an average of 2,250 coyotes annually during FY10-14, with a range of 1,598 to 3,192. These numbers represent 1.0% to 2.0% of the estimated coyote population in Colorado.

Coyote take by WS-Colorado varies considerably from year to year, and we anticipate such variation in future years. Under Alternative 1, we anticipate annual take of coyotes to be less than 3,951 (99% upper confidence limit based on the FY10-14 take data). This take represents less than 2.5% of the estimated population, which studies estimate can withstand annual take of at least 60%. Based on this information, PDM by WS-Colorado would have a low impact on coyotes locally, and no impact on the overall coyote population in Colorado. WS-Colorado coyote take may cause a temporary decrease in localized populations where heavy PDM is performed, but other coyotes will re-occupy these areas, and there will be no effect on the statewide population. Moreover, short-term decreases in local populations are often the goal of PDM, as discussed previously.

Indirect Impacts: Annual mortality in coyote populations is known to range from 19-100% with 40-60% mortality most common. In an EIS on mammalian predator damage management USDI 1979), studies of coyote survival rates were analyzed and the following conclusions were made:

Typical annual survival rates are only 45% to 65% for adults coyotes. High mortality rates have also been shown in four telemetry studies involving 437 coyotes that were older than 5 months of age; 47% of the marked animals are known to have died. Mortality rates even among “unexploited” coyote populations were reported to be between 38-56%. Thus, most coyote populations, even those that are not subjected to control activities, are dynamic. In studies, where reported coyote mortality was investigated, only 14 of 326 recorded mortalities were due to WS activities.

Dispersal of “surplus” young coyotes is the main factor that keeps coyote populations distributed throughout their habitrat. Such dispersal of subdominant animals removes surplus animals from higher density areas and repopulates areas where artificial reductions have occurred. Two studies (Connolly et al. 1976, Gese and Grothe 1995) investigated

the predatory behavior and social hierarchy of coyotes, and determined that the more dominant (alpha) animals were the ones that initiated and killed most of the prey items. Connolly et al. (1976) concluded that the inclination of individuals to attack seemed related to their age and relationships with conspecifics. The coyotes that attacked sheep most frequently were 2-year old males and females paired with these males. Gese and Grothe (1995) concluded from observing wild coyotes that the dominant pair was involved in the vast majority of predation attempts. The alpha male was the main aggressor in all successful kills, even when the other family members were present. Thus, it would appear that removal of local established territorial coyotes actually removes the individuals that are most likely to kill livestock and can result in the immigration of young coyotes that are less likely to kill livestock. Connor (1995) suggested that some WS employees are not very successful in removing dominant territorial coyotes. However, the study involved coyotes at the Hopland Research and Extension Center in California that had already been captured once for radio telemetry purposes and were thus substantially more difficult to catch (G. E. Connolly 1997, pers. comm.). In a review of the study and its conclusions, R. Timm (Superintendent and Extension Wildlife Specialist, Hopland Research and Extension Center; letter dated April 15, 1996 to C. Coolahan, State Director, WS, CO) disagreed with Connor's conclusions, citing "noise" (i.e., confounding factors or unaccounted variables) in the data used, and expressed the opinion that WS efforts "usually reduced the amount of coyote-caused loss which we would have otherwise experienced on our research sheep flock." In general, experienced WS personnel are comparatively proficient at removing dominant pairs.

In a study in New Mexico, Windberg et al. (1997) found no statistically significant difference between territorial and transient coyotes in the proportion of each type that consumed Angora goats. They concluded that management measures to protect livestock during periods of exposure of highly vulnerable kid goats or lambs may be best directed at local coyote populations rather than at particular cohorts or individuals. Their study supports the belief that removal of coyotes from a local population without regard for age or territoriality is advisable in many situations and would not result in a worsening of predation problems or more vulnerable types of livestock such as Angora goats. Wagner and Conover (1999) found that total lamb losses declines 25% on grazing allotments in which coyotes were removed by winter aerial predator management 5-6 months ahead of summer sheep grazing, whereas total lamb losses only declined 6% on allotments that were not aerial hunted. Confirmed losses to coyotes declined by 7% on aerial hunted allotments, but increased 35% on allotments receiving no aerial predator management (Wagner and Conover 1999). This study provides evidence that coyote removal even several months ahead of the arrival of livestock can be effective in reducing predation losses, and that such removal does not actually result in increased losses.

Indirect impacts of WS-Colorado PDM on coyotes include the possibility of increased dispersal and increased fecundity as individual coyotes respond to lower local populations. These are both natural responses to other environmental factors, and WS-Colorado has no reason to believe that such changes would result in any negative impact to the statewide coyote population. Under Alternative 1 we anticipate that indirect impacts would be negligibly low, and that there would be no indirect impact on the statewide coyote population.

Cumulative Impacts: Sportsman harvest is the largest category of take, and it can be estimated. Coyote removal by private individuals for PDM also occurs, and all such known data is included in the "Other Take" category (Table 15). Additional PDM take may occur, but there are no data available to estimate this take, and it is likely to be negligibly low compared to all other methods of take. Therefore, we believe we are including the vast majority of all take, and all of the known take which can be estimated or quantified.

Sportsman harvest is estimated in most years by CPW based on surveys. We used 2009-10 season data for FY10, and so forth, because these timeframes best match our FYs. However, estimates were not available for FY10 or FY14, so we used the prior year's estimate for these years. Thus, sportsman harvest for FY13 and FY14 are identical. Sportsman harvest estimates for the FY10-14 timeframe ranged from 41,337 to 64,294. Rather than double-counting the estimate for 2012-13 (FY13), we used the estimates from the five most recent years with available data to calculate the average sportsman harvest during FY10-14. Those estimates are from the 2007-08, 2008-09, 2010-11, 2011-12, and 2012-13 hunting/trapping seasons, and averaged 45,847 coyotes. Sportsman harvest estimates have consistently remained in the 40,000s, with the exception of 2011-12, where the estimate was 64,294. This number seems to be an outlier, and because these numbers are estimates based on surveys, this estimate may be a statistical anomaly; it is 44% higher than the surrounding years. In fact, the 95% confidence interval for this estimate is 49,947 to 82,763; if the true harvest rate was at the low end of this confidence range, it would be consistent with all other years within this analysis. In further support of this notion, the same surveys produced an estimate of the number of coyote hunters which was 54% higher than the surrounding years, and an estimate of days hunted (for coyotes) which was 99% higher than the surrounding years. Still, in the interest of transparency, we report here the estimate published by CPW (2014d).

The "Other Take" in Table 15 includes aerial predator management by private individuals as reported to CDA (W. East, personal communication). "Other Take" ranged from 17 to 218, with an average of 94 coyotes. On average, sportsmen took 45,847 coyotes per year during FY10-14, representing 29% of the coyote population. Using these numbers, cumulative take averaged 48,097 coyotes per year during FY10-14, with a high of 66,075 in FY12. This represents an average harvest of 31% of the state's coyote population, with a high of 42% in FY12. These numbers are all well below the 60% sustainable harvest threshold. We anticipate a low impact on coyotes locally, and no impact on the overall Colorado coyote population (Table 15).

Even with possible under-reporting of "Other Harvest" (*e.g.*, PDM by other individuals), the coyote population would not be negatively affected unless this additional harvest totaled more than 45,000 coyotes each year, bringing the cumulative total above 62,500 (60% of the estimated population). Moreover, occasional years with take above the 60% threshold would also not impact the coyote population, as long as such take levels did not continue long-term.

Our determination of low impact on the coyote population is consistent with the U.S. General Accounting Office (1990) assessment that WS's PDM program nationwide has not threatened statewide predator populations, including coyotes, particularly in the western United States where such PDM programs were most prevalent. This is due, at least in part, to the ability of coyotes to rapidly occupy vacant territories where coyotes have been removed during PDM (Windberg and Knowlton 1988). Whereas removing coyotes from localized areas at the appropriate time can protect vulnerable livestock, immigration of coyotes from the surrounding area quickly replaces the animals removed (Stoddart 1984). Connolly (1978) further noted that coyotes have survived and even thrived in spite of early 20th century efforts to exterminate them.

4.1.1.1b Red Fox Population Impact Analysis.

Long-term sustainable harvest rates for red fox up to 65% (Layne & McKeon 1956) and 70% (Davis 1974) have been reported. We will use the more conservative rate of 65% as the sustainable harvest threshold, below which fox populations would remain unchanged.

Direct Impacts: The majority of fox-related predator damage incidents logged by WS-Colorado involve the red fox: an average of 129 incidents per year during FY10-14. WS-Colorado took an average of 88 red fox in Colorado, 3.3% of the average WS-Colorado predator take during FY10-14 (Table 16). Red fox take by WS-Colorado ranged from 34 (1.8% of total predator take) in FY14 to 129 (4.2% of total predator take) in FY10. This level of take represents a maximum of 0.14% of the red fox population in Colorado, with an average of less than 0.1%. Red fox take by WS-Colorado consistently decreased during FY10-14, but a longer term analysis (FY00-14) shows that red fox take has varied considerably over the years (Figure 4). Under Alternative 1, we anticipate that WS-Colorado will take less than 179 red foxes (99% upper confidence limit of the FY10-14 take). This represents less than 0.2% of the estimated red fox population, which studies estimate can withstand annual take of 65%. Under Alternative 1, we anticipate a low impact on red fox locally, and no impact on the statewide red fox population in Colorado. Red fox take by WS-Colorado may cause a temporary decrease in localized populations where heavy PDM is performed, but other red foxes will re-occupy these areas, and there will be no effect on the statewide population. Moreover, short-term decreases in local populations are often the goal of PDM, as discussed previously.

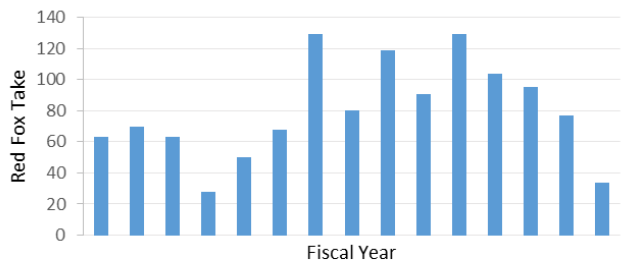


Figure 4. WS-Colorado take of Red Fox during federal Fiscal Year 2000-14, showing the variation among the years.

-Indirect Impacts: Coyotes comprise 85% of WS-Colorado's average annual predator take, and red fox comprise only 3%. Because coyotes and red foxes compete for habitat, the disparity in take between the species may result in local decreases in interspecific competition. This may result in increases in local red fox populations. However, statewide populations are not likely to be affected. We know of no other indirect impacts to red fox populations due to PDM conducted by WS-Colorado. We anticipate indirect impact to statewide red fox populations to be negligibly low.

Cumulative Impacts: CPW estimated an average of 1,287 red fox taken by sportsmen (CPW 2014d), which is approximately 1.4% of the estimated red fox population in Colorado (Table 16, A. Hollard, CPW, pers. comm. 2/10/2015). This average is based on the five most recent estimates available: 2001-02, 2002-03, 2003-04, 2004-05, and 2009-10. We used this average for each year analyzed, because only one population estimate was available during the timeframe of the analysis in this EA (FY10-14). We believe that this number is the best estimate of sportsman harvest within this timeframe based on the available data. We are not aware of any other known harvest numbers for red fox, except for the take of one red fox in FY10 during aerial predator management by a private individual. For simplicity, this fox was not included in our analysis because we only know of such take in one year, and it represents less than 0.1% of cumulative take (~0.001% of the statewide population). Using these numbers, cumulative take of red fox ranged from 1,321 to 1,416 in FY10-14, with an average of 1,375. This represents an average of 1.46% of the estimated red fox population, with a maximum take of 1.51% (Table 16). Under Alternative 1, we anticipate cumulative take to be less than 2,935 red fox (sum of the 99% upper confidence intervals of all known take). This represents a maximum harvest of 3.1% of the estimated red fox population, which can withstand long-term harvest of 65%. This level of take will have a low impact on red fox locally, and no impact on the statewide red fox population.

Table 16. Overview of red fox impact analysis.

Year	WS Take[α]	Sportsman Harvest[β]	Cumulative Take[γ]	Estimated Population	WS Take % of Pop.	Cumulative Take % of Pop.	Long-Term Sustainable Harvest Rate	Impact
FY 2010	129	1,287	1,416	94,000	0.14%	1.51%	65%	Low
FY 2011	104	1,287	1,391	94,000	0.11%	1.48%	65%	Low
FY 2012	95	1,287	1,382	94,000	0.10%	1.47%	65%	Low
FY 2013	77	1,287	1,364	94,000	0.08%	1.45%	65%	Low
FY 2014	34	1,287	1,321	94,000	0.04%	1.41%	65%	Low
Average	**88**	**1,287**	**1,375**	**94,000**	**0.09%**	**1.46%**	**65%**	**Low**

[α]WS Take is all lethal take, including nontarget take.

[β]Sportsman Harvest estimates not available for most years during FY10-14, so the average of the five most recent estimates is used. This includes 2001-02, 2002-03, 2003-04, 2004-05, and 2009-10 seasons. Data from CPW 2014d.

[γ] Cumulative take excludes one red fox taken by aerial shooting by a private individual in FY10. This is the only other known take of red fox, and it is too small (<0.1% of cumulative take) to be considered.

As in the coyote analysis above, it is likely that some number of red fox are taken annually without our knowledge, including those taken by private citizens for PDM which are not reported. However, this number is likely to be very small compared to sportsman harvest. Moreover, due to the large disparity between cumulative take and sustainable take, the inclusion of this take (if it were known) would not affect our analysis.

4.1.1.1c Gray Fox Population Impact Analysis. The population of gray fox was estimated at 36,000 for Colorado (Chapter 2). Long-term sustainable harvest rates for gray fox were estimated at 25-50% (Fritzell 1987). For this analysis, we will use the lowest reported number, 25%.

Direct Impacts: During FY10-14 WS-Colorado did not record any predator damage incidents due to gray fox (Table 1). WS-Colorado rarely takes gray fox in PDM and did not take any during FY10-14. The prior EA reported WS-Colorado take of only 1 gray fox on average during FY00-15, with a maximum annual take of 3 (WS 2005). We anticipate the potential take of up to 5 gray fox annually by WS-Colorado, which constitutes less than 0.1% of the statewide gray fox population of an estimated 36,000 individuals (A. Hollard, CPW, pers. comm. 2/10/2015). Because gray fox take by WS-Colorado would be only occasional and sporadic, we do not anticipate any effect on local gray fox populations. Under Alternative 1, we anticipate a low impact on gray fox locally, and no impact on the statewide gray fox population.

Indirect Impacts: As discussed for red fox above, local decreases in interspecific competition due to the take of coyotes may allow for increases in local gray fox populations. However, these local effects are not likely to affect the statewide gray fox population. We know of no other indirect impacts to gray fox due to PDM conducted by WS-Colorado. We anticipate that the indirect impacts to the statewide gray fox population to be negligibly low.

Cumulative Impacts: CPW estimates of sportsman harvest during FY10-14 averaged 607 per year, with a range of 109 to 1,047 (CPW 2014d). No estimate was available for FY11 (the 2010-11 season), and the hunting/trapping season for gray fox was closed for many years prior to FY10, so the only four recent and available estimates (2009-10, 2011-12, 2012-13, and 2013-14) were used for the average. Because there was no other known take of gray foxes in Colorado during FY10-14, these numbers reflect the cumulative harvest also. We anticipate that less than 1,639 gray foxes (up to 5 by WS-Colorado plus the 99% upper confidence interval of sportsman harvest) would be taken cumulatively under Alternative 1. This represents 4.6% of the estimated gray fox population in Colorado, and we consider the cumulative impacts to be negligibly low. A summary of this impact analysis is presented in Table 14.

4.1.1.1d Swift Fox Population Impact Analysis. The estimated statewide population of swift fox is 9,100 (Chapter 2, A. Holland, CPW, pers. comm. 2/15/2015). We know of no published long-term sustainable harvest rates for swift fox. For this analysis, we will use the lowest published rate for gray fox (25%) as a conservative estimate of swift fox sustainable harvest.

Direct Impacts: During FY10-14 WS-Colorado recorded an average of two predator damage incidents due to swift fox (Table 1). WS-Colorado took an average of 1 swift fox per year during FY10-14. Swift fox take ranged from 0 to 4, including 3 taken as non-targets in FY10 and 4 targeted in FY14. No swift fox were taken in FY11-13. WS-Colorado rarely targets this species in PDM because they generate few complaints, and infrequently cause damage. Under Alternative 1, we anticipate maximum annual take of swift fox by WS-Colorado to be less than 10. This represents 0.1% of the statewide swift fox population; thus, we anticipate a negligibly low impact to swift fox locally, and no impact on the statewide swift fox population.

Indirect Impacts: Local decreases in interspecific competition due to the take of coyotes and red fox may allow for increases in local swift fox populations. However, these local effects are not likely to affect the statewide swift fox population. We know of no other indirect impacts to swift fox due to PDM conducted by WS-Colorado. We anticipate that the indirect impacts to the statewide swift fox population to be negligibly low.

Cumulative Impacts: Sportsman harvest estimates ranged from 107 to 416 during FY10-14, with an average of 264 (CPW 2014d). We know of no other take of swift fox in Colorado. Cumulative take averaged 265, with a maximum of 420 in FY14. These numbers represent 2.9% and 4.6%, respectively, of Colorado's estimated population of 9,100 (Chapter 2). Under Alternative 1, we anticipate annual cumulative take to be less than 602 (less than 10 taken by WS-Colorado plus the 99% upper confidence interval of sportsman harvest), which represents less than 6.6% of the swift fox population. Historic sportsman harvest averaged 602 swift fox (6.6% of the population), with a high of 2,210 (24%) in 1986-87 (Table 8), without any apparent effect on the population, which supports the 25% sustainable take threshold. Under Alternative 1, cumulative impacts on the statewide swift fox locally is anticipated to be low, and we anticipate no impact on the statewide swift fox population. A summary of this impact analysis is presented in Table 14.

4.1.1.1e Striped Skunk Population Impact Analysis. Boddicker (1980) cited a 60% long-term sustainable harvest threshold for skunks. This rate may be based only on experience, rather than on empirical data, but we know of no other published sustainable harvest rate for striped skunks. The estimated population of striped skunks in Colorado is 208,000 (Chapter 2, A. Hollard, CPW, pers. comm., 2/15/2015).

Direct Impacts: The majority of requests for assistance for skunk-related damage is for striped skunks. WS-Colorado took an average of 98 striped skunks in Colorado which is 3.6% of the average WS-Colorado predator take during F10-14, and less than 0.1% of the estimated statewide striped skunk population. WS-Colorado take ranged from 30 in FY14 to 142 in FY11 (Table 17). Under Alternative 1, we anticipate that WS-Colorado would take less than 206 striped skunks in any year (99% upper confidence limit of FY10-14 take), which represents less than 0.1% of the statewide population. As such, we anticipate a low impact on striped skunks locally, and no impact on the statewide striped skunk population.

Indirect Impacts: We are not aware of any significant indirect impacts to striped skunks due to PDM conducted by WS-Colorado.

Table 17. Overview of striped skunk impact analysis.

Year	WS Take[α]	Sportsman Harvest[β]	Cumulative Take	Estimated Population	WS Take % of Pop.	Cumulative Take % of Pop.	Long-Term Sustainable Harvest Rate	Impact
FY 2010	92	1,254	1,346	208,000	0.04%	0.65%	60%	Low
FY 2011	142	1,254	1,396	208,000	0.07%	0.67%	60%	Low
FY 2012	115	1,254	1,369	208,000	0.06%	0.66%	60%	Low
FY 2013	109	1,254	1,363	208,000	0.05%	0.66%	60%	Low
FY 2014	30	1,254	1,284	208,000	0.01%	0.62%	60%	Low
Average	**98**	**1,254**	**1,352**	**208,000**	**0.05%**	**0.65%**	**60%**	**Low**

[α]WS Take is all lethal take, including nontarget take.

[β]Sportsman Harvest estimates not available for most years during FY10-14, so the average of the five most recent estimates is used. This includes 2001-02, 2002-03, 2003-04, 2004-05, and 2009-10 seasons. Data from CPW 2014d.

Cumulative Impacts: CPW estimated sportsman harvest in 2009-10, but not in any other years during FY10-14. To determine a reasonable estimate of average sportsman harvest, we used the five most recent years with available data: 2001-02, 2002-03, 2003-04, 2005-05, and 2009-10. The average sportsman harvest was 1,254, with a range of 274 to 2,482 (CPW 2014d). Cumulative take averaged 1,352, with a range of 1,284 to 1,396. Under Alternative 1, we anticipate that cumulative take would not exceed 3,642 striped skunks in any year (the sum of the 99% upper confidence limits for WS-Colorado take and sportsman harvest), which represents less than 1.8% of the statewide population. As noted above, the reported sustainable harvest rate (60%) may not be based on empirical data, and as such, it could be inaccurate. But even if the true sustainable harvest rate is only a third of what has been reported (20%), maximum anticipated cumulative take would still be a small fraction of sustainable harvest. Cumulative impacts under Alternative 1 are anticipated to be negligibly low.

4.1.1.1f Spotted Skunk and Hog-nosed Skunk Population Impact Analyses.

Statewide populations of spotted skunks are estimated at 26,500 and 2,650 for western and eastern spotted skunks, respectively (A. Hollard, CPW, pers. comm., 2/15/2015). There is no population estimate for hog-nosed skunks, which may not have an established population in Colorado. We know of no published sustainable harvest threshold data for any of these species. Historically, sportsman harvest of eastern and western spotted skunks averaged 3 and 98, respectively (Table 8), which suggests some level of sustainable harvest for these species.

Direct Impacts: WS-Colorado rarely receives complaints for damage due to eastern or western spotted skunks, or hog-nosed skunks, and these species are rarely targeted by WS-Colorado for PDM. WS-Colorado did not take any of these skunk species during FY10-14, but 3 western spotted skunks were taken during FY00-04. It is possible that an extant population exists in Colorado and is not generating damage complaints due to the hog-nosed skunk's habitat preference for rocky canyons. If so, the population would likely number at least a few hundred individuals and limited take would not be likely to impact the population as a whole. If hog-nosed skunks expanded their range from New Mexico into Colorado, the impact would be minimal because New Mexico's population of hog-nosed skunks is healthy enough to withstand some level of harvest (BISON-M 2004). Under Alternative 1, we anticipate that occasional take of these skunk species is unlikely, but may occur, with a maximum of 5 western spotted skunks, 1 eastern spotted skunk, and 1 hog-nosed skunk in any year. We anticipate these levels of take to have negligible

impacts on spotted and hog-nosed skunks locally, and no impact on the statewide populations of these species.

Indirect Impacts: These skunk species are not common in Colorado, and it is unlikely that PDM conducted by WS-Colorado would have any indirect effects on these species.

Cumulative Impacts: Sportsman harvest for western spotted skunk was estimated by CPW in 2010 (CPW 2014d) when the hunting and trapping season was re-opened, and that estimate was zero. Western spotted skunk harvest has not been estimated since then, and prior to that, the hunting and trapping season had been closed since 1995. The hunting and trapping season on eastern spotted skunk has been closed since 1995, and they are considered non-game wildlife. Known cumulative take of the two species of spotted skunks has remained at zero during FY10-14. Therefore, there is has been no effect of cumulative take on these populations. Under Alternative 1, spotted skunks may be taken occasionally by WS-Colorado and/or sportsman. We anticipate a maximum cumulative take of 20 western spotted skunks and 2 eastern spotted skunks. These numbers are below the historical sportsman harvest estimates, and are expected to have a negligibly low impact on the statewide populations. Hog-nosed skunks may occasionally be taken by WS-Colorado and/or sportsman. We anticipate cumulative take not to exceed 2 hog-nosed skunks. The cumulative impact to hog-nosed skunks is expected to be negligibly low.

4.1.1.1g Black Bear Population Impact Analysis. Black bears were the number 2 species, behind coyotes, for the amount of damage caused by predators, and for predator damage incidents recorded by WS-Colorado. Black bear were responsible for 35% of the predator damage recorded by WS-Colorado during FY10-14. WS-Colorado logged an average of 476 such incidents per year, which was 9.7% of the total (Table 1). CPW estimated the black bear population in Colorado to be 17,000 – 20,000 CPW 2015, Chapter 2). The long-term sustainable harvest rate for black bears has been estimated at 20% (D. Koch pers. comm. 12/13/89, M. Pelton pers. comm. 12/11/89, C. Willey pers. comm. 12/11/89). Clark and Smith (1994) estimated sustainable yield of 26% for a location in Arkansas with good bear habitat, though they noted that this level may not be able to maintained indefinitely. Other published rates have been as low as 14.2-15.9% based on models (Miller 1990).

Direct Impacts: WS-Colorado lethally took an average of 72 black bears per year during FY10-14, with a range of 44 (FY13) to 101 (FY14). This corresponds to an average of 0.4%, with a maximum of 0.6% of the statewide black bear population (Table 18). Under Alternative 1, we anticipate an increase in black bear take by WS-Colorado, up to 200 black bears, due to an increasing bear population, increasing conflicts between citizens and bears, as well as future projects to protect native wildlife from black bear predation, in cooperation with CPW (Appendix A). This corresponds to 1.2% of the estimated statewide black bear population. This level of black bear take is well below the 20% sustainable harvest threshold, and is expected to have a low impact on black bears locally, and no impact on the statewide black bear population.

Indirect Impacts: We are not aware of any significant indirect impacts to black bears due to PDM conducted by WS-Colorado.

Cumulative Impacts: Sportsman harvest averaged 1,103 black bears per year, with a range of 800 to 1,364. Cumulative take ranged from 856 (FY10) to 1,465 (FY14), with an average of 1,175 per year (CPW 2014b; Tables 8 and 18). This corresponds to an average of 6.9%, with a maximum of 8.6% of the estimated black bear population in Colorado. Under Alternative 1, we anticipate cumulative take not to exceed 1,828 black bears in any year (up to 200 taken by WS-Colorado plus 99% upper confidence interval of sportsman harvest). This corresponds to 10.8% of the estimated black bear population in Colorado. This level of harvest is well below the 20% sustainable harvest threshold. In fact, it is below even the lowest reported sustainable harvest rate (14.2%). These levels of

cumulative take are expected to have a low impact on black bears locally, and no impact on the statewide black bear population.

Table 18. Overview of black bear impact analysis.

Year	WS Take	Sportsman Harvest	Cumulative Take	Estimated Population	WS Take % of Pop.	Cumulative Take % of Pop.	Long-Term Sustainable Harvest Rate	Impact
FY 2010	56	800	856	17,000	0.3%	5.0%	20%	Low
FY 2011	74	1,074	1,148	17,000	0.4%	6.8%	20%	Low
FY 2012	84	1,172	1,256	17,000	0.5%	7.4%	20%	Low
FY 2013	44	1,106	1,150	17,000	0.3%	6.8%	20%	Low
FY 2014	101	1,364	1,465	17,000	0.6%	8.6%	20%	Low
Average	**72**	**1,103**	**1,175**	17,000	**0.4%**	**6.9%**	20%	**Low**

WS-Colorado's take of black bears is generally in response to requests by state agencies to remove problem bears. In the absence of these actions by WS-Colorado, the bears would likely still be removed either by the state agencies or their agents. CPW intensively manages black bears and makes decisions about annual harvest rates. CPW may decide to effect a decrease in the black bear population when it determines the population to be too high. WS-Colorado's involvement in the take of black bears in such a scenario would not be considered significant impact. Also, similar to mountain lion management, WS-Colorado's involvement should actually *benefit* the ability of CPW to control black bear mortality by encouraging livestock owners to utilize government assistance in resolving depredation problems. WS-Colorado is more likely to target the correct bear, whereas private resource owners may not kill the target bear as reliably.

4.1.1.1h Raccoon Population Impact Analysis. The raccoon population in Colorado was estimated to be 135,000 animals (Chapter 2, A. Hollarnd, CPW, pers. comm., 2/15/2015). Sanderson (1999) reported sustainable harvest rates of 49%, 53%, and 59% for raccoon populations with low, medium, and high fecundity, respectively. For this analysis, we will use the lowest reported harvest rate (49%) as a very conservative estimate.

Direct Impacts: WS-Colorado took an average of 111 raccoons per year during FY10-14, with a range of 92 to 136 (Table 19). This corresponds to an average of 0.08%, with a maximum of 0.1% of the estimated raccoon population in Colorado. Under Alternative 1, we anticipate that WS-Colorado would take no more than 162 raccoons (99% upper confidence interval of the FY10-14 take). This corresponds to 0.1% of the estimated statewide raccoon population, which is well below the 49% sustainable harvest rate. Under Alternative 1, we anticipate that WS-Colorado PDM would have a low impact on raccoons locally, and no impact on the overall raccoon population in Colorado.

Indirect Impacts: We are not aware of any significant indirect impacts to raccoons due to PDM conducted by WS-Colorado.

Cumulative Impacts: Sportsman harvest was estimated by CPW in 2009-10, but not in any other years during FY10-14, so we used the five most recent estimates available to calculate an average for the purpose of this analysis. Sportsman harvest was estimated at 3,703, 2,777, 2,153, 293, and 5,299 in 2001-02, 2002-03, 2003-04, 2004-05, and 2009-10 respectively (CPW 2014d). The average sportsman harvest was 2,845, and cumulative take averaged 2,956, with a maximum of 2,981 (Table 19). Cumulative take was consistently 2.2% of the population during FY10-14. Under Alternative 1, we anticipate cumulative take not to exceed 7,791 raccoons (sum of the 99% upper confidence limits of WS-Colorado take and recent sportsman harvest), which corresponds to 5.8% of the estimated statewide population. We anticipate this level of take to have a low impact on raccoons locally, and no impact on the overall raccoon population in Colorado.

Table 19. Overview of raccoon impact analysis.

Year	WS Take[α]	Sportsman Harvest[β]	Cumulative Take	Estimated Population	WS Take % of Pop.	Cumulative Take % of Pop.	Long-Term Sustainable Harvest Rate	Impact
FY 2010	93	2,845	2,938	135,000	0.07%	2.2%	49%	Low
FY 2011	136	2,845	2,981	135,000	0.10%	2.2%	49%	Low
FY 2012	110	2,845	2,955	135,000	0.08%	2.2%	49%	Low
FY 2013	126	2,845	2,971	135,000	0.09%	2.2%	49%	Low
FY 2014	92	2,845	2,937	135,000	0.07%	2.2%	49%	Low
Average	**111**	**2,845**	**2,956**	**135,000**	**0.08%**	**2.2%**	**49%**	**Low**

[α]WS Take is all lethal take, including nontarget take.

[β]Sportsman Harvest estimates not available for most years during FY10-14, so the average of the five most recent estimates is used. This includes 2001-02, 2002-03, 2003-04, 2004-05, and 2009-10 seasons. Data from CPW 2014d.

4.1.1.1i Feral Dog Impact Analysis. Feral and free-roaming dogs are somewhat common in Colorado. Requests for assistance with feral dogs are approved by the appropriate State or local agency, as regulated by Colorado State laws. WS-Colorado logged an average of 11 damage complaints involving feral dogs annually during FY10-14 (Table 1).

Direct, Indirect, and Cumulative Impacts: WS-Colorado took an average of 1 feral dog per year in FY10-14 (Table 13). Under Alternative 1, we anticipate that WS-Colorado may take up to 5 feral dogs in any year. This level of take will have a low impact on the feral dog population in Colorado, which is considered slightly beneficial. Take of feral or free-ranging dogs by WS-Colorado is considered to have little impact on the human environment because feral dogs are not an indigenous component of the ecosystem in Colorado. In addition, the annual take of dogs by WS-Colorado is insignificant compared to the thousands killed by animal control and humane organizations in Colorado each year. Therefore, no further analysis of population impacts is provided. Moreover, as a non-native species in Colorado, the removal of feral dogs is generally considered to have a positive impact on the environment.

4.1.1.1j Mountain Lion Population Impact Analysis. WS-Colorado logged an average of 111 incidents of damage due to mountain lions per year during FY10-14 (Table 1). The mountain lion population in Colorado was estimated at 4,850 (Chapter 2, A. Hollarnd, CPW, pers. com., 2/15/2015). Several studies on mountain lion population dynamics provide insights into long-term sustainable harvest levels. Ashman *et al*. (1983) found that a mountain lion population in Nevada had the recruitment capacity (reproduction and immigration) to rapidly replace annual losses under "moderate to heavy exploitation of 30%-50% removal". Logan *et al*. (1996) determined the rate of increase in a New Mexico population varied from 8-11% in an un-hunted and uncontrolled population, to 21-28% in a population where harvest and control was simulated by removing 50% of the lions from the study area. They concluded that rates of increase in mountain lion populations are density dependent; as a population declines in relation to carrying capacity, the rate of increase becomes higher. This is a natural mechanism of wildlife populations that serves to protect species by enhancing the ability of populations to recover from declines. Logan *et al*. (1996) suggested that, for a lion population to remain at or near maximum carrying capacity, no more than 11% of the adults should be harvested annually. They also stated that the harvest level might need to exceed 28% per year to produce a substantial decline in the population, as may be desired if a State determines that a population is too high. They further determined that a viable population can be maintained at about 50% of carrying capacity with harvest levels that range from 21% to 28%. Consequently, the long-term sustainable harvest threshold may vary from 11% to 28%, depending on the size of the population that is desired (100% or 50% of carrying capacity).

We use the most conservative estimate of 11% for this analysis. However, state wildlife agencies will sometimes allow a greater percentage of mountain lions to be harvested in order to reach management goals. CPW intensively manages mountain lion populations and makes decisions about annual harvest rates. CPW may decide to effect a decrease in

the mountain lion population when it determines the population to be too high in a specific area, or statewide. Localized populations of mountain lions can be harvested more intensively, partly due to immigration. A localized population can recover to pre-harvest levels in 9 months when 36% of the local population is harvested, and 31 months when 47% of the population is harvested (Lindzey *et al*. 1992, Logan and Sweanor 2001). Increased localized mountain lion harvest may be conducted to protect mule deer in Colorado at rates up to 36% of the local mountain lion population (C. Anderson, CPW, pers. comm, Aug 16, 2016).
Most such harvest is accomplished through hunting regulations, but as mountain lion populations decrease, hunting pressure declines, and hunter harvest can also be reduced by poor snow conditions (Hurley *et al*. 2011). WS-Colorado's involvement in the take of mountain lions in such a scenario would not be considered significant impact.

Direct Impacts: WS-Colorado took an average of 12 mountain lions per year (0.25% of the population), with a range of 7 to 17 (Table 20). WS-Colorado also took 1 mountain lion as a non-target, which was released. The capture and release of this 1 lion is not expected to have any effect on the population, so the rest of this section focuses on lethal take. Under Alternative 1, mountain lion take by WS-Colorado may increase over the FY10-14 levels due to additional resources, and projects to protect mule deer from mountain lion predation (Appendix B). We anticipate that WS-Colorado would take no more than 40 mountain lions in any year, which is 0.8% of the statewide population. This level of take is expected to result in a low impact on mountain lions locally, and no impact on the statewide mountain lion population. WS-Colorado's take of mountain lions is generally in response to requests by state agencies to remove problem lions. In the absence of these actions by WS-Colorado, the lions would likely still be removed either by the state agencies or their agents.

Indirect Impacts: Intentional high harvest rates may be implemented by CPW to allow ungulate populations to reach population objectives. Once objectives are met, CPW may relax mountain lion harvest rates. Depending on the percentage of the lion population reduced, recovery to the original population level may take 1-3 years.

Concern may exist about increased mountain lion harvest may lead to decreased kitten survival. This suggests overall mountain lion harvest may be higher than direct harvest due to infanticide (Cooley et al. 2009, Ruth et al 2011). Increased male lion harvest has been suggested to lead to increased sub-adult males in the population and territorial instability (Logan and Sweanor 2010, Ruth et al. 2011). However, recent mountain lion research in Colorado have shown higher infanticide rates during a 5-year non-hunting period than the subsequent 5-year hunting phase of the study (Logan 2015). Infanticide mostly occurs in winter when mountain lion territories overlap and adult males, resident males and immigrating males practice infanticide on mountain lion cubs and possibly their mother (Ruth et al. 2011). However, cub survival is highest with increased density of adult male mountain lions (Ruth et al. 2011).

Cumulative Impacts: During FY10-14, sportsman harvest averaged 407 mountain lions, with a range of 270 to 467 (Table 8, CPW 2014c). Cumulative take averaged 419, with a maximum of 484 in FY13. This corresponds to an average of 8.6%, with a maximum of 10.0% of the estimated mountain lion population (Table 20). Cumulative lion take by WS-Colorado and sportsman's harvest in Colorado is less than 11% over last 5 year period which would keep the mountain lion population at carrying capacity (Logan et al. 1996). Under Alternative 1, we anticipate slightly higher mountain lion take, but not generally higher than 534 mountain lions, or 11% of the statewide population. This may include localized take up to 36% of local populations. And statewide cumulative take may exceed 11% in some years, especially when the state may decide to decrease the mountain lion population as discussed below. Cumulatively under Alternative 1, we anticipate a moderate impact to mountain lions locally, and potentially a low impact on the statewide mountain lions population. It should be noted that these local and statewide impacts would

be at the direction of and under the control of CPW, as discussed below. WS-Colorado would have no authority and no ability to alter these impacts on mountain lions.

Table 20. Overview of mountain lion impact analysis.

Year	WS Take	Sportsman Harvest	Cumulative Take	Estimated Population	WS Take % of Pop.	Cumulative Take % of Pop.	Long-Term Sustainable Harvest Rate	Impact
FY 2010	11	370	381	4,850	0.23%	7.9%	11%	Low
FY 2011	16	374	390	4,850	0.33%	8.0%	11%	Low
FY 2012	10	383	393	4,850	0.21%	8.1%	11%	Low
FY 2013	17	467	484	4,850	0.35%	10.0%	11%	Low
FY 2014	7	442	449	4,850	0.14%	9.3%	11%	Low
Average	**12**	**407**	**419**	**4,850**	**0.25%**	**8.6%**	**11%**	**Low**

Mountain lion populations are managed intensively by CPW, and decisions about annual harvest rates are determined by the State of Colorado, which may decide to effect a decrease in the population when it determines the population to be too high. The consistent maintenance of cumulative take just below 11% of the population is an indication of the State's intensive management, as well as their current goals regarding the lion population, as discussed above. WS-Colorado's involvement in the take of mountain lions in such a scenario would not be considered significant impact. Similar to black bear management discussed above, WS-Colorado's involvement should actually *benefit* the ability of CPW to control lion mortality by encouraging livestock owners to rely on government assistance in resolving depredation problems. WS-Colorado is more likely to target the correct lion, whereas private resource owners may not reliably kill the target lion.

CPW has management objectives for the 19 mountain lion data analysis units (DAUs) in Colorado. Hunter harvest and non-hunter mortality objectives have been set. CPW uses a 5 year average of harvest to estimate mortality (hunter and non-hunter), and to determine the harvest potential for a DAU, and to set the next season's quota. WS-Colorado take is included in the CPW analyses. Based on CPW analyses, WS-Colorado is not impacting the population in any DAU. CPW can and will reduce the quota in an area where they suspect an over-harvest has occurred or can increase licenses in areas where the population is higher than the desired objective.

4.1.1.1k Bobcat Population Impact Analysis. WS-Colorado recorded an average of 32 incidents of damage due to bobcats each year (Table 1). The statewide bobcat population was estimated at 21,000 (Chapter 2, A. Holland, CPW, pers. comm., 2/15/2015). CPW (2014d) uses 17% as the long-term sustainable harvest threshold for bobcats, and we will use this number for our analysis also.

Direct Impacts: WS-Colorado took an average of 3 bobcats annually during FY10-14. Maximum WS-Colorado bobcat take was 5 in FY10. This corresponds to an average of 0.01%, with a maximum of 0.02% of the estimated statewide bobcat population. WS-Colorado take was also a very small fraction of the total take; it averaged 0.17%, with a maximum of 0.37%. These levels of take are negligibly low compared to the population, and to total take. Under Alternative 1, we anticipate that WS-Colorado could take up to 10 bobcats in any year, which corresponds to 0.05% of the statewide population. This level of take would be expected to have a low impact on bobcats locally, and no impact on the statewide bobcat population.

Indirect Impacts: WS-Colorado would take very few bobcats in any year under Alternative 1, and any indirect impacts of such take would be negligible.

Cumulative Impacts: Sportsman harvest ranged from 1,303 to 1,945, with an average of 1,644 annually during FY10-14 (Table 21). A few bobcats are knows to be hit by cars each year, but these numbers are insignificant compared to sportsman harvest. We know of no other sources of bobcat losses, other than natural causes (*e.g.*, disease, starvation). Such natural factors are taken into account when determining sustainable harvest thresholds, so they will not be analyzed here. Cumulative take averaged 1,660 bobcats, with a range of 1,336 to 1,959. These numbers represent an average of 7.9% of the bobcat

population, with a maximum of 9.3% in FY14. There is a definite trend of increasing cumulative take during this timeframe, which is due to the increasing trend of sportsman harvest (Table 21). CPW (2014d) suggested that this increasing trend was due to increasing fur prices over this timeframe. Although the trend is increasing, cumulative take during FY10-14 was well below the 17% sustainable harvest threshold. Under Alternative 1, we anticipate cumulative harvest may continue to increase, depending on fur prices, up to a maximum of 2,939 bobcats (50% higher than the maximum cumulative harvest in FY10-14). This corresponds to 14% of the bobcat population, which is below the 17% sustainable harvest threshold. As such, we expect the impact to bobcats to be low, and that there would be no impact to the statewide bobcat population. The results of our analysis match the results of an analysis by CPW (2014d), who analyzed all bobcat mortality. They found that total mortality was increasing, but remained below the sustainable threshold. They concluded that the bobcat population is stable, or perhaps increasing slightly. Based on this analysis, they did not recommend changing bobcat management rules, such as seasons, methods, and bag limits.

Table 21. Overview of bobcat impact analysis.

Year	WS Take	Sportsman Harvest	Other Take[α]	Cumulative Take	Estimated Population	WS Take % of Pop.	Cumulative Take % of Pop.	Long-Term Sustainable Harvest Rate	Impact
FY 2010	5	1,303	28	1,336	21,000	0.02%	6.4%	17%	Low
FY 2011	3	1,489	10	1,502	21,000	0.01%	7.2%	17%	Low
FY 2012	4	1,628	13	1,645	21,000	0.02%	7.8%	17%	Low
FY 2013	0	1,854	4	1,858	21,000	0.00%	8.8%	17%	Low
FY 2014	1	1,945	13	1,959	21,000	0.00%	9.3%	17%	Low
Average	**3**	**1,644**	**14**	**1,660**	**21,000**	**0.01%**	**7.9%**	**17%**	**Low**

[α]Other Take is game damage and 30-day permits, as reported by CPW (2014d), minus WS take which they included.

State agencies manage bobcat season, methods, and bag limits if they determine that the cumulative bobcat mortality exceeds their management thresholds, as alluded to above. WS-Colorado take is included in cumulative mortality, and the State's management objectives are not influenced by WS-Colorado.

4.1.1.1l Badger Population Impact Analysis. WS-Colorado logged an average of 14 incidents of damage due to badgers annually during FY10-14 (Table 1). The statewide population of badgers was estimated at 52,000 (Chapter 2, A. Holland, CPW, pers. comm., 2/15/2015). Boddicker (1980) has suggested that the long-term sustainable harvest threshold is above 30-40%. These rates may be based only on experience, and not on any empirical data, so they may not be accurate. But we are not aware of any other published sustainable harvest rates for badgers. Historic sportsman harvest of badgers in Colorado can give us some information, though. Estimated harvest in 1986-87 was 2,276 badgers, which did not appear to negatively affect the population, because 3,211 badgers were harvested the following year (CPW 2014d). After the 1987-88 trapping season, badger harvest decreased, which may be due to lower fur prices, which dropped for many species during this period (see discussion on marten below). The harvest of 2,276 badgers in 1986-87 represents 10.8% of the estimated badger population in Colorado. This level of harvest was not sustained, so we cannot speculate as to the long-term sustainability of this harvest rate, but this is the only information we have on sustainable harvest in badgers.

Direct Impacts: WS-Colorado took an average of 7 badgers annually, including a total of 1 badger taken as a non-target (Table 13). WS-Colorado also took 2 badgers as non-targets, which were released on-site. The capture and release of these 2 badgers is not expected to have any impact on the badger population, so the rest of this section focuses on lethal take. WS-Colorado lethal take averaged 0.01%, with a maximum of 0.03% of the badger population in FY11 and FY12. Under Alternative 1, we anticipate that WS-Colorado would take no more than 23 badgers (99% upper confidence limit of FY10-14 take), which corresponds to 0.04% of the estimated badger population. Direct impacts from these levels of take would be negligibly low, and would have no impact on the overall badger population.

Indirect Impacts: We do not foresee any significant indirect impacts to badgers due to PDM conducted by WS-Colorado.

Cumulative Impacts: Sportsman harvest averaged 224 during FY10-14, with a high of 550 in FY13. Sportsman harvest estimates were only available for 2009-10, 2011-12, and 2012-13, so we used these as well as the 2006-07 and 2004-05 estimates to calculate the average (the 5 most recent estimates available; CPW 2014d). This average is also used as the estimate of sportsman harvest for FY 11 and FY14 (Table 22). Cumulative harvest averaged 272 (0.5% of the population), with a maximum of 556 (1.1% of the population). Under Alternative 1, we anticipate cumulative take of no more than 734 badgers in any year (the sum of the 99% upper confidence limits of WS-Colorado take and sportsman harvest). This corresponds to 1.4% of the statewide badger population, which is much lower than the lowest published sustainable harvest threshold (30%). This maximum cumulative take is low even compared the 10.8% harvest rate from the 1986-87 trapping season in Colorado discussed above. Under Alternative 1, we anticipate cumulative impacts to badgers to be low, and we expect no impact to the overall badger population in Colorado.

Table 22. Overview of badger impact analysis.

Year	WS Take[α]	Sportsman Harvest[β]	Cumulative Take	Estimated Population	WS Take % of Pop.	Cumulative Take % of Pop.	Long-Term Sustainable Harvest Rate	Impact
FY 2010	3	225	228	52,000	0.01%	0.4%	30%	Low
FY 2011	13	224	237	52,000	0.03%	0.5%	30%	Low
FY 2012	14	102	116	52,000	0.03%	0.2%	30%	Low
FY 2013	6	550	556	52,000	0.01%	1.1%	30%	Low
FY 2014	1	224	225	52,000	0.00%	0.4%	30%	Low
Average	**7**	**224**	**272**	**52,000**	**0.01%**	**0.5%**	**30%**	**Low**

[α]WS Take includes target take and 1 badger taken as a non-target during FY10-14.

[β]Sportsman Harvest from CPW (2014d). Average is from the 5 most recent years with available data: 2004-05, 2006-07, 2009-10, 2011-12, and 2012-13. Number listed for FY11 and FY14 is the average, because no estimate was available.

4.1.1.1m Feral Cat Impact Analysis. Feral cats are common in Colorado, but WS-Colorado rarely conducts PDM directed at them. WS-Colorado recorded an average of 13 incidents of damage due to feral cats annually during FY10-14 (Table 1). Feral cats are not native to North America, and therefore there is no estimate of the feral cat population in Colorado.

Direct, Indirect, and Cumulative Impacts: WS-Colorado killed an average of 7 feral cats annually, with a maximum of 14 in FY12 (Table 13). This includes a single non-target feral cat killed during these five years. An additional 13 non-target feral cats were captured and released. Under Alternative 1, we anticipate that feral cats would continue to be taken occasionally by WS-Colorado, with a maximum of 21 in any year (99% upper confidence limit of the FY10-14 take). These numbers are minor compared to the number killed by animal control and humane organizations in Colorado each year. The take of feral cats by WS-Colorado under Alternative 1 is considered to be insignificant, and may have beneficial effects on native wildlife populations. We are not aware of any indirect impacts to feral cats due to PDM conducted by WS-Colorado. Cumulative impacts to feral cats were not analyzed because feral cats are non-native, and are generally considered to have a negative impact on the ecosystem, especially native bird populations (American Bird Conservation 1997). The effect of feral cat control would likely be positive, especially for wild birds.

4.1.1.1n Opossum Population Impact Analysis. WS-Colorado recorded an average of 2 incidents of opossum damage during FY10-14 (Table 1). The statewide population of opossums was estimated at 9,500 individuals (Chapter 2, A. Hollard, CPW, pers. comm., 2/15/2015). No long-term sustainable harvest estimate is available for opossums, though

it is likely high as long as refuges (areas where they are not hunted) for them are maintained (Seidensticker *et al*. 1999).

Direct Impacts: WS-Colorado and did not kill any opossums during FY10-14 (Table 13). However, Under Alternative 1, WS-Colorado could take a few opossums occasionally in the future if they cause damage, with a maximum of 5 in any year. This represents 0.05% of the opossum population, which would have no impact on opossums.

Indirect Impacts: We are not aware of any indirect impact to opossums due to PDM conducted by WS-Colorado, except that WS-Colorado personnel may hit one with an automobile occasionally.

Cumulative Impacts: Sportsman harvest is estimated at 45 per year based on the 2009-10 estimate (CPW 2014d). The hunting and trapping seasons were closed in 1995, and then re-opened in 2009. CPW calculated a sportsman harvest estimate the following year, but has not calculated one since. Cumulative take was 45, which is less than 0.5% of the statewide population. Under Alternative 1, we anticipate cumulative take of opossums up to a maximum of 90 (twice the only recent sportsman harvest estimate available), which comprises 0.9% of the estimated population. Cumulative take of less than 0.9% of the population is negligibly low, and would have no effect on the population. In fact, historic sportsman harvest of opossums averaged 204 over a 10-year period (Table 8), without any apparent negative affect on the population. If this harvest rate were not sustainable, it could not have lasted for 10 years.

4.1.1.1o Weasel Populations Impact Analysis. No incidents of damage due to long-tailed weasels or short-tailed weasels were reported to WS-Colorado during FY10-14. There were an estimated populations of 104,000 long-tailed weasels and 40,000 short-tailed weasels in Colorado (Chapter 2, A. Holland, CPW, pers. comm., 2/15/2015). No long-term sustainable harvest estimates are available, but sportsman took an average of 187 long-tailed weasels and 31 short-tailed weasels per year between 1987 and 1994 (Table 8), without any apparent effect on their populations. If this rate was not sustainable, it could not have lasted for these 8 years.

Direct Impacts: WS-Colorado did not take any long-tailed weasels or short-tailed weasels during FY10-14. Under Alternative 1, it is unlikely that WS-Colorado would take any weasels, but it is possible that an occasional weasel may be taken, up to 1 long-tailed weasel, and 1 short-tailed weasel in any year.

Indirect Impacts: We are not aware of any indirect impacts to long-tailed weasels or short-tailed weasels due to PDM conducted by WS-Colorado.

Cumulative Impacts: Sportsman harvest is estimated at zero based on the 2009-10 estimate. The hunting and trapping season were closed in 1995, and then re-opened in 2009. CPW calculated a sportsman harvest estimate the following year, but has not calculated one since. Cumulative take is also estimated at zero for each species during FY10-14 (Table 14). Under Alternative 1, sportsman may harvest a few in the future, and WS-Colorado could take an occasional weasel if they cause damage. We anticipate maximum cumulative harvest of 10 of each species, which is well below the historic harvest rates. These levels of cumulative harvest would be expected to have no impact on either long-tailed weasels or short-tailed weasels.

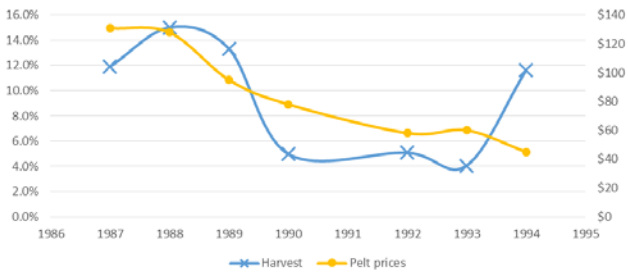
4.1.1.1p Feral Domestic Ferret Impact Analysis. No incidents of damage due to feral domestic ferrets were reported to WS-Colorado during FY10-14.

Direct, Indirect, and Cumulative Impacts: WS-Colorado did not take any (Table 14). However, WS programs in several other States have received requests for assistance for feral ferret damage in the past. Under Alternative 1, WS-Colorado might take an

occasional ferret, with a maximum of 3 in any year. Any take of feral ferrets by WS-Colorado would have a low impact on the feral ferret population. This would be considered to be a benefit to the ecosystem because domestic ferrets are not an indigenous component of ecosystem in Colorado, and may cause damage. We are not aware of any indirect impacts of PDM conducted by WS-Colorado on feral ferrets. We did not analyze cumulative impacts because they are non-native species, and any take would be considered a benefit to the ecosystem.

4.1.1.1q Marten Population Impact Analysis. No incidents of damage due to martens were reported to WS-Colorado during FY10-14. CPW estimated the population at 20,000 martens (Chapter 2, A. Hollard, CPW, pers. comm., 2/15/2015). There is no accepted threshold for long-term sustainable marten harvest. The most useful data are historical harvest data from Colorado, which show an average annual harvest of 1,885 marten (9.4% of the estimated population) between 1987 and 1996, with a range of 811 to 3,006 (4-15% of the population) (Table 8, CPW 2014d). Marten harvest remained high (12-15% of the population) for 3 years in 1987-1989, which suggests that these rates of harvest are below the sustainable harvest threshold (Table 8, CPW 2014d). Harvest rates decreased over the next three years, but this followed a decreasing trend in pelt prices (Poole and Mowat 2001, Figure 5), which is the more likely reason for the decrease. The increase in estimated harvest in 1994 while pelt prices were low is enigmatic, and the season was closed in 1995. The most important factor in maintaining a healthy marten population is having refuge areas where they are not harvested (Strickland and Douglas 1999). For example, Hodgman *et al*. (1994) determined that marten were being overharvested on their study site in Maine, and their model showed a rapidly declining population. However, this area produced high trapping rates for at least a decade, which should not have been possible due to the apparent overharvesting. They concluded that immigration from a nearby refuge was responsible for the continuation of the population. Thus, it appears that marten can withstand locally high harvest rates, as long as there are unharvested refuges nearby. The highest estimated harvest prior to the trap ban was 3,006 in 1988 representing 15% of the estimated population.

Figure 5. Historic sportsman harvest (percent of estimated population) and pelt prices of marten in Colorado.



Direct Impacts: WS-Colorado did not take any martens during FY10-14. Under Alternative 1, it is unlikely that WS-Colorado would take any martens, but it is possible that one could be taken occasionally, with a maximum of 2 per year. This represents 0.01% of the estimated marten population, which is expected to have no impact on martens.

Indirect Impacts: We are not aware of any significant indirect impacts to marten due to PDM conducted by WS-Colorado.

Cumulative Impacts: The hunting and trapping seasons for marten were closed in 1995, but re-opened in 2006. Sportsman harvest averaged 575 (Table 8), with a range of 52 to 1,569. The five most recent years with available data were used for this analysis: 2006-07, 2009-10, 2011-12, 2012-13, and 2013-14 (CPW 2014d). There was no other known means of take for martens, so these numbers reflect cumulative take also. Under Alternative 1, we anticipate the maximum cumulative take of martens in any year to be 2,280 (99% upper confidence interval of recent sportsman harvest plus one), which is 11% of the estimated marten population. This is a large increase from the recent sportsman harvest average because the numbers varied widely, with a range of 52 to 1,569. In fact, these numbers

suggest a trend of increasing marten harvest. We expect that this level of cumulative take would have a low impact on marten, and no impact on the statewide marten population, because it is below the historic harvest levels (12-15% of the population) which we appear to be sustainable. The USFS reported that the marten population was stable on the Routt NF in Colorado (USFS 1998).

4.1.1.1r Mink Population Impact Analysis. No incidents of damage due to mink were reported to WS-Colorado during FY10-14. CPW estimated the statewide population to be 80,000 mink (Chapter 2, A. Holland, CPW, pers. comm., 2/15/2015). No long-term sustainable harvest rate has been determined for mink, but historic harvest levels in Colorado can provide some insight. Mink harvest prior to the 1995 season closure averaged 324 per year, but 1993-94 was remarkably higher than the preceding years (Figure 6, CPW 2014d). Prior to that season, sportsman harvest averaged a very consistent 249, or 0.3% of the population, which suggests that 0.3% is below the long-term sustainable threshold for mink. This is likely well below the true sustainable harvest threshold for mink, but these are the only data we are aware of.

Direct Impacts: WS-Colorado did not take any mink in FY10-14. Under Alternative 1, it is unlikely that WS-Colorado would take any mink, but it is possible that an occasional mink may be taken, with a maximum of 2 mink in any year. This represents less than 0.01% of the estimated mink population, which is expected to result in no impact to mink.

Indirect Impacts: We are not aware of any significant indirect impacts to mink due to PDM conducted by WS-Colorado.

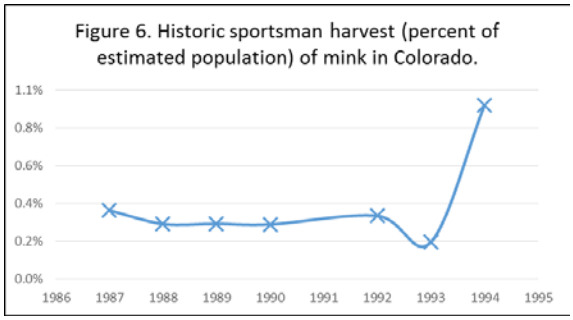


Figure 6. Historic sportsman harvest (percent of estimated population) of mink in Colorado.

Cumulative Impacts: The hunting and trapping seasons were closed in 1995, but re-opened in 2006. Sportsman harvest was estimated at zero in 2006-07, and 15 in 2009-10 (CPW 2014d). No other estimates are available since the season was closed in 1995. The average sportsman harvest based on these data is 8 per year (Table 8). There was no other known means of take for mink, so these numbers reflect cumulative take also. Under Alternative 1, cumulative take of mink is anticipated to remain below 150 mink in any year. This is considerably higher than the current cumulative take; such an increase would be almost entirely due to potential increased sportsman harvest. Such cumulative harvest rates under Alternative 1 (less than 0.2% of the mink population) would be below the historic sportsman harvest rate of 0.3%, which is below the sustainable harvest threshold. These level of take would be expected to result in low impacts to mink, and no impact to the overall mink population.

4.1.1.1s Ringtail Population Impact Analysis. No incidents of damage due to ringtail were reported to WS-Colorado during FY10-14. CPW estimated the statewide population at 12,500 ringtails (Chapter 2, A. Holland, CPW, pers. comm., 2/15/2015). No long-term sustainable harvest rate has been determined for ringtails, but historic harvest levels in Colorado can provide some insight. Ringtail harvest prior to the 1995 season closure averaged 168 per year (1.3% of the population), with a maximum of 292 (2.3% of the population) (CPW 2014d).

Direct Impacts: WS-Colorado did not take any ringtails during FY10-14. Under Alternative 1, we anticipate the take of ringtails by WS-Colorado to be unlikely, but possible, with a maximum of 2 ringtail in any year. This represents less than 0.02% of the statewide ringtail population. This level of take would result in a negligibly low impact to ringtail locally, and no impact to the overall ringtail population.

Indirect Impacts: We are not aware of any significant indirect impacts of PDM conducted by WS-Colorado on ringtails.

Cumulative Impacts: The hunting and trapping seasons were closed in 1995, but re-opened in 2009. Sportsman harvest averaged 28 per year during FY10-14, with a range of zero to 74, based on the only three estimates available (2009-10, 2011-12, and 2012-13; Table 8; CPW 2014d). There was no other known means of take for ringtails, so these numbers reflect cumulative take also. Average cumulative take was 0.2%, with a maximum of 0.6% of the estimated statewide ringtail population. Under Alternative 1, we expect that the cumulative take of ringtails would not exceed 132 (99% upper confidence limit of FY10-14 sportsman harvest). This level of take is considerably higher than the FY10-14 average due to high variation and low sample size in those hunter harvest estimates. But it comprises only 1% of the estimated ringtail population. It is also comprised almost entirely of hunter harvest, which WS-Colorado has no control over. This level of take is lower than historic levels, and would be expected to have a low impact on ringtails locally, and no impact on the statewide ringtail population.

4.1.1.1t Summary of Direct, Indirect, and Cumulative Impacts to target wildlife populations Under Alternative 1: WS-Colorado take is less than 0.3% of the estimated statewide populations of mountain lions, red fox, raccoon, and striped skunks; less than 0.5% of black bear; less than 2% of coyote; and less than 0.1% of all other predatory mammal populations. We anticipate similar levels of take under Alternative 1. Therefore, impacts to these predatory mammal populations from WS-Colorado PDM is negligible at the statewide and regional levels. However, there may be short-term impacts to localized coyote, black bear, and mountain lion populations.

Indirect impacts may include increased localized immigration and fecundity for coyotes, black bear, and mountain lions where WS-Colorado may substantially decrease local populations. There may also be a younger age structure in local coyote populations where WS-Colorado conducts PDM. We are not aware of any other indirect impacts to target wildlife species due to PDM conducted by WS-Colorado.

Predatory mammals are managed by CPW on a sustainable basis. Cumulative impacts to target predator species under Alternative 1 would be negligible. The largest contributor to cumulative take for target predator species is sportsman harvest. The cumulative harvest of all predator species is below the long-term sustainable harvest rates, and for most species, substantially below the long-term sustainable harvest rates (Table 14).

4.1.1.2 Alternative 2 - No Federal WS PDM.

Direct, Indirect, and Cumulative Impacts: Under this alternative, WS-Colorado would not provide assistance with PDM, so there would be no direct impact by WS-Colorado on target predator populations in Colorado. However, PDM has shown to be effective in limiting losses due to predators (Nass 1977, 1980; Howard and Shaw 1978; Howard and Booth 1981; O'Gara *et al.* 1983; Gantz 1990; Wagner and Conover 1999). As such, under Alternative 2, producers would either suffer higher losses, which would be passed on to consumers, or other entities would conduct PDM to some degree to compensate for the reduction in federal services. The latter is more likely, and could include state agencies (CDA and CPW), and private entities or organizations. If such entities did not effectively respond to damage complaints, the public could become intolerant of such damaging wildlife species (International Association of Fish and Wildlife Agencies 2004). Individuals who would conduct PDM in the absence of a WS program would probably be less trained and would not have access to certain PDM methods and applications which would mean the use of less effective or selective methods. In the case of private individuals, accountability, records maintenance, regulatory and policy compliance, and coordination with other agencies may not be required or adhered to the same extent that WS-Colorado is required. Thus, under Alternative 2, the potential for impacting predator

populations by non-WS entities could be higher than under the current program alternative (Alternative 1), however there may be a brief lack of PDM services available from any entity in the state as other such entities gear up to replace WS-Colorado. So while WS-Colorado anticipates a brief decline in the number of animals taken, it's likely that the subsequent increase in services provided by other activities would equal 10-20% of total take by WS. This take is estimated because most private individuals and companies conducting predator damage management limit their work to within ½ mile of roads, yet most coyotes taken by WS-Colorado are taken greater than ½ miles from a road. The private individuals' ability to resolve predation damage to livestock is limited by access and the cost of doing business. Private individuals reported the need to earn at least $500 per coyote taken to cover PDM costs. The use of vehicles or ATVs is restricted on public lands by the land management agency necessitating the use of horses or walking. Access to private land will be variable and up to the landowner about the level of access the private individual would be allowed.

Thus the indirect impact on coyote populations from Alternative 2 would be estimated at 20% of take by WS-Colorado due to restricted access, limited tools (Table 12A), most private individuals work within ½ mile of roads, most coyotes depredating livestock are taken more than ½ mile from a road and less training, experience and knowledge. The estimated indirect impact on bear and mountain lion populations would be expected to approach but not equal the take by WS-Colorado due to less experience and knowledge. Also, the cost recovery required of the private sector may consume scarce public funds available to resolve bear and lion predation on livestock. Thus less livestock depredations would be investigated and abated since funding would be exhausted.

For example, in the cases of mountain lion and black bear damage, cumulative take would likely decrease under Alternative 2, because the private individuals who may be enlisted to remove problem animals would be less likely to remove the offending animals due to lower levels of experience, training, and oversight. Additionally, bears and mountain lions not involved in livestock depredation would likely be killed due to inexperience of private individuals investigating livestock depredations and running the wrong bear or lion. Lastly, since private businesses and individuals would need to recover costs and make a profit to stay in business, public funds available to resolve bear and mountain lion depredations would likely be exhausted before all depredations were resolved. These impacts would be considered indirect impacts. In addition, the potential for improper use of legal chemicals, and the use of illegal chemical toxicants as described in 4.1.2 could lead to unknown, but potentially high impacts, on carnivore populations. Other factors contributing to cumulative impacts would likely be similar to Alternative 1, including sportsman harvest. But cumulative take would likely decrease then plateau at a level less than alternative 1. Under Alternative 2 indirect impacts would be lower as discussed above. It is highly unlikely that predator populations would be affected by implementation of Alternative 1. Under Alternative 2, the likelihood of negative impacts on target predator populations would likely be lower than under Alternative 1 but some individual bears and lions not involved in depredations would be incorrectly blamed as livestock killers and would be killed.

4.1.1.3 Alternative 3 - Technical Assistance Only.

Direct, Indirect, and Cumulative Impacts: Under this alternative, WS-Colorado would only provide advice or guidance on PDM techniques and methods. WS-Colorado would not conduct any direct operational PDM in attempting to resolve damage complaints. Therefore, WS-Colorado would have no direct impacts on predators in Colorado. As discussed under the No Federal WS PDM Alternative (Alternative 2), similar PDM would likely be conducted by private individuals, state agencies, land managers and other organizations, but at lower proportion to the federal services lost. Similar negative impacts as discussed under Alternative 2 could occur (improper use of PDM methods, lower take of the larger predators, probable misidentification of bears and mountain lions involved in

livestock depredation, illegal use of chemicals, and public intolerance towards wildlife). These would be considered indirect impacts. However the negative effects may be lessened by the fact that under this Alternative, WS-Colorado would still be able to advise people on the proper safe and effective use of strategies and methods. Other factors included in cumulative take, chiefly sportsman harvest, would likely be similar to those under Alternative 2. But cumulative negative impacts on target wildlife would likely be lower under Alternative 3 than under Alternative 1 but lower than Alternative 2.

4.1.1.4 Alternative 4 - Lethal PDM Methods Used Only for Corrective Control.

Direct, Indirect, and Cumulative Impacts: Under this alternative, WS-Colorado take of target predator species would probably be somewhat less than that of the proposed action (Alternative 1) for some species, because lethal actions by WS-Colorado would be restricted to situations where damage had already occurred. For other species, such as black bears and mountain lions, most or all of WS-Colorado PDM actions are corrective in nature, so this Alternative would not be different from the Proposed Action (Alternative 1). For many damage situations, this alternative would be similar to Alternative 1 (the current program) because many producers do not contact WS-Colorado until damage has already occurred or after they have already tried non-lethal methods. In addition, WS-Colorado does not conduct preventative PDM for many of the predator species in this EA because of the relatively low occurrence and unpredictability of damage (e.g. mountain lion removal before there is a human safety issue). Because Alternative 1 would result in low or no direct impacts to target predator populations by WS-Colorado, direct impacts under Alternative 4 would not be significantly different.

Preventive control is used most often in cattle and sheep production areas that have had historical damage, primarily from coyotes. Even with preventive nonlethal methods in use, preventive aerial predator management has been shown to reduce sheep and lamb losses later in the year, compared to sites without (Gantz 1990, Wagner and Conover 1999). Under this Alternative, WS-Colorado would be less effective in resolving these types of predator damage issues, because: (1) the most effective methods such as aerial predator management may not be as effective later in the season, (2) other methods may be more logistically difficult due to accessibility issues, and (3) less effective methods may be the only options during the summer months. The coyotes most likely to kill sheep are the ones raising pups (Till and Knowlton 1983), and aerial predator management of coyotes on sheep summering grounds removes coyotes that otherwise would likely have produced pups (Gantz 1990). By conducting preventive PDM in late winter, the likelihood of transient coyotes re-occupying vacated territories and establishing new territories in time to produce pups is greatly reduced. Gantz (1990) concluded that late winter aerial predator management of coyotes on summer sheep range was an effective method to reduce coyote predation. Additionally, by restricting corrective PDM to the immediate vicinity of predation losses, WS-Colorado would be unable to effectively resolve some depredation problems. Till (1992), found that depredating coyotes traveled an average of 2 miles and as far as 6 miles from their den site to the sheep flocks where they were killing lambs. Without WS-Colorado conducting proactive PDM activities, it is likely that private efforts at proactive control would increase, or WS-Colorado may need to remove more coyotes later in the season to reduce damage that could have been prevented. WS-Colorado conducts preventive PDM for species such as coyotes and red fox where a resource owner has had historic damage. Predators taken by WS-Colorado may initially be fewer than anticipated under Alternative 1, but private efforts may increase resulting in similar levels of cumulative take, or perhaps increased take.

WS-Colorado take under this alternative could be higher than Alternative 1, or private efforts may increase after a period to make up for the lack of WS assistance. Sportsman harvest would likely be similar under this alternative to Alternative 1 (the current

program). Cumulative impacts on target predators would likely be similar or slightly higher than under Alternative 1 due to the potential for higher indirect impacts.

4.1.2 Effects on Non-target Species Populations, Including T&E Species

Non-target species can be impacted by PDM whether implemented by WS-Colorado, other agencies, or the public. Impacts can range from direct take while implementing PDM methods to indirect impacts resulting from the reduction of predators in a given area. Measures are often incorporated into PDM to reduce impacts to non-target species. Various factors may, at times, preclude the reasonable use of certain methods, so it is important to maintain the widest possible selection of PDM tools for resolving predator damage problems, and assess all non-target concerns. The use of legal and biologically sound PDM methods, along with measures to reduce non-target impacts can minimize impacts to non-target species. Where impacts occur, they are mostly of low magnitude in terms of non-target species populations. Following is a discussion of the impacts under the various Alternatives.

4.1.2.1 Alternative 1 - Continue the Current Federal PDM Program.

During FY10-14, WS-Colorado took 12 different non-target species, averaging 7 animals per year (Table 10). Of the 33 total non-target animals WS-Colorado took during FY10-14, only 13 of them (0.1% of total predator take) were taken lethally. The other 20 animals were freed. The capture and release of these animals constitutes nonlethal take, which is not likely to impact the populations of these species. Most non-target species taken during PDM (8 of 12 species, and 28 of 33 total animals) were other predator species which were not targeted during a specific operation, or were not the specific individual targeted, but were on the cooperative agreement as a target species. Impacts on these target predator species were discussed in Section 4.1.1, and the nontarget take listed here was included in the total WS-Colorado take analyzed for each target species.

Other than wild predators, non-target take in FY10-14 included one domestic dog, one porcupine (*Erethizon dorsatum*), two desert cottontails (*Sylvilagus audubonii*), and one common raven (*Corvus corax*). The dog and the cottontails were released. The dog is discussed under Public Safety and Pets. Desert cottontails are very abundant throughout eastern Colorado, and are known to cause problems. For example, cottontails attract raptors to airports, which threaten public safety and property. Further, in 2012, Colorado sportsmen harvested an estimated 57,859 cottontails (eastern, desert, and mountain cottontails combined; CPW, 2014a). Cottontails are very abundant in Colorado, and the non-target take of two animals over five years is negligible, especially because the take was non-lethal. Porcupines are found in the western 3/4 of Colorado (Fitzgerald *et al*. 1994), and are locally abundant in many areas. In 1989, sportsmen harvested 4,625 porcupines in Colorado (CPW, 2014a), giving an indication of their abundance. The non-target take of one porcupine over the course of five years is negligible compared to sportsman harvest. Common ravens are abundant throughout much of Colorado. As a predatory bird species, they occasionally cause damage to agricultural and natural resources, and as such, they are targeted by WS-Colorado and non-federal entities for lethal control. During FY10-14, WS-Colorado lethally took 220 common ravens, as a target species, which is covered under a separate EA (WS 2013). The non-target take of one common raven over five years is negligible compared to their abundance and targeted take.

WS-Colorado has the potential of capturing other non-target species as well. Species that are of similar or more weight and size as the targeted species can be accidentally taken with several of the PDM methods used. WS-Colorado SOPs (*e.g.*, pan-tension devices) have been effecting in keeping non-target take low. These were discussed in Chapter 3. Under Alternative 1, species with the highest potential to be taken as non-targets, with the exception of the T&E and candidate species presented in Table 11, are relatively common in Colorado, either locally or statewide, and occasional non-target take during PDM would

not be expected to negatively affect their statewide populations. In fact, the abundance of small carnivores, which are common non-target species during PDM, typically increases in areas where coyote populations have been reduced (Robinson 1961, Nunley 1977). Thus, current PDM activities in Colorado may benefit the smaller predators, even if a few are taken as non-targets. WS-Colorado does not anticipate any substantial increase in nontarget take under Alternative 1. This may include non-lethal and lethal take of an occasional carnivore, rodent, lagomorph, or bird. Other than T&E species, and other species of concern as discussed below, we anticipate that these levels of take would result in no impacts to the statewide populations of non-target species.

4.1.2.1a Effects on listed threatened and endangered species.

WS-CO consulted with the USFWS on potential impacts of predator damage management activities on federal listed threatened and endangered species, including critical habitat (Appendix C). The USFWS concurred with WS-CO analysis and mitigation measures to avoid impacting threatened and endangered species (Appendix D). Moreover, the WS-CO program has a track record of consulting with the USFWS since 1992 to avoid harm to federal listed threatened and endangered species. No threatened or endangered species have been harmed or taken by WS-Colorado since the transfer from the USFWS in 1986. Additionally, WS-CO has played important roles in assisting with the recovery of federally listed threatened and endangered wildlife in Colorado, including black-footed ferrets, Gunnison sage grouse, piping plover, least tern, Colorado greenback cutthroat trout, Colorado pikeminnow, humpback chub, bonytail chub and razorback sucker.

4.1.2.1b Effects on Bald and Golden Eagles.

Bald (*Haliaeetus leucocephalus*) and golden (*Aquila chrysaetos*) eagles are protected under the Bald and Golden Eagle Protection Act (BGEPA) and the MBTA. Some of the methods proposed for use in PDM have the potential to capture or kill eagles. There are also concerns about the risks to eagles from consumption of carcasses of animals taken by WS-Colorado that are killed with lead ammunition. (Stauber *et al*. 2010, Bedrosian *et al*. 2012, Haig *et al*. 2014). Much of the risk of lead consumption in eagles appears to be associated with eagles foraging on waterfowl that have ingested lead ammunition, fishing tackle, or offal piles (Bedrosian *et al*. 2012, Haig *et al*. 2014). Stauber *et al*. (2010) detected an increase in eagles admitted to rehabilitation centers after the big game hunting season, and hypothesized that the increase might have been associated with an increase in coyote hunting, as hunters shifted from big game to coyotes at the end of hunting season. However, no increase in coyote hunting was documented. Multiple eagles and other scavengers can feed from single carcasses and are at risk from ingesting lead fragments. WS-Colorado disposes of carcasses of animals taken with lead ammunition in a manner that reduces risks to scavengers when possible. However, for some methods, such as removal via aircraft, burial, or off-site disposal is not a safe or practical option. The majority of coyotes taken by WS-Colorado are taken via use of shotguns from aircraft.

WS-Colorado uses copper-plated lead shot in all aerial predator management operations to minimize any likelihood of poisoning eagles. Hayes (1993) reviewed literature and determined the hazard of lead from shotgun pellets may have lower risks to eagles than some other types of ammunition. Some key findings were:

1. Eagles are known to scavenge on coyote carcasses, particularly when other food sources are scarce or when food demands are increased.
2. In studies that documented lead shot consumption by eagles (*i.e.*, based on examining the contents of regurgitated pellets), the shot was associated with waterfowl, upland game bird, or rabbit remains, and was smaller than BB or #4 buckshot used in aerial predator management.

3. Lead residues have been documented in jackrabbits, voles (*Microtus spp.*), and ground squirrels, which could explain how eagles could ingest lead from sources other than lead shot.
4. Frenzel and Anthony (1989) suggested that eagles usually reduce the amount of time that lead shot stays in their digestive systems by casting most of the shot along with other indigestible material. It appears that healthy eagles usually regurgitate lead shot in pellet castings which reduces the potential for lead to be absorbed into the blood stream (Pattee *et al.* 1981; Frenzel and Anthony 1989).

WS-Colorado personnel examined nine coyotes shot with copper plated BB shot to determine the numbers of shot retained by the carcasses. A total of 59 shot pellets were recovered, averaging 6.5 pellets per coyote. Of the 59 recovered pellets, 84% were amassed just under the surface of the hide opposite the side of the coyote that the shot entered, many exhibited minute cracks of the copper plating, and two shot pellets were split. The fired shot were weighed and compared with unfired shot and were found to have retained 96% of their original weight. Eagles generally peel back the hide from carcasses to consume muscle tissue. Because most shot retained by coyotes tends to end up just under the hide, it would most likely be discarded with the hide. Any shot consumed would most likely still have the nontoxic copper plating largely intact, reducing the exposure of the lead to the digestive system. These factors, combined with the usual behavior of regurgitation of ingested lead shot indicate a low potential for toxic absorption of lead from feeding on coyotes killed by aerial predator management. In fact, of known causes of anthropogenic mortality of golden eagles with satellite transmitters that were found dead, lead toxicity was the least common form of eagle mortality (USFWS 2016). Eagle mortality from WS-Colorado's use of lead ammunition is possible, although no known instances directly attributable to WS-Colorado actions have been reported.

Any potential effect from ingestion of lead ammunition appears to be limited to individual birds. Bald eagle populations are increasing in the contiguous 48 states. Golden eagle populations also appear to be healthy. Breeding Bird Survey Data indicate a general increasing trend in breeding populations of both golden and bald eagles in North America since 1966 (Sauer *et al.* 2004). Thus, eagle populations do not appear to be adversely affected by toxicity problems. Based on this information and the discussion below on lead impacts to non-target species, we conclude that WS-Colorado's use of lead ammunition could result in the death of some eagles, but that this impact is low relative to other sources of lead poisoning and is not having a significant cumulative adverse impact on eagle populations.

Under the Bald and Golden Eagle Protection Act, the definition of "*take*" includes actions that "*molest*" or "*disturb*" eagles. For the purposes of the Act, under 50 CFR 22.3, the term "*disturb*" as it relates to take has been defined as "*to agitate or bother a bald…eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.*" Routine activities conducted by WS-Colorado's personnel under the proposed action alternative could occur in areas where Bald Eagles are present, which could disrupt the current behavior of an eagle or eagles that were nearby during those activities. WS-Colorado has reviewed those methods available under the proposed action alternative and the use patterns of those methods. The routine measures that WS-Colorado conducts would not meet the definition of "disturb" requiring a permit for the non-purposeful take of Bald Eagles. The USFWS states, "Eagles are unlikely to be disturbed by routine use of roads, homes, or other facilities where such use was present before eagle pair nesting in a given area. For instance, if eagles build a nest near your existing home, cabin, or place of business you do not need a permit" (USFWS 2012). Therefore, activities that are species specific and are not of a duration and intensity that would result in disturbance as defined

by the Act would not result in non-purposeful take. Activities, such as walking to a site, discharging a firearm, or riding an ATV along a trail, generally represent short-term disturbances to sites where those activities take place. WS-Colorado would conduct activities that were located near known eagle nests and would follow the National Bald Eagle Management Guidelines (USFWS 2007) to avoid disturbance. The categories that would encompass most of these activities are Category D (Off-road vehicle use), Category F (Non-motorized recreation and human entry), and Category H (Blasting and other loud, intermittent noises). These categories generally call for buffers of 330 feet for category D, 660 feet for category F, and ½-mile for category H.

Another PDM method which could potentially adversely affect bald eagles is the use of foothold traps. To mitigate this impact, WS Policy mandated that traps are placed at least 30 feet from carcasses or "draw stations." To date, WS-Colorado has not taken a bald eagle, but acknowledges that the potential exists. Therefore, WS-Colorado will minimize these risks by abiding by the SOPs and measures to reduce the potential for take given in Chapter 3. Bald eagle populations are increasing across their range indicating that the population is recovering and that mortality from all causes has not exceeded a significant level. WS-Colorado has not added to any known take of eagles during FY10-14.

Under Alternative 1, we do not anticipate any significant difference in our potential to impact eagles; thus, we expect no direct or indirect impacts to eagle populations from WS-Colorado PDM, and no cumulative impact.

4.1.2.1c Effects on Non-target Animals from Consumption of Lead Fragments.

Agencies and members of the public have expressed concerns regarding the potential for adverse environmental impacts and risks to public safety from the materials used in ammunition. These would constitute indirect impacts from PDM by WS-Colorado. The majority of concerns expressed pertain to the use of lead ammunition, and this section correspondingly focuses on risks associated with lead (*e.g.*, Watson *et al*. 2009). However, it should be noted that some of the non-lead materials used in ammunition and lead-free ammunition (arsenic, nickel, copper, zinc, tungsten) are also known to pose environmental risks (Clausen and Korte 2009, EPA 2005, Beyer *et al*. 2004, Eisler 1998). Exposure and risk to non-target animals would be greatest for wild and domestic animals that consume carcasses containing lead ammunition from PDM actions. There is also the potential for lead exposure to non-target mammals and birds from consumption of lead bullet fragments in the soil. The potential for lead exposure and risk to these types of scavengers would be reduced in situations where carcasses are removed or otherwise rendered inaccessible to scavengers through burial or state, territory, or tribally-approved carcass disposal practices. Lead exposure and risk would also be further reduced in cases where the use of lead-free shot can be effectively, safely, and humanely used to remove target animals.

For all programs, WS-Colorado uses lead-free ammunition when practical, effective, and available in order to mitigate and/or minimize the effects of its use of lead ammunition on the environment, wildlife, and public health and to comply with federal, state, territory, or tribal regulations on the use of lead ammunition. WS-Colorado does not use lead ammunition in areas where it is prohibited by law or where prohibited by the landowner/manager (*e.g.*, National Parks). WS-Colorado uses lead-free shot when using shotguns to remove birds for MBTA-permitted activities, including activities in waterfowl production and wintering areas.

The WS program has specific ammunition and firearm requirements to maximize performance, safety, and humaneness similar to those for other wildlife damage management applications (Caudell *et al*. 2012). Precision performance of bullets is essential for project efficacy, safety, humaneness (shot placement to result in rapid death) (MacPherson 2005, Caudell *et al*. 2009), and shot placement to preserve tissues for animal

health monitoring. Direction of ricochet/ pass-through is difficult to predict (Burke and Rowe 1992) and is a safety concern, especially at airports, near residences, around rocky substrate, and for WS-Colorado personnel in aerial predator management teams. Ammunition which conveys its full energy to the target animal and which results in low or no pass through is needed for reasons of humaneness (instant or near-instant incapacitation) and to reduce safety risks associated with wounded animals.

Current challenges associated with lead-free ammunition include that some types of lead-free ammunition are harder than lead ammunition and more likely to ricochet off hard surfaces, which increases the odds of hitting aircraft, personnel, or other unintended targets, and presents unacceptable risks to human safety (APHIS 2012). WS has tested bismuth ammunition for aerial operations but found the product too frangible for safe and effective use. Increased wounding has been associated with lighter bullets (Aebischer *et al*. 2014). Lead-free alloys require longer bullets to obtain comparable bullet weights. Terminal performance (the performance of the bullet upon striking the target animal) is, in part, determined by bullet weight. Ballistically, a faster rate of twist is usually necessary to stabilize longer bullets, though individual firearm performance varies. Accuracy of non-lead ammunition is less than accuracy of lead ammunition in many of the firearms presently in use by WS-Colorado. Whereas non-lead ammunition is available in many calibers, its suitability and accuracy in all firearms is not universally equal to lead ammunition. Harder lead-free rifle ammunition is more likely to result in "non-frangible bullet pass-through," and failure of the bullet to convey its full energy to the target animal, although similar problems also exist with some types of lead rifle ammunition. In addition to the increased risk of hitting an unintended target, non-frangible pass through also increases the likelihood that the target animal may not be rapidly or instantly killed by the shot and may be considered less humane (APHIS 2012). WS-Colorado evaluates new lead-free ammunition alternatives as they become available.

Lead-free ammunition is often more expensive than equivalent ammunition using lead. Costs may sometimes be secondary to overriding environmental, legal, public safety, animal welfare, or other concerns, but it is still an issue. Cooperators usually pay a substantial portion of operational program costs and may be unwilling to pay the additional ammunition costs in areas where it is otherwise legal to use lead ammunition.

WS-Colorado aims to use the fewest number of shots on targeted animals. Lead ammunition use by WS-Colorado for PDM activities is minimal compared to lead use at firing ranges and use for hunting, fishing, and shooting sports. The national WS programs' FY08 - FY012 total estimated lead use in all program activities including feral swine damage management was approximately 5.87 tons (12,948 lbs.) with a yearly average of 1.174 tons (2,588 lbs.). The average yearly total amount of lead used in all states by WS (FY08-FY12) is small (0.0017%) compared to the U.S. use of lead from ammunition, shot, and bullets based on data from 2011 (USGS 2013).

At the current rate of use, lead ammunition by WS-Colorado may have the potential to adversely impact individual non-target animals, particularly animals which scavenge carcasses, and birds which may inadvertently pick up lead shot when seeking grit for their crop. A review of population trends for the primary non-target avian scavengers of concern (turkey vultures and eagles) during 2003-2013, indicates that population trends for turkey vultures have been relatively stable in the state, and increasing in the Western BBS region and nationwide (Sauer *et al* 2015). Impacts of lead ammunition on eagle populations were discussed above. Based on this information, current use of lead ammunition is not adversely affecting overall populations of these species.

WS total program use of lead ammunition, including ammunition used for FSDM is only a small fraction of lead ammunition use by other entities (*e.g.*, hunting, target shooting). WS adheres to all applicable laws governing the use of lead ammunition in WS activities and landowner/manager desires for lead-free ammunition in their projects. Additionally,

the WS program is working to shift to lead-free ammunition as new lead-free alternatives that meet WS standards for safety, performance, and humaneness are developed and become reliably available in adequate quantities for program use. Use of lead ammunition by the APHIS program is anticipated to decrease over time. Consequently, cumulative impacts of WS-Colorado use of lead ammunition would be very low. Given that the majority of lead ammunition is used by non-WS-Colorado entities, the decisions made by states, territories, tribes, federal regulatory agencies, and land management agencies regarding use of lead ammunition will be the greatest factor affecting the cumulative contribution of lead in the environment. If state or federal law or WS-Colorado policy were changed to require an adherence to more restrictive use of lead ammunition, WS-Colorado would adopt the more stringent measures into its SOPs accordingly.

4.1.2.1d Impacts on wildlife populations caused by low-level flights during aerial predator management.

Concern is sometimes expressed that aerial predator management might disturb other wildlife species populations to the point that their survival and reproduction are adversely affected, and thus lead or contribute in some significant way to population declines. A number of studies have looked at responses of various wildlife species to aircraft overflights. The National Park Service (1995) reviewed many such studies and revealed that a number of them have documented responses by certain wildlife species that suggest adverse impacts could occur. Few, if any studies, have proven that aircraft overflights cause significant adverse impacts on wildlife populations, although the report stated it is possible to draw the conclusion that impacts to populations are occurring. The Air National Guard (ANG) came to the conclusion that military training flights were not expected to cause adverse effects on wildlife after extensive review of numerous studies of this issue (ANG 1997a, 1997b).

Waterbirds and Waterfowl: Low level overflights of 2-3 minutes in duration by a fixed-wing airplane and a helicopter produced no “drastic” disturbance of tree-nesting colonial waterbirds, and, in 90% of the observations, the individual birds either showed no reaction or merely looked up (Kushlan 1979). Conomy *et al*. (1998) quantified behavioral responses of wintering American black ducks (*Anas rubripes*), American wigeon (*A. americana*), gadwall (*A. strepera*), and American green-winged teal (*A. crecca carolinensis*) exposed to low-level flying military aircraft in North Carolina and found that only a small percentage (2%) of the birds reacted to the disturbance. They concluded that such disturbance was not adversely affecting the “time-activity budgets” of the species. Other reviews have suggested there may be adverse effects on waterfowl (National Park Service 1995). WS aerial predator management activities are not conducted over wetland habitats, and a majority of such flights occur in winter when waterfowl and waterbirds have migrated further south. Thus, there is little to no potential for any adverse effects on these types of species.

Raptors: Mexican spotted owls (*Strix occidentalis lucida*) did not flush when chain saws and helicopters were greater than 110 yards away; owls flushed to these disturbances at closer distances and were more prone to flush from chain saws than helicopters. Owls returned to their pre-disturbance behavior 10-15 minutes following the event, and researchers observed no differences in nest or nestling success which indicates that helicopter flights did not result in adverse effects on owl reproduction or survival (Delaney *et al*. 1999).

Andersen *et al*. (1989) conducted low-level helicopter overflights directly at 35 red-tailed hawk (*Buteo jamaicensis*) nests and concluded that red-tailed hawks habituate to low level flights during the nesting period. Their results showed similar nesting success between hawks subjected to such overflights and those that

were not. White and Thurow (1985) did not specifically evaluate the effects of aircraft overflights, but found that ferruginous hawks (*B. regalis*) are sensitive to certain types of ground-based human disturbance to the point that reproductive success may be adversely affected. However, military jets that flew low over the study area during training exercises did not appear to bother the hawks, nor did the hawks become alarmed when the researchers flew within 100 feet in a small fixed-wing aircraft. White and Sherrod (1973) suggested that disturbance of raptors by aerial surveys with helicopters may be less than that caused by approaching nests on foot. Ellis (1981) reported that five species of hawks, two falcons (*Falco spp.*), and golden eagles (*Aquila chrysaetos*) were "incredibly tolerant" of overflights by military fighter jets, and observed that, although birds frequently exhibited alarm, negative responses were brief and the overflights never limited productivity.

Regarding potential effects of WS aircraft overflights on bald eagles, ANG (1997a) analyzed and summarized the effects of overflight studies conducted by numerous Federal and state government agencies and private organizations. These studies determined that military aircraft noise initially startled raptors, but negative responses were brief and did not have an observed effect on productivity (Ellis 1981, USFS 1992, Fraser *et al*. 1985, Lamp 1989, cited in ANG 1997a). A study conducted on the impacts of overflights to bald eagles suggested that the eagles were not sensitive to this type of disturbance (Fraser *et al*. 1985). During the study, observations were made of over 850 overflights of active eagle nests. Only two eagles rose out of either their incubation or brooding postures. This study also showed that perched adults were flushed only 10 percent of the time during aircraft overflights. Evidence also suggests that golden eagles are not highly sensitive to noise or other aircraft disturbances (Ellis 1981, Holthuijzen *et al*. 1990). Finally, one other study found that eagles were particularly resistant to being flushed from their nests (Awbrey and Bowles 1990, cited in ANG 1997a). There is considerable evidence that eagles would not be adversely affected by WS aerial predator management overflights.

The above studies indicate raptors are relatively unaffected by aircraft overflights, including those by military aircraft which produce much higher noise levels than the small aircraft used in aerial predator management. Therefore, we conclude that WS aerial predator management flights have little or no potential to adversely affect raptors.

-<u>Passerines:</u> Reproductive losses have been reported in one study of small territorial passerines (songbirds such as sparrows and blackbirds) after exposure to low altitude overflights (Manci *et al*. 1988 cited in ANG 1997a), but natural mortality rates of both adults and young are high and variable for most passerines. The research reviewed indicated that passerine birds cannot be driven any great distance from a favored food source by a non-specific disturbance, such as military aircraft noise, which indicates the much quieter noise of WS small planes would have even less effect. Passerines avoid intermittent or unpredictable sources of disturbance more than predictable ones, but return rapidly to feed or roost once the disturbance ceases (Gladwin *et al*. 1988, USFS 1992). These studies and reviews indicate there is little or no potential for WS-Colorado overflights to cause adverse effects on passerine bird species.

-<u>Sage-grouse</u>: We could find no studies of the effects of overflights on sage-grouse. However, impacts are probably minor when overflights only occur on an infrequent basis and care is taken to avoid leks (strutting grounds used by males during the breeding season), because State wildlife agencies routinely use aircraft to locate sage-grouse leks. The USFWS reviewed available scientific and other information on threats to sage-grouse and did not identify aerial overflights as a concern, although they did identify other types of activities such as off-road

vehicles and recreation as potentially having disturbance effects on breeding (USFWS 2005). Because WS-Colorado avoids flying near known or observed lek locations during the strutting season, any potential disturbance effects on breeding are most likely avoided. One potential benefit to sage-grouse is that WS-Colorado aerial crews can watch for and report any new lek locations to the CPW or land management agencies who can then take other actions to protect such sites from other, more potentially more chronic sources of disturbance, when appropriate. The Gunnison Sage-grouse, which is a federally threatened species, is most abundant in sagebrush habitats in Gunnison County, but they also inhabit suitable sagebrush habitats in Dolores, San Miguel, Montrose, and Saguache counties in southwestern Colorado. WS-Colorado aerial predator management activities have occurred in 3 of those counties (Gunnison, Montrose, and San Miguel) in the past 5 years (Table 9). Because WS-Colorado aerial predator management crews watch for and avoid leks during the breeding season, no adverse effects on Gunnison sage-grouse are expected from aerial predator management activities. PDM activities that remove coyotes and red fox (the species usually targeted by WS-Colorado aerial predator management activities) may actually benefit sage-grouse and other prairie grouse species by reducing predation by these species.

-Deer: Krausman *et al*. (1986) reported that fixed-wing overflights by Cessna 172 and 182 model small aircraft $\geq$ 100 feet above ground level (AGL) did not generally disturb desert mule deer in Arizona. They observed that only 3 of 70 observed responses of mule deer to the overflights at 150 to 500 feet AGL resulted in the deer changing habitats. The few that did change habitats did so on the first overflight experience, but then did not change habitats on subsequent overflight exposure. The aircraft they evaluated are larger and noisier than the J3 Supercub and Huskey airplanes used for most WS-Colorado aerial predator management. For example, at level flight 500 feet directly overhead, the Cessna 182 generates noise levels of 73.8 cdBA at ground level, whereas the J3 Supercub (Piper PA-18) generates 65 cdBA[13,14]. Therefore, we induce that the airplanes used in aerial predator management would be even less disturbing to mule deer than the aircraft used in the above study that concluded minimal disturbance. VerCauteren and Hygnstrom (2002) noted in a study that included aerial censuses of deer that deer typically just stood up from their beds, but did not flush, when the aircraft passed overhead. In addition, WS-Colorado aerial predator management personnel frequently observe deer and antelope standing apparently undisturbed beneath or just off to one side of WS aircraft. We conclude that WS-Colorado aerial predator management operations produce minimal disturbance to deer.

One particular concern with overflights is the potential to affect mule deer on their winter range in years when conditions such as heavy snow and poor forage availability have already stressed the deer to the point that heavy “winter kill” losses are likely. WS-Colorado has conducted aerial predator management to protect sheep in several areas of known deer winter range, particularly in the Little Snake and White River BLM RAS. However, the potential for adverse effects on wintering deer, particularly during severe winter conditions, is minimized by the fact that WS-Colorado’s aerial predator management pilots are instructed to avoid concentrations of deer and other readily visible nontarget wildlife (L. Burraston, National Aviation Manager, WS, pers. comm. 2005).

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[13] Data from http://www.faa.gov/about/office_org/headquarters_offices/aep/noise_levels/; “A-weighted decibels” are a standard measure used to compare noise levels of aircraft; FAA has published data on noise levels of various aircraft measured directly beneath the aircraft flying overhead at 500 feet above ground level for small propeller driven airplanes; cdBA is “corrected” “A-weighted” decibels. (Tom Connor, FAA, pers. comm. 2005).

[14] A noise level of 65 dBA is described by the FAA as “comparable to normal conversation at 5' in a commercial area.” Info. from: http://www.awp.faa.gov/atenviro/CRITERIA.htm.

Also, removal of coyotes during winter may benefit wintering mule deer herds to some extent. Coyotes are documented to cause substantial direct mortality of wintering deer. For example, Mackie *et al*. (1976) documented high winter losses of mule deer due to coyote predation in north-central Montana and stated that coyotes were the cause of most overwinter deer mortalities. Hurley *et al.* (2011) also found coyote removal increased fawn survival under certain conditions. Coyotes may cause additional stress on wintering deer indirectly from the stress of chasing and pursuit. This source of stress is most likely reduced by the removal of coyotes through aerial predator management and other PDM activities during or prior to severe winter periods. Gese and Grothe (1995) found that territorial alpha coyotes (*i.e.*, dominant breeding males and females) were more likely than subordinate coyotes to prey on, or at least pursue in an attempt to prey upon, wintering mule deer and elk. During winter, coyote populations are at or approaching their lowest numbers in their annual cycle (Knowlton *et al*. 1999). They also have the highest proportion of older adults during winter, which are more likely to pursue and attack wintering deer and elk than younger, less experienced coyotes (Gese and Grothe 1995; E. Gese, pers. comm. 2005). Removal of adult coyotes on winter range at that time of year would therefore be expected to result in at least some reduction in direct winter predation and indirect impacts (*e.g.*, pursuit) on deer. Thus, it is likely that the relatively infrequent and brief aerial predator management activities that occur on deer winter range actually result in at least some level of net benefit to the deer populations allowing more deer to survive through severe winter periods.

Mule deer populations on a statewide basis have fluctuated over the years, and are currently estimated to be about 400,000. The population reached a high of about 625,000 in the early 1980s, fluctuated between 500,000 and 600,000 from the early 1980s to early 2000s, and has recently dropped back to pre-1980s numbers (Figure 7). Whereas deer numbers have declined since 2006, we find no evidence that this is due in any part to aerial predator management. In fact, the prior EA (WS 2005b) showed consistently high and increasing deer numbers from 2000-2004, when aerial predator management was also occurring. No significant changes to our aerial predator management program have occurred since then, so the recent declines in deer populations must be due to some other factor(s).

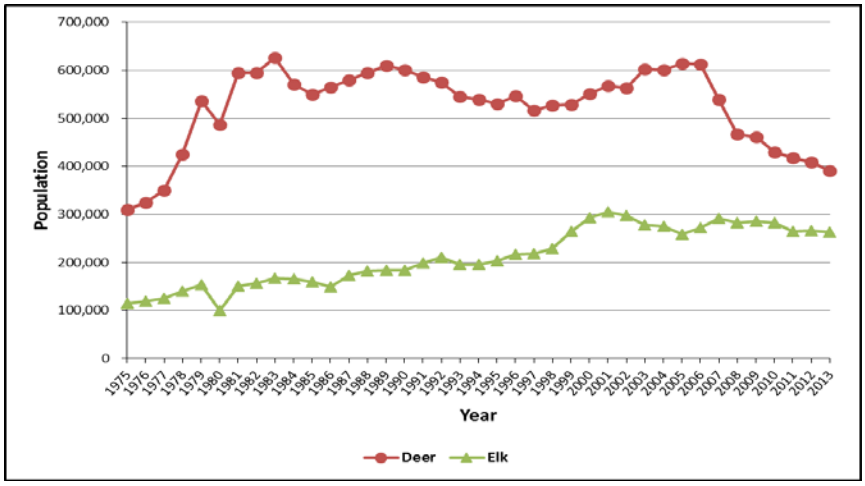


Figure 7. Colorado deer and elk population trends from 1975 to 2013 (A. Holland, Big Game Coordinator, CPW, *unpubl. data* 2015).

In April 2013, CPW held an internal summit regarding the declining mule deer population in western Colorado, and they identified ten management concerns: barriers to migration, competition with elk, disease, doe harvest and hunting demands, declining habitat quality, habitat loss, highway mortality, predation,

recreational impacts, and weather (CPW 2014a). Recent research suggests that the most significant factors affecting mule deer populations in the western U.S. are weather and habitat, and to a lesser extent, predation. This includes the quantity and quality of winter forage, winter severity, summer precipitation, and to some extent, mountain lion predation (Bishop *et al.* 2008, Hurley *et al.* 2011). To our knowledge, research has never cited occasional overflights on winter range as a limiting factor for deer survival. In fact, researchers commonly use aerial surveys to determine survival rates and population trends.

Accordingly, CPW expressed the opinion that aerial overflights on deer winter range during severe winter periods should not adversely impact deer if flights over deer are of short duration (B. Watkins, Big Game Coordinator, CPW, pers. comm. 2005). WS-Colorado's aerial predator management overflights in these areas (*e.g.*, BLM and USFS grazing allotments) are of short duration and low frequency (discussed further below). In conclusion, we find no evidence that WS-Colorado aerial predator management overflights on deer winter range cause any substantive adverse impacts on deer populations, and it is probable that aerial predator management results in some level of net benefit to such populations.

Elk: We could find no studies on the impacts of aerial overflights on elk. However, Espmark and Langvatn (1985) found that the species does become habituated to noise. Further, elk populations on a statewide basis have remained stable at near-record-high levels over the last ten years, while WS-Colorado aerial activities have been occurring (Figure 4). The Statewide population has increased from about 115,000 in 1975 to more than 260,000 today. No significant cumulative impact on elk populations from aircraft overflights, or any other stressor, is apparent.

Bighorn sheep: Krausman and Hervert (1983) reported that, in 32 observations of the response of bighorn sheep to low-level flights by small fixed-wing aircraft, 60% resulted in no disturbance, 21% in “slight” disturbance, and 19% in “great” disturbance. Another study found that 14% of bighorn sheep had elevated heart rates that lasted up to 2 minutes after an F-16 flew over at an elevation of 400 feet, but it did not alter the behavior of the penned bighorns (Krausman *et al.* 1998). Weisenberger *et al.* (1996) found that desert bighorn sheep and mule deer had elevated heart rates for 1 to 3 minutes and changed to alert behavior for up to 6 minutes following exposure to jet aircraft. Thus, bighorns’ response to overflights appears to be limited and transient, even from much louder aircraft than used by WS.

Areas of bighorn sheep habitat are also generally too rugged to be suitable for aerial predator management. And as stated previously, WS pilots are instructed during training to avoid nontarget wildlife, including bighorn sheep. Therefore, we find little or no potential for WS aerial overflights to cause any effects on bighorn sheep.

-Bison: Fancy (1982) reported that only 2 of 59 bison (*Bison bison*) groups showed any visible reaction to small fixed-wing aircraft flying at 200-500 feet AGL. Therefore, available evidence indicates bison herds would not be adversely affected by aerial predator management overflights that happen to occur in areas they inhabit. Moreover, bison overflights are expected to be an extremely rare event, because WS-Colorado rarely conducts aerial predator management in areas of wild bison herds in Colorado, and WS pilots are instructed to avoid nontarget wildlife.

Pronghorn (antelope): Krausman *et al*. (2004) found that Sonoran pronghorn (a T&E species in Arizona) were not adversely affected by military fighter jet

training flights and other military activity on an area of frequent and intensive military flight training operations. They also reported that pronghorn and desert mule deer do not hear noise from military aircraft as well as humans do, which would explain why they appear not to be disturbed as much as previously thought. Therefore, available scientific evidence indicates that overflights do not cause any adverse effects on pronghorn populations. The statewide pronghorn population has been on an increasing trend since the late 1970s. During FY00-04, the analysis period for the prior EA (WS 2005b), pronghorn numbers steadily increased, and during FY10-14, pronghorn numbers reached a record high (Figure 8). WS-Colorado conducted aerial predator management throughout these timeframes. Thus, there does not appear to be any deleterious effect of occasional overflights on pronghorn populations. We are unaware of any studies that indicate that coyotes can cause significant winter mortality of pronghorns, but removal of coyotes in winter might theoretically reduce fawn predation in the spring, much like it reduces lamb losses in the spring (Wagner and Conover 1999). If so, then aerial predator management of coyotes may have a net benefit to pronghorn populations.

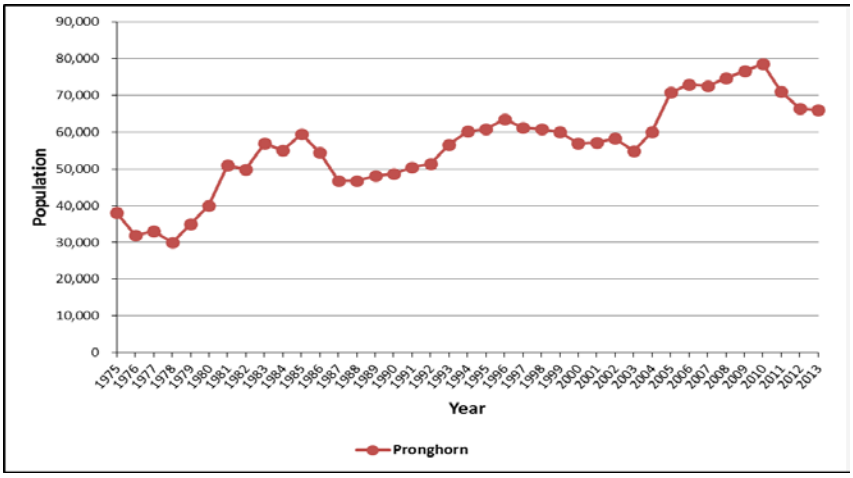


Figure 8. Colorado pronghorn population trend from 1975 to 2013 (A. Holland, Big Game Coordinator, CPW, *unpubl. data* 2015).

Wild Horses: Four wild horse areas are located on BLM lands in Colorado (Piceance Basin, Little Bookcliffs, Sandwash Basin, and Spring Creek). Concern is sometimes expressed that aircraft overflights could impact horses. We could not find studies conducted specifically on wild horse response to aircraft overflights. However, whereas wild horses have been reported to become alarmed at the sight and sound of helicopter activity, especially in areas where helicopters are predominately used by BLM during round-ups, the small fixed-wing aircraft that are used by WS have little noticeable effect on wild horses. Wild horses in the proximity of WS aerial predator management operations in Nevada have completely ignored the fixed-wing aircraft, even to the point of not getting up from a recumbent position (WS 1999c). We conclude that WS-Colorado's aerial predator management activities would likely have no significant effect on wild horses.

Domestic Animals and Small Mammals: A number of studies with laboratory animals (*e.g.*, rodents [Borg 1979]) and domestic animals (*e.g.*, sheep [Ames and Arehart 1972]) have shown that these animals can become habituated to noise. Long term lab studies of small mammals exposed intermittently to high levels of noise demonstrate no changes in longevity. The physiological "fight or flight" response, while marked, does not appear to have any long-term health consequences on small mammals (ANG 1997a). Small mammals habituate, albeit with difficulty, to sound levels greater than 100 dbA (A-weighted decibels) (USFS

1992). As shown below, the noise levels of the aircraft used by WS are low in comparison to other aircraft. Small mammals such as field rodents and rabbits have small home ranges and are generally widely distributed. The fact that WS only conducts aerial predator management on less than 2.5% of the land area of the State indicates that more than 97% of small mammal populations are not even exposed to WS-Colorado aerial predator management overflights. And such flights occur only a few days per year, which further decreases the potential for any significant adverse impacts. Regarding potential effects on livestock, the only persons likely to have concerns are livestock owners or managers. However, they are the ones requesting PDM assistance in most cases, and they are more concerned with stopping or preventing predation on their livestock. Still, livestock managers do express concern for such disturbances. However, by policy, WS stays at least 500 feet from livestock when aerial predator management, which precludes livestock disturbance in most cases, based on personal observations of WS aerial crews.

4.1.2.1e Impacts from noise due to WS-Colorado aircraft used in aerial predator management.

WS uses small fixed-wing aircraft and, on occasion, small helicopters for aerial predator management. Helicopters have been used very infrequently in recent years due to the higher costs of operation than fixed-wing aircraft. Less than 1% of WS aerial predator management hours in Colorado have been with helicopters in FY10-14. The fixed-wing aircraft used by WS are relatively quiet, whereas helicopters are somewhat noisier. As stated previously herein, the noise level of the J3 Supercub (Piper PA-18), which is not as quiet in operation as the Husky airplane model also used by WS (L. Burraston, WS National Aviation Manager, pers. comm. 2005), is reported by FAA to be 65 dBA when measured directly underneath the airplane flying at 500 feet AGL[15]. Put in perspective, that noise level is similar to "normal conversation at 5 feet" (in a commercial area)[16]. In comparison, most military jet aircraft noise levels at 500 feet AGL range from 97 to 125 dB at various power settings and speeds (U.S. Coast Guard 1999). To experience the same level of noise by common military aircraft as one would experience directly beneath a J3 Supercub in flight, one would have to be nearly 2 miles away from an F-16 and more than 3.7 miles away from a B-1B flying at 200 to 1000 feet AGL (from data presented in ANG 1997a). The effects on wildlife from these and other similar types of military aircraft have been studied extensively as shown in the information presented in this section, in ANG (1997a, 1997b), and references therein, and were found to have no expected adverse effects on wildlife. The aircraft used in aerial predator management have far less potential to cause any adverse effects on wildlife than these military aircraft because the military aircraft produce much louder noise and are flown over certain training areas as many as 2,500 times per year. Further lessening the potential for effect from WS aerial predator management flights is that they occur on a small percentage of the land area of the State and of public lands. See below for a more complete analysis of WS-Colorado aerial predator management on public lands.

4.1.2.1f Summary of aircraft overflight impacts to wildlife.

The above analysis indicates that most bird and mammal species are relatively tolerant of aircraft overflights, even those that involve noise at high decibels such as from military aircraft. It appears that some species will frequently, or at least occasionally, show what appear to be adverse responses to even minor overflight occurrences. In general, the greatest potential for impacts would be expected when overflights are frequent and over many days, which could represent "chronic" exposure. Chronic exposure situations

[15] Information from: http://www.faa.gov/about/office_org/headquarters_offices/AEP/noise_levels/media/uscert_appendix_07.xls

[16] FAA "Criteria for Evaluation of Aviation Generated Noise" @ http://www.awp.faa.gov/atenviro/CRITERIA.htm.

generally involve areas near commercial airports and military flight training facilities. Even then, many wildlife species become habituated to frequent overflights, which appears to naturally mitigate for adverse effects on their populations in local areas where such flights occur on a regular basis (as discussed above). WS aerial predator management operations occur in relatively remote rangeland areas and not near commercial airports or military flight training facilities. In addition, WS conducts very few flights over any one area in any one year as shown by the data in Tables 10 and 11 below. Therefore, WS-Colorado aerial overflights have little potential to reach a level that could be viewed as "chronic" in any local area.

4.1.2.1g Effects of gunshot noise on wildlife.

Some commenters have expressed concern that gunshot noise during WS-Colorado aerial predator management overflights might result in significant disturbance impacts on wildlife species. A few studies have indicated that gunshot noise can alter behavior of some wildlife species, including waterfowl (Meltofte 1982) and eagles (Stalmaster and Newman 1978). It has also been suggested that firearms noise affects species that are hunted due to their association of such noise with being pursued and shot at by humans (Larkin 1996). However, the time spent shooting at coyotes from aircraft during aerial predator management flights is an exceedingly small proportion of overflight times. WS aerial predator management data for Colorado in FY10-14 show an average of 2.2 predators killed per hour of aerial predator management. A typical "pass" in which shots are taken at a predator takes usually involves 2 to 4 shots with a 12 gauge shotgun in rapid succession. Time spent shooting during each pass is generally 2 to 3 seconds or less. It generally takes an average of just more than 1 pass to successfully shoot and kill a predator (because most are killed on the first pass). Using high estimates of 3 seconds of shooting per pass and 2 passes per predator, we estimate that at most, less than 15 seconds of each hour of flying time (less than 0.5% of the time spent aerial predator management) is actually spent shooting at target animals and generating gunshot noises. WS flew an average of 621 hours per year in FY10-14, which corresponds to less than 3 hours per year generating gunshot noises statewide. WS took an average of 1,375 predators per year during aerial predator management activities in FY10-14 in Colorado. At an estimated average of 4 shots per predator killed, the number of shots fired by WS per year during aerial predator management is approximately 5,500 statewide.

As part of the existing human environment, about 259,000 persons participated in hunting in Colorado in 2013, who spent 2.2 million person-days hunting, and killed about 86,000 big game animals and more than 880,000 small game animals (CPW 2014b, 2014c, 2014d, Raftovich *et al.* 2014, USFWS 2014a). The number of shots fired by private hunters each year would, at a highly conservative estimate of 2 shots fired per animal killed, would be more than 1.9 million. WS's contribution to overall gunshot noise in areas of wildlife habitat is less than 0.3% of the number of shots fired at wild animals in the State each year. Therefore, WS adds only exceedingly small amounts of gunshot noise to that which occurs annually as part of the existing human environment in wildlife habitat areas of Colorado.

Further, WS aerial predator management activities are infrequent, of short duration, and cover only a small proportion of geographic area involved (2.5% of the land area of the State, 4.3% of BLM grazing allotment acreage, and less than 1% of USFS land area) which means only small proportions of nontarget wildlife populations would ever hear any noise from WS gunshots. Also, shooting from aircraft is virtually always at an extreme downward angle towards the ground. Pater (1981 *cited in* Larkin 1996) reported that muzzle blast is louder in the direction toward which the weapon is pointed by up to 14 decibels. Thus shooting downward toward the ground would serve to lessen the noise in lateral directions from the aircraft. WS personnel on the ground observing aerial predator management training passes in which shots are taken report that the gunshot noise heard at a distance of 150 yards or more is more like a "pop" noise rather than the sound of an

explosion (L. Burraston, National Aviation Manager, WS, pers. comm. 2005). This suggests that shotgun noise from WS aerial operations is not loud enough to cause much of a startling or disturbance effect at a distance. Animals that happen to be directly beneath or in close proximity to the aircraft when shooting passes are made will undoubtedly hear the firearm noise as much louder, but the low frequency of occurrence of flights and small fraction of aerial predator management time actually spent firing the shotgun, along with the very small proportion of the geographic area over which shooting passes are made suggests only very small proportions of wildlife populations would be exposed to any close-proximity shotgun firing noise.

Finally, if gunshot noise caused serious adverse effects on wildlife populations, we believe the USFS, BLM, and State wildlife agencies would have addressed and mitigated such effects from the hundreds of thousands of private hunters who shoot at game and near certain nongame animals on public lands and elsewhere annually. All of these factors suggest that the gunshot noise from WS aerial predator management does not negatively impact wildlife in Colorado.

4.1.2.1h Cumulative impacts of aircraft overflight.

Some public comments to prior versions of this EA have raised the concern that WS-Colorado aerial predator management overflights, when added to other types of low level overflights, might result in cumulative adverse effects on certain wildlife species populations.

Besides PDM, WS-Colorado also conducted aerial predator management activities for feral swine damage management during FY10-14. These activities were very limited in duration, frequency, and geographic scope, even when compared to the WS-Colorado aerial predator management activities for PDM discussed above. In FY10-14, WS-Colorado flew an average of 5.8 hours per year for feral swine. This includes 1.8 flights per year on average. Aerial predator management for feral swine in Colorado represents less than 1% of additional flight hours over the PDM aerial predator management analyzed in 2.3.2.1 through 2.3.2.4 above. This small increase does not significantly alter our analyses or determinations in those Sections. Moreover, most (89%) of the aerial predator management for feral swine was conducted in Baca County, where no aerial predator management for PDM was conducted.

The only other aerial predator management that occurs in Colorado besides that performed by WS-Colorado is by private individuals under a permit from either CDA (for livestock protection) or CPW (if they approve it for wildlife protection). No permits for wildlife protection by private entities have been issued by CPW in a number of years. CDA-permitted aerial predator management by entities other than WS has been limited in terms of magnitude, frequency, and geographic scope. On average, 94 predators were killed per year by private aerial predator management in FY10-14. Although data on number of hours flown was not available from the reports that CDA maintains, we estimated the number of hours flown using predator take data by assuming that private aerial hunters had a success rate of 1.1 predators per hour flown, which is ½ of the average success rate of WS-Colorado aerial predator management in FY10-14 (2.2 predators per hour flown). This estimate should result in an overstatement of the number of hours flown by private entities and, therefore, an overstatement of their potential overflight impacts. Using this calculation, we estimate that private individuals spent an average of 85.8 hours per year in FY10-14 conducting aerial predator management. Thus, cumulative aerial predator management in Colorado averaged 701.5 hours per year, 88% of which was conducted by WS, and 12% of which was conducted by private individuals. This represents an increase of approximately 14% over the WS aerial predator management activities analyzed above. This small increase does not significantly alter our analyses or determinations in those Sections.

Also, none of the permits authorized aerial predator management on federal public lands (W. East, CDA, pers. Comm. 2015). Therefore, private aerial predator management has had no potential to contribute to cumulative impacts from overflight effects to wildlife on public lands. It is expected that private aerial predator management will not increase above levels that occurred over the last several years unless WS reduces its aerial predator management activities. Therefore, we find no reason to expect effects on coyote populations or of overflights on other wildlife from private aerial predator management to increase over the levels that have occurred recently. The levels of private aerial predator management that have occurred and are expected to occur in future years should thus have no potential to lead to significant cumulative impacts on wildlife when added to WS's aerial predator management flights.

The Air National Guard finalized an EIS (ANG 1997a) on a proposal to expand military training flights in Colorado. That EIS contains considerable analysis on the potential for military training overflights by jet aircraft to adversely affect numerous wildlife species, and we refer readers to that document for a more thorough coverage of the detailed analysis. Below, we identify those areas and counties within Colorado where military training flights occur. In summary, the analysis in that EIS established the following:

- Many studies exist that have documented behavioral responses in wildlife, but those studies have not provided evidence that wildlife species populations have been adversely affected to any substantial degree. ANG (1997a) concluded that their Preferred Alternative (the "Colorado Airspace Initiative"), which involved from 62 to 2,461 "sorties" (military training flights) on 14 separately identified airspace components per year, was not expected to result in any significant environmental impacts. In particular, ANG concluded that no adverse impacts were expected on any wildlife species in any of the airspace components where the training flights would occur.

- Aircraft overflights within 650 to 1,640 feet have been shown to increase the heart rates and cortisol levels of large herbivores (USFS 1992). However, even when animals flee temporarily from approaching aircraft, available evidence suggests risks of damage are low, as animals flee with caution and do not injure themselves when startled or frightened.

- Studies of wildlife subjected to aircraft overflights have not shown evidence of compromised reproduction, either directly or indirectly (USFS 1992).

- A majority of the literature reviewed led to the conclusion that numerous wildlife species have the ability to adapt to the presence of man and various man-made sound sources, including jet aircraft noise. Although initially startling, habituation to jet aircraft noise occurs with most wildlife species.

- No published scientific evidence was identified that indicated harm may occur to wildlife as a result of exposure to the levels of noise generated by military aircraft that would utilize the airspace associated with military training flight areas.

- USFWS and state wildlife agencies expressed some concerns about the potential for adverse effects from military overflights on waterfowl in waterfowl habitat areas, and on bighorn sheep in their lambing areas. WS-Colorado does not conduct aerial predator management actions in those types of areas unless requested by responsible wildlife management agencies; conversely, in other states, WS has been requested to protect waterfowl nesting areas from coyote predation impacts, and aerial predator management has been used to meet those objectives to enhance waterfowl populations.

- It can be concluded that the activities associated with the Colorado Airspace Initiative (the preferred alternative in ANG (1997a)) will not adversely affect wildlife species within the region of influence.

The ANG (1997a) EIS analysis thus shows that military overflights, even where they occur on a regular basis up to many hundreds of times a year over specific areas, are not likely to result in adverse effects on wildlife. ANG (1997a) described the locations of areas in and routes on which military training flights occur in Colorado. The areas, Military Operations Areas (MOAs), and training flight routes are shown in Figure 9.

Table 23. Average number of WS-Colorado aerial predator management flights and military training flights (sorties) during federal Fiscal Year 2010-14 in Colorado counties where military training flights occur (ANG 1997a).

County	Average WS Flights per Year	Number of Military Sorties per Year		WS Flights as Percentage of Total Flights
		MOA or Training Route	Sorties	
Las Animas		Pinon Canyon MOA	62	
		Two Buttes Low MOA	475	
		Two Buttes High MOA	845	
		IR-409 Whole Route	53	
		IR-409 Segments F to I	845	
		XVR-1427 Whole Route	343	
		XVR-1427 Segments F to I	185	
Las Animas Total	**8.4**	**7 MOAs/Routes**	**2,808**	**0.3%**
Otero		Pinon Canyon MOA	62	
		Two Buttes Low MOA	475	
		Two Buttes High MOA	845	
Otero Total	**9.8**	**3 MOAs/Routes**	**1,382**	**0.7%**
Crowley		IR-415 Segments A to D	88	
		IR-414	62	
		XIR-424	211	
Crowley Total	**12.2**	**3 MOAs/Routes**	**361**	**3.3%**
Baca		Two Buttes Low MOA	475	
		Two Buttes High MOA	845	
		IR-409 Whole Route	53	
		IR-409 Segments F to I	845	
Baca Total	**1.4**	**4 MOAs/Routes**	**2,218**	**0.1%**
Lincoln		IR-415 Segments A to D	88	
Lincoln Total	**4.4**	**1 MOA/Route**	**88**	**4.8%**
Fremont				
Fremont Total	**0.3**			
Weld		IR-416	62	
		XIR-426	62	
Weld Total	**0.2**	**2 MOAs/Routes**	**124**	**0.2%**
TOTAL COUNTIES	**36.4**	**20 MOAs/Routes**	**6,981**	**0.5%**

WS-Colorado conducted aerial predator management in 7 counties (Baca, Crowley, Fremont, Las Animas, Lincoln, Otero, and Weld) during FY10-14 where military training flights (called "sorties") also occurred (Table 23). When the number of WS-Colorado flights is added to military sorties, WS-Colorado's flights comprise only 0.5% of the total flights in those Counties. Therefore, WS-Colorado flights do not add appreciably to the total number of overflights in any of the affected counties. Moreover, aircraft used by WS-Colorado are considerably quieter than those used by the military. In conclusion, cumulative effects of WS-Colorado and military overflights are not likely to produce any significant impacts on wildlife.

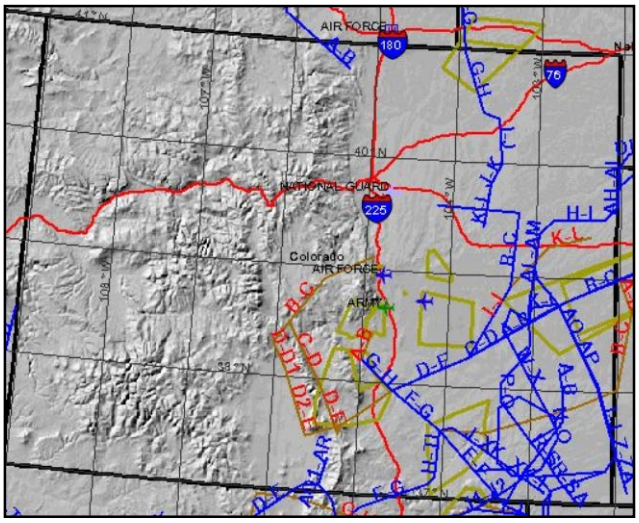


Figure 9. Military operations areas (tan outlined polygon areas) and training flight routes (lines with hyphenated letter designations) in Colorado. Red lines are interstate highways (map obtained @ http://www.usahas.com/bam/).

At least one comment received from the public in a prior version of this EA expressed that commercial aircraft flights could present concerns about cumulative impacts on wildlife when considered together with WS-Colorado aerial predator management overflights. However, most such flights occur at such high altitudes (generally more than 30,000 feet), that they present virtually no potential to disturb wildlife, and we are unaware of any scientific evidence to the contrary. Therefore, we conclude such flights have no potential to contribute to cumulative impacts on wildlife that are affected by or exposed to WS-Colorado aerial predator management overflights.

There is no obvious "threshold" of significance when it comes to the cumulative effects of overflights on wildlife. Our analysis and the considerable analysis of ANG (1997a, 1997b) show that, despite considerable research on numerous wildlife species, no scientific evidence exists that indicates any substantive adverse effects on wildlife populations will occur as a result of any of the types of low level or other overflights that do or may occur in Colorado. WS-Colorado's past and future aerial predator management activities that have occurred within the same areas flown by military training flights are an inconsequential addition to what has already been found by analysis in an EIS to have little to no potential for causing adverse impacts on any wildlife species populations, despite the fact that the military training flights are far more numerous and produce far greater noise levels than the small aircraft used by WS-Colorado. Aerial predator management overflights by non-WS entities are too few in frequency and geographic scope to suggest any possibility of adding significantly to any cumulative adverse effects. The evidence from available studies, particularly those involving military aircraft, suggests that adverse effects do not occur even when flights are far more frequent than when private or WS-Colorado aerial predator management activities occur in specific areas.

The duration, frequency, and geographic scope of WS-Colorado's aerial predator management activities in Colorado are very low. Even the lands most heavily flown in Colorado were exposed to aerial predator management on less than 5% of the days of any one year. And given that average flight times were less than 1 hour per day, total flight times on the most heavily flown land constituted less than 0.2% of the year. On the basis of land area under agreement, only 2.5% of Colorado, 4.3% of BLM lands, and less than 1% of USFS lands are potentially exposed to some level of aerial predator management in a typical year. Even if such overflights were to increase ten-fold in the future, available scientific evidence as discussed in this chapter indicates that wildlife would not be adversely affected because most species are tolerant of or habituate to overflights. WS-Colorado's standard practice of avoiding concentrations of wildlife during aerial predator management activities further lessens the already low to nonexistent potential for such flights to adversely affect their populations.

The scientific evidence supports the conclusion that aerial overflights by WS-Colorado have no significant impacts on wildlife, and that even when added to other types of overflights, such cumulative impact is negligible to non-existent. There is considerable scientific evidence presented herein that overflights do not adversely affect wildlife. That fact by itself goes a long way toward providing qualitative support for a finding that there is no potential for significant adverse effects on the quality of the human environment, either on a State-wide basis or at the local level, from WS-Colorado overflights. In conclusion, we have found no evidence to suggest that overflights' effects on wildlife, even cumulatively, would result in significant impacts on wildlife species populations, l*et al*one result in effects on such populations that would rise to the level of causing a significant impact on the quality of the human environment.

4.1.2.1i Consideration of Impacts to T&E Species in Colorado.

Measures to avoid T&E impacts were described in Chapter 3. Those measures should ensure that the proposed action (Alternative 1) will not have adverse effects on T&E species. Of the federal and state listed species occurring in Colorado, PDM has the potential to adversely affect certain terrestrial vertebrate species (mammals and birds), as discussed below. Table 11 in Chapter 2 identified the species that could potentially be impacted by PDM; 11 species could be adversely affected by PDM activities whereas 9 T&E species could benefit.

WS-Colorado PDM will have no effect on any of Colorado's T&E fish and amphibian species because PDM methods will not affect water or wetlands, and PDM activities are not generally conducted in aquatic or wetland environments. This includes greenback

cutthroat trout, Colorado pikeminnow, humpback chub, bonytail chub, and razorback sucker.

Colorado does not have any reptile species listed. WS-Colorado PDM will have no effect on any of Colorado's T&E plant and invertebrate species because PDM activities do not modify or impact habitat to any extent, and PDM activities are not generally conducted in these species' habitat. Moreover, WS-Colorado follows SOPs (as discussed in Chapter 3) to minimize or eliminate any the potential impact to these species. This includes the following plant species: Mancos milk-vetch, Osterhout milk-vetch, clay-loving wild buckwheat, Penland alpine fen mustard, Colorado butterfly plant, Pagosa skyrocket, Dudley Bluffs bladderpod, Knowlton cactus, Parachute beardtongue, Penland beardtongue, North Park phacelia, DeBeque phacelia, Dudley Bluffs twinpod, Colorado hookless cactus, Mesa Verde cactus, and Ute ladies'-tresses. This also includes the following invertebrate species: Uncompahgre fritillary butterfly and Pawnee montane skipper.

USFWS and CPW monitor several species considered threatened, endangered, or sensitive in Colorado. These agencies monitor these species' populations to determine if different activities singly or combined are impacting the populations (a cumulative impact analysis). Mortality for T&E species is monitored where feasible. But mortalities due to road kills, loss of habitat (*e.g.*, land development, construction, housing, industrial complexes, road, mining, and oil and gas development), and natural disasters (*e.g.*, fires, floods, lightning, heavy winters, and drought) are the same under all alternatives and much of this activity that results in mortality or population limiting factors is difficult to determine. These factors are not likely to be determined sufficiently even with unlimited funding; they can only be estimated based on population trends (increasing, decreasing, or stable). The availability of habitat is often the most critical concern because the available habitat determines the population which an area can support. WS-Colorado consults with CPW and USFWS, as necessary, to provide them with information regarding WS-Colorado's potential to take these species with PDM methods. WS-Colorado has determined that one or more PDM activities have the potential to adversely affect 11 T&E species (not including 2 species considered extirpated).

Black-footed Ferret. In Colorado, black-footed ferrets are federally listed as a nonessential experimental population. The black-footed ferret was recently reintroduced into eastern Colorado, beginning in 2013, and reestablished populations are now known to exist at various reintroduction sites in southeast and Colorado and along the Front Range, from Denver to Wyoming. WS-Colorado PDM methods including foothold traps and gas cartridges have the potential for taking ferrets (the label for the M-44 does not allow its use in prairie dog towns to preclude exposure to ferrets and thus has no effect on the ferret). WS-Colorado coordinates with the USFWS to conserve black-footed ferrets and this is accomplished by following conditions in Safe Harbor Agreements. Additionally, WS-Colorado uses pan-tension devices which preclude capture of the ferrets when working in or near prairie dog colonies. WS-Colorado has worked with USFWS by conducting PDM to reduce predation on ferrets. In one of the first releases in Moffat County, CO in 2001, 34 of the 39 ferrets released were killed by predators. It was found that controlling predators in the area prior to the release helped get their population established in subsequent releases. WS-Colorado has not taken any black-footed ferrets. Additionally, WS-Colorado has added the reintroduction of black-footed ferrets across the prairie in eastern Colorado by treating black-tailed prairie dog colonies to kill fleas and prevent the spread of sylvatic plague. The risk from plague can result in the loss of prairie dogs which make up 80% of the ferrets diet, death of ferrets from plague, and loss of the ferrets food supply which leads to failure of the ferret reintroduction effort.

Kit fox. Kit fox are listed by the State of Colorado as endangered. Colorado is on the eastern part of their range in the U.S. Several tools used in PDM have the potential for taking a kit fox; however, CPW has regulations that, when implemented, minimize the potential for WS-Colorado Specialists to take one. WS-Colorado follows these regulations, as discussed in Chapter 3 under SOPs. For example, WS-Colorado avoids using lethal methods where kit fox are known to exist. WS-Colorado also uses pan-tension devices on foothold traps and stops on snares to exclude kit fox from take. None were taken by WS-Colorado during FY10-14. Nationally, a few kit fox have been taken as target species in the past, which indicates that they can cause damage. However, kit fox are listed as Endangered by the State of Colorado, and as such, WS-Colorado does not target kit fox for lethal removal. They also cause very few complaints or damage in Colorado due to their low numbers. During the period from 1987 to 1994, an average of 13 were harvested annually (Table 8, CPW 2014d), but in 1995, the season on kit fox was closed, and it remains so. These harvest figures illustrate that the population can sustain some low level of harvest without detriment to the population. Limited distribution in Colorado, habitat loss, and predation likely contribute to their low population. WS-Colorado will not target kit fox in Colorado due to their protected status and low population in Colorado.

Canada Lynx. Canada lynx are federally listed as threatened. PDM methods that have the greatest probability of incidental take include foothold traps and snares, and, to a lesser extent, M-44s and trailing dogs. WS-Colorado abides by the August 23, 2005 BO from the USFWS (2005) which authorizes incidental take and established reasonable and prudent measures and terms and conditions to minimize the risk of take. WS has not taken a lynx in Colorado with the exception of one in response to a request from CPW officials to live-capture and translocate a lynx that had left lynx habitat and was found in a desert wash west of Grand Junction. The lynx was captured by WS-Colorado (acting as an agent for CPW) under CPW's USFWS permit. Trailing dogs treed the lynx, and it was immobilized, rehabilitated, and transported by CPW personnel back to lynx habitat (it had become emaciated). Currently, the lynx population in Colorado has been expanding its range and increasing as a result of natural reproduction. Mortalities can be attributed to lynx being shot, killed on highways, and other factors, and are closely monitored by CPW and USFWS. Thus far, WS-Colorado has not added to any mortality and, based on the experience of the WS-Colorado program over many years, we believe WS-Colorado PDM is not likely to result in take that would adversely affect lynx recovery in the State.

Some commenters have expressed a concern that WS-Colorado PDM activity might contribute in some substantive way to what might be significant cumulative impacts on lynx because of other actions unrelated or unconnected to WS-Colorado PDM, examples of which include oil and gas development, timber harvesting, residential subdivision development, and grazing.

USFWS evaluated and considered future cumulative effects in the BO (USFWS 2005) of other types of activities such as residential and commercial development, recreational activities such as snowshoeing and snowmobiling, agricultural development, and livestock grazing, and concluded that the potential effects of WS-Colorado PDM actions in the State when combined with these other activities would not pose jeopardy to the continued existence of lynx. Therefore, we find no evidence presented from the USFWS that WS-Colorado PDM poses any significant threat to lynx conservation in the State.

The USFWS has previously determined that timber harvesting could be a threat to lynx, but could also be beneficial depending on harvest methods, spatial and temporal specifications, and the inherent vegetation potential of the site. Forest

practices in lynx habitat that result in or retain a dense understory provide good snowshoe hare habitat that in turn provides good foraging habitat for lynx (FR 68 40076 - 40101, July 3, 2003). Regarding effects of other types of activities, the USFWS determined that roads and trails, agricultural and urban development, off-road-vehicle and snowmobile use, ski resort expansion, mining, fire suppression, and grazing could also adversely affect lynx. They found that the threat to lynx by some of these activities, such as fire suppression, is low, and also found no evidence that some activities, such as forest roads, pose a threat to lynx. Some of the activities suggested, such as mining and grazing, were not specifically addressed because they had no information to indicate they pose threats to lynx.

Most suitable lynx habitat in the Colorado is on USFS lands, with lesser amounts occurring on lands under BLM management (FR 68 40076 - 40101, July 3, 2003). The USFS and BLM are committed to habitat and land management actions that will serve to benefit lynx, and they have signed an agreement with the USFWS (referenced in FR 68 40076 - 40101, July 3, 2003) to operate in accordance with the Lynx Conservation Assessment and Strategy (Ruediger *et al*. 2000). Therefore, we find no reason to believe lynx recovery efforts in Colorado will be adversely affected by the many activities identified above that might occur in suitable lynx habitat areas. More importantly, WS-Colorado has no decision-making authority over these land management actions. Therefore, those actions and their effects are part of the existing human environment, whether or not WS-Colorado conducts any PDM activities.

WS-Colorado PDM actions do not alter or otherwise affect habitat. Such actions also have no potential to adversely affect the primary prey species of the lynx which is the snowshoe hare. No snowshoe hares have been taken as non-target animals by PDM activities in Colorado. Currently, the only PDM methods used by WS-Colorado on USFS and BLM lands involve shooting (aerial or ground based), which are virtually 100% selective for target species. Thus, they pose no risk of taking a lynx in the areas where lynx are most likely to occur, which further lessens the chance of any contribution to adverse cumulative effects by WS-Colorado PDM. Any coyote removal from lynx habitat that occurs because of PDM may actually benefit lynx (see additional discussion about T&E species that might benefit from WS-Colorado PDM here in Chapter 4). Because WS-Colorado PDM activities have not contributed to any lynx mortality, and because the potential for those activities to contribute to future lynx nontarget mortality is low, we find no reason to conclude that WS-Colorado PDM in the State is likely to contribute to any significant cumulative adverse effects on lynx.

The Canada lynx occurs in the boreal forests of North America where it is highly associated with its primary prey, the snowshoe hare (*Lepus americanus*). The species is abundant and common in Canada and Alaska, where the core of its range occurs. Suitable lynx habitat consists of montane and subalpine forest ecosystems. At one time, lynx occurred in several states, including Colorado. The lynx became endangered under state law in Colorado in 1973; coincidentally, the last year that a lynx was documented to be taken in Colorado. There is no fur trapping for lynx in Colorado. USFWS federally listed the Canada lynx as threatened in its historic range in the lower 48 contiguous states in 2000. Colorado represents the extreme southern edge of its range.

In coordination with several other agencies and organizations, CPW began a reintroduction program in 1999 using lynx that were captured in Alaska and Canada and brought into the State. The entities involved in the reintroduction program determined the ideal location for a “Canada Lynx Recovery Area” in Colorado was in the southwestern part of the State. Reproduction was confirmed for the first time in 2003 with 16 kittens being found by CPW and 36 more kittens

in 2004 (Shenk 2004). Lynx are now (2016) believed distributed above 9,000 feet elevation where spruce-fir forests and adequate snowshoe hare populations exist in southwestern and central Colorado. They also occur in lodgepole pine and aspen habitat in the Sawatch Range of central Colorado and the use of the Medicine Bow and Front Range of northern part of Colorado (Ivan et al. 2011).

Lynx can potentially be both negatively and positively affected by PDM. WS nationally has only taken 1 non-target lynx. That lynx was taken by the Idaho WS Program in 1991 in non-lynx habitat and was released alive. In the same time frame, WS nationally took 74,419 target coyotes (avg. = 2,481/yr) and 3,142 target bobcats (avg. = 105/yr) in foothold traps. Because lynx occupy high elevation spruce-fir habitats rarely utilized by livestock, it is extremely unlikely that WS-Colorado would impact lynx using these methods. However, WS has never taken a lynx accidentally in Colorado and we consider the risk of take to be highly unlikely under current circumstances in the State. WS has intentionally captured lynx in Colorado as part of the reintroduction effort. Lynx have expanded their range in Colorado in spite of other wildlife that may compete with lynx for snowshoe hares and other food resources.

River Otter: River otters, a state threatened species, were once widely distributed in Colorado, but were believed to be extirpated in the early 1900s. Otters prey on a variety of animals but prefer fish and crayfish. The river otter, a State threatened species, has been successfully reintroduced into Colorado and has since been down-listed from endangered. The reintroduction sites, where more than 100 were released, included Cheesman Reservoir, and the Gunnison, Piedra, Dolores, and upper Colorado rivers. They now can be found in aquatic environments in much of Colorado (CPW 2016).

Non-target take of river otters can be avoided by not trapping along lake shores, streams, and rivers where river otter sign is found. CPW has measures to reduce the potential for take. These are adhered to by WS-Colorado personnel and are listed in Chapter 3. WS-Colorado has not taken a river otter while conducting PDM during FY10-14. CPW has down-listed the river otter from endangered to threatened as a result of successfully establishing a viable population in the state.

Gray Wolf: Gray wolves, a federal endangered species, were extirpated from in Colorado by the mid-1930s, but occasional migrants may enter Colorado from reintroduced populations in neighboring states. Several tools used in PDM such as foothold traps, snares, M-44s, and aerial predator management for large predators such as coyotes and mountain lions have the potential to take a wolf. SOPs that would be used by WS-Colorado to minimize risks to the gray wolf include all SOPs and other measures to reduce the likelihood of take listed in Chapter 3. No gray wolves have been taken by WS-Colorado since the 1930s. Gray wolf populations have been increasing and doing well in their experimental areas. WS-Colorado will be notified of verified wolf sightings by USFWS or CPW. In turn, WS-Colorado will notify USFWS and CPW if a WS-Colorado Specialist documents the presence of a gray wolf in Colorado. WS-Colorado conducts no livestock protection from wolf predation and no predation by transient wolves has been reported in Colorado.

California Condor: California condors are federally listed as endangered. Some concern has arisen regarding the potential of PDM to affect condors that venture out of their experimental range in Arizona and enter Colorado. PDM tools that have the potential to affect California condors include the M-44, snares, foothold traps, and lead pellets/bullets ingested from carcasses of predators taken by shooting. Measures to reduce likely impacts to the condor are given in Chapter 3. WS-Colorado has not taken a condor nor does WS-Colorado anticipate such an

occurrence, and will abide by relevant measures to minimize any potential take anywhere condors come into Colorado. The experimental population of condors in Arizona has been increasing slowly through introductions and successful wild reproduction. However, condors reproduce slowly and it may take some time to fully establish their population. Whereas California condors from the experimental population were documented to briefly visit Colorado in 1998, Colorado is outside the historic range of California condors, and they are not listed in Colorado.

Wolverine. Wolverines are listed by the State of Colorado as endangered. The largest member of the mustelid family (*e.g.*, weasels, skunks, badgers), the wolverine was probably never common in Colorado (Fitzgerald *et al*. 1994). Wolverines were found in higher elevation forests and alpine tundra. They most likely disappeared from Colorado in the early 1900s (CPW 2004), and are now listed as endangered by the State of Colorado. Wolverines feed on carrion, and small birds and mammals. Some evidence suggests that they could still persist in Colorado. However, the last documented wolverine sighting was reported in 2012 near Rocky Mountain National Park. This wolverine's presence was first reported in 2009. Habitat protection and reintroduction could be considered to establish a viable population in the future. The historic range of wolverines and their habitat in Colorado mostly preclude them from being taken during PDM. Wolverines could be negatively affected by PDM, but they have been considered extirpated from the state. Therefore, Under Alternative 1, WS-Colorado PDM should have no effect on them.

Plains Sharp-tailed Grouse and Lesser Prairie-chicken: Plains sharp-tailed grouse is on Colorado's endangered species list. They are found in open habitat in the eastern portion of Colorado. Lesser prairie-chickens, a state threatened species, are found in short grass prairies of southeastern Colorado. Decline in these species has been linked primarily to habitat loss, although other factors may play a role (Arritt 1997). WS-Colorado will not use foot-hold traps without pan-tension devices where plains sharp-tailed grouse or lesser prairie-chicken are known to exist. WS-Colorado can will rely on cage traps or other methods to capture small predators in these areas if needed. WS-Colorado has not added to any known take, and likely has benefitted many subpopulations of these species by conducting PDM in their range.

WS is currently conducting PDM nationally to protect several gallinaceous species, including the greater sage-grouse, from predators. In Colorado, lesser prairie-chicken and plains sharp-tailed grouse numbers have declined. Predators have been found to have at least some impact on grouse populations in their range, so PDM could have a positive effect on grouse populations by keeping their numbers at higher levels.

The Western Association of Fish and Wildlife Agencies Sage-grouse Management Guidelines (Connelly *et al*. 2000) suggest that PDM for protection of sage-grouse should be implemented only if nest success is less than 25%, or survival of adult hens is less than 45%, but they do not address the appropriateness of PDM in areas with low chick survival. Results of studies conducted in 1999 and 2000 in Idaho suggested that survival rates for sage-grouse chicks were only 15% and 18%, respectively, and that predators were responsible for 90-100% of the mortality (Burkepile *et al*. 2001). Although most sage-grouse management plans suggest indirect management of grouse-predator relationships through habitat manipulation, Schroeder and Baydack (2001) have suggested that managers should consider PDM as a management option and evaluate its viability through experimentation.

Gunnison Sage-grouse: The Gunnison sage-grouse was listed as federally threatened on November 20, 2014 (79 FR 69192). Gunnison sage grouse occur on sage brush habitats and rangelands with a sage brush component in central Colorado in and near the Gunnison Basin. The species has declined in abundance due to substantial changes in habitat from human disturbance and small population size (Gunnison Sage Grouse Rangewide Steering Committee 2005). These population declines are exacerbated by the interaction of predation with habitat loss and small population size (Gunnison Sage Grouse Rangewide Steering Committee 2005). Changes in habitat affect the distribution of Gunnison sage grouse on the landscape. Some habitat changes have resulted in increases in wildlife species that depredate Gunnison sage grouse, resulting in negative population effects.

The decline of Gunnison sage grouse is due to poor or no productivity (Davis et al. 2015), especially among the 7 small satellite populations (Davis et al. 2015, Oyler-McCance et al. 2005). Taylor et al. (2012) found female survival and chick survival were the most important vital rates for greater sage grouse population growth, which is similar to little to no population growth afflicting Gunnison sage grouse populations. The poor productivity and survival of chicks is likely attributed to declining habitat quality and introduction of anthropogenic habitat alterations harmful to sage grouse survival. Many studies report habitat characteristics that have changed to the detriment of Gunnison and greater sage grouse (Hovick et al. 2014, Aldridge et al. 2012, Hess and Beck 2012). Whereas habitat loss or change may be the proximate cause of sage grouse decline, these changes introduce ultimate factors, such as predation, that cause population loss (Gregg and Crawford 2007).

Raven and corvid populations have increased significantly over the last 40 years as man has introduced anthropogenic structures into sagebrush habitat (Coates et al. 2016, Coates and Delehanty 2010, Manzer and Hannon 2005). Ravens are one of the predators depredating sage grouse and in some locations are impacting population growth and survivability of nests and eggs (Coates and Delehanty 2010,). These population losses normally would not occur in pristine sage brush habitat. WS Colorado has conducted limited raven damage management to protect Gunnison sage grouse at one satellite population.

Most PDM projects have little potential to impact T&E species in Colorado because they are conducted in areas where T&E species, except Gunnison sage grouse, are known to rarely be present. Many different methods and strategies are used to abate predation to livestock and wildlife species of management concern. However, two routine methods may disturb Gunnison sage grouse. Aerial predator damage management and calling and shooting coyotes with or without decoy dogs may disturb Gunnison sage grouse on leks during late winter and early spring. WS Colorado conducts aerial predator damage management on the Cerro Mesa, Sapinero Mesa (Gunnison Basin) and Crawford 0-2 times per year for 15-30 minutes per location to remove coyotes that may depredate sheep. Eleven aerial predator damage management flights were conducted over the 5 years with only 2 flights occurring after March 15. Gunnison sage grouse were observed on leks during aerial operations over the years with about half the grouse staying on the lek and the other half dispersing into the sagebrush. Calling and shooting coyotes with or without the aid of decoy dogs has resulted in the dog or WS employee walking by or running by sage grouse with grouse displaying various behaviors from observation, hiding and walking away from the dog or WS employee. These interactions are infrequent and do not happen in all years. In summary, the disturbances are infrequent and of short duration, resulting in no

harm to the Gunnison sage grouse. The removal of coyotes to protect sheep has collateral benefits to Gunnison sage grouse by removing a potential predator, especially since the sage grouse populations are low to very low on some sites where individual grouse are important to population recovery. PDM for the protection of Gunnison sage-grouse would have a beneficial impact and no adverse effects.

A potential indirect effect on sage-grouse of coyote removal that has been identified is "meso-predator release", which is the increase in smaller mammalian carnivore species after larger carnivores have been reduced or eliminated. Concerns have been expressed that red fox populations might increase in areas of sage-grouse habitat where coyote removal is conducted and that red fox would be worse predators of sage-grouse than coyotes (Gunnison Sage-grouse Rangewide Steering Committee 2005). The "meso-predator release" theory claims that smaller predators are allowed to increase due to either a lack of predation or release from competition or both. However, Gehrt and Clark (2003) present an opposing view of "meso-predator release" and point out several weaknesses in the circumstantial evidence that has been used to suggest that meso-predator release occurs.

The Gunnison Sage-grouse Rangewide Steering Committee (2005) cited studies of red fox and coyote home ranges in duck breeding areas of North Dakota as evidence that red fox numbers may increase if coyote numbers are reduced. Sargeant *et. al*. (1984) reported on the effects of red fox predation on breeding ducks. Their data were collected when coyote populations were presumably suppressed by widespread use of predacides, and he notes that at the time (1968-73), "*[c]oyote populations in most of the midcontinent area appear to be suppressed by man*." The authors noted an inverse relationship between red fox and coyote populations and speculated that "*protection of coyotes will result in expansion of local or regional populations that in turn will cause reductions in fox populations.*" They inferred that this will reduce predation on upland nesting ducks. Sargeant *et al*. (1987) reported on spatial relationships between coyotes and red foxes and showed that home ranges of fox families did not overlap the core centers of coyote home ranges on a North Dakota study site. Although none of their radio collared foxes were killed by coyotes in their study, they hypothesized that red foxes tended to avoid coyote territories, presumably because of the fear of being killed by coyotes. Thus, they inferred that a red fox population would increase if the coyote population is reduced, because the removal of territorial coyotes would create vacant coyote territories that could then become occupied by red foxes.

However, other research has demonstrated that the presence of coyotes does not completely displace red foxes. Voigt and Earle (1983) verified that red fox travel through coyote areas during dispersal, but did not establish there. They also reported that "*individual foxes and coyotes can occur in close proximity to each other along territory borders and when coyotes travel into fox areas.*" They also noted that "*fox-coyote range overlap near borders was similar to fox-fox range overlap near borders and that coyotes do not completely displace foxes over areas.*" Gese *et al*. (1996) reported that coyotes tolerated red foxes about half of the time when encountered in Yellowstone National Park, although they would sometimes show aggression toward and kill the foxes.

Other studies suggest that coyote territories would not remain vacant for very long after the coyotes are removed. Gese (1998) noted that adjacent coyote packs adjusted territorial boundaries following social disruption in a neighboring pack, thus allowing for complete occupancy of the area despite removal of breeding

coyotes. Blejwas *et al*. (2002) noted that a replacement pair of coyotes occupied a territory in approximately 43 days following the removal of the territorial pair. Williams *et al*. (2003) noted that temporal genetic variation in coyote populations experiencing high turnover (due to control) indicated that "*localized removal did not negatively impact population size*…." Considering the level of coyote removals that WS PDM activities achieve (only 2% of the estimated population - see section 4.1.1), it is most likely that coyote populations are probably not impacted enough, even at the individual territorial level, to create the vacant territories that would theoretically allow red fox populations to increase substantially at the local level based on the North Dakota studies discussed above. Therefore, we believe it would be unlikely for WS-Colorado's coyote removal actions to lead to indirect increases in predation effects on sage-grouse populations.

Burrowing Owl: The burrowing owl is a State threatened species which lives in abandoned rodent burrows, mainly those of prairie dogs and rabbits, in sparsely vegetated areas of Colorado. Of the PDM methods used by WS-Colorado, fumigants used for coyote and fox dens, could potentially affect burrowing owls. PDM in areas inhabited by burrowing owls could also potentially be a benefit to them, but no scientific studies have documented this. PDM methods used by WS-Colorado have never resulted in the take of a burrowing owl in Colorado.

Piping Plover and Least Tern: The federally threatened piping plover and federally endangered least tern are found primarily from March through September in southeastern Colorado. The piping plover feeds primarily on invertebrates, and the least tern feeds on invertebrates and fish. Both species nest on sandy beaches, especially on islands. They are not negatively impacted by PDM, and can benefit from PDM where predation from species such as raccoons has been identified as a limiting factor for a particular colony.

4.1.2.1j Impacts on Biodiversity and Ecosystem Resilience.

Biodiversity refers to the variety of species within an ecosystem. Ecosystem resilience refers to the magnitude of disturbance that can be absorbed before the system redefines its structure by changing the variables and processes that control behavior (Gunderson 2000). Predators, particularly apex predators, can have a pronounced impact on biodiversity and ecosystem resilience (Estes *et al*. 2011). In diverse ecosystems, there is a degree of redundancy in the roles species play within the different ecological levels (*e.g.*, apex predators, mesopredators, herbivores, plants, decomposers). In general, ecosystems that are less complex in terms of biodiversity and trophic levels, are more susceptible to adverse impacts and stressors such as climate change, disease outbreaks, introduction of invasive species, etc. In other words, such less complex ecosystems have lower ecosystem resilience (Beschta *et al*. 2013, Crooks and Soulé 1999, Ritchie and Johnson 2009, Estes *et al*. 2011, Bergstrom *et al*. 2014).

Predators directly impact ecosystems through predation and indirectly through exclusion/reduction in populations of other predators/mesopredators, and alteration of prey behavior and habitat use. Theses impacts, both direct and indirect, affect the abundance of prey species and alter impacts these species have on other levels of the food web (see discussion of trophic cascades below; Prugh *et al*. 2009, Ritchie and Johnson 2009, Estes *et al*. 2011, Wallach *et al*. 2010, Miller *et al*. 2012). Wallach *et al*. (2010) showed that increases in dingo populations (due to the absence of exclusion and poison baiting) resulted in decreases in mesopredators and generalist herbivores, and increases in small and intermediate-weight mammals. Allowing predator populations to achieve a degree of social stability (the presence of packs and associated territoriality) was also identified as important because it established natural population control at levels below the maximum that could potentially be sustained by the prey base. The complete loss of apex predators

from an ecosystem can reduce biodiversity and shorten the food web length in the system, which may alter the presence and abundance of mesopredators, increase the intensity of herbivory, and ultimately impact the abundance and composition of plant communities, soil structure, nutrients, and even physical characteristics of the environment (Diamond 1992, Berger *et al*. 2001, Beschta and Ripple 2006, Ripple and Beschta 2006, Prugh *et al*. 2009, Estes *et al*. 2011). Presence of native predators in a healthy ecosystem may also improve the ability of the system to resist adverse impacts of invasive species.

Some members of the public have raised concerns that PDM actions by WS-Colorado may result in unintentional adverse impacts on biodiversity and ecosystem resilience by eliminating or reducing predator populations (Bergstrom *et al*. 2014, Estes *et al*. 2011). However, Under Alternative 1, WS-Colorado PDM activities would occur in localized areas and would not be conducted throughout the year, as previously discussed. This includes corrective PDM, which occurs for short periods after damage had occurred, and preventive PDM, which would likely occur for short periods during the time of year when addressing predators would be the most beneficial to reducing threats of damage (*e.g.*, the period of time immediately preceding and during calving and lambing in the spring). On average, WS-Colorado conducts PDM under agreements that comprise 4.958 million acres annually, which is 7.4% of the land area of Colorado. WS-Colorado only conducts activities on a small portion of the land acres allowed under MOUs, annual WPs, Work Initiation Documents, or other comparable documents. As discussed in Chapter 1, WS-Colorado typically conducts PDM on only 20% of the land area under agreement in any given year; thus, we anticipate that WS-Colorado would conduct PDM on less than 1.5% of the land area of Colorado. In addition, the number of predators taken annually by WS-Colorado and other entities is a small percentage of the estimated populations of those species in the state. Under Alternative 1, we anticipate similar levels of work and similar levels of take; therefore, the potential effects on biodiversity would be low.

Most evaluations of the impacts of predator removal or loss on biodiversity involve the complete removal of a predator species from the ecosystem for multiple years (*e.g.*, Berger *et al*. 2001, Beschta and Ripple 2006, Frank 2008, Gill *et al*. 2009). WS-Colorado's actions will not result in long-term extirpation or eradication of any wildlife species, so findings of most of these studies are not relevant to the proposed action. WS-Colorado operates in accordance with international, federal, and state laws and regulations enacted to ensure species viability. WS-Colorado operates on a relatively small percentage of the land area of Colorado, and take is only a small proportion of the total population of any species as analyzed in Section 4.1.1. The analysis in this EA and in GAO (1990) indicate that the impacts of the current WS-Colorado program on biodiversity are not significant statewide or nationally. Any reduction of a local population or groups would be temporary because natural immigration from adjacent areas or reproduction from remaining animals would replace the animals removed, unless actions are taken by the landowner/manager to make the site unattractive to the target species. The limited nature of WS-Colorado take of most predator species listed in this EA is so low that substantive shifts in population age structure are not anticipated (Section 4.1.1). Thus, further discussions of this issue will focus on removal of coyotes which are the species most commonly taken by WS-Colorado.

Henke (1992, 1999) documented decreases in species richness and rodent diversity and increases in relative abundance of badgers, bobcats, and gray foxes in areas of Texas where year-round coyote removals resulted in a sustained 48% reduction in the local coyote population. However, the year-round level of coyote removals in these studies does not occur during normal PDM operations which would occur in Colorado under Alternative 1. Similarly, the degree of PDM (exclusion or sustained year-round intensive population reduction efforts via the use of toxicants) was far greater in the study by Wallach *et al*. (2010) than what occurs as a result of PDM that would be conducted by WS-Colorado. This combined with the fact that cumulative take of coyotes is a low percentage, between 28% and 42% of Colorado's estimated coyote population, and WS-

Colorado kills an even smaller percent of the population (1.0-2.0%) than the cumulative take, indicates that PDM has a minimal effect on the overall ecosystems in Colorado (Table 15). Based on findings of Gese (2005), both the number of coyotes and the number of packs in areas with PDM patterns similar to that of WS-Colorado had returned to pre-control levels within 8 months. Although there was evidence of a reduction in the average age of the population, there was no evidence that this resulted in an increase in coyote densities above pre-control levels. Based on this information, we conclude that the impacts of the current WS-Colorado program are not of sufficient magnitude or scope at the local or state level to adversely impact biodiversity or ecosystem resilience. Under Alternative 1, we anticipate similar levels of PDM and take; thus, there would be no impact on biodiversity or ecosystem resilience.

4.1.2.1k Impact on Trophic Cascades Including Prey Populations and Potential for Mesopredator Release.

A trophic cascade is an indirect ecological effect that occurs when one trophic level is modified to an extent that it affects other trophic levels in a food chain or web. In a simple example, predators, their herbivore prey, and plants that provide food for the herbivores are three trophic levels that interact in a food chain. The presence of the predator causes reductions in prey populations or causes the prey population to alter its use of habitat which, in turn, impacts plant community composition and health. Depending on the nature of the impact and the prey species, changes in vegetation and prey behavior can have impacts on abiotic factors such as soil compaction, soil nutrients, and river morphology (Beschta and Ripple 2006, Naiman and Rogers 1977). In the Midwest, changes in coyote activity were documented to impact white-tailed deer activity and plant community composition (Waser *et al*. 2014). However, as with most ecosystems, the nature and magnitude of these types of relationships varies. For example, Maron and Pearson (2011) found no evidence that the presence of vertebrate predators fundamentally affected primary production or seed survival in a grassland ecosystem.

Mesopredator release is a trophic cascade where the removal of an apex predator (*e.g.*, wolves or coyotes) results in increased populations of the smaller predator(s) (*e.g.*, fox, raccoons, feral cats), which may produce different impacts on prey populations and other trophic levels (Prugh *et al*. 2009, Brashares *et al*. 2010, Miller *et al*. 2012). For example, the presence of coyotes in an area has been shown to limit the density of smaller predators which may prey more heavily than coyotes on songbirds, ground nesting birds such as ducks and game birds, and some rodents (Levi and Wilmers 2012, Miller *et al*. 2012). Also, recovery of wolf populations and associated long-term declines in coyote populations have been documented to result in an increase in survivorship of pronghorn deer fawns (Berger and Conner 2008). And carnivores such as badgers, bobcats, and fox have also been shown to increase in number when coyote populations are reduced (Robinson 1961, Nunley 1977, Crooks and Soulé 1999).

However, data on the impacts of coyotes and coyote removal on prey populations are mixed. In two studies conducted in south Texas (Beasom 1974b, Guthery and Beasom 1977), intensive short-term predator removal was employed to test the response of game species to reduced coyote abundance. At the same time, rodent and lagomorph species were monitored. A marked reduction in coyote numbers apparently had no notable effect on the populations of rabbits or rodents in either study. Similarly, Neff *et al*. (1985) noted that reducing coyote populations on their study area in Arizona to protect pronghorn antelope fawns had no apparent effect on rodent or rabbit populations.

Wagner and Stoddart (1972) noted that coyote predation is a significant source of mortality in jackrabbit populations, and may have played an important part in jackrabbit population trends. But they made no connections between PDM and jackrabbit mortality or coyote populations. Moreover, the coyote population in this study was subject to more sustained and intensive control (coyotes were taken through use of aerial shooting,

trapping for bounties and pelts, and the use of 1080 poison bait stations that were placed in fall and recovered in spring) than is expected to occur under the current WS-Colorado PDM program.

Wagner (1988) reviewed literature on PDM impacts on prey populations, and concluded that such impacts vary by location. In some ecosystems, prey species, such as snowshoe hares, increased to the point that vegetative food sources were depleted, despite predation. In others, coyotes may limit jackrabbit density, while food shortages do not limit jackrabbit abundance (Wagner 1988, Stoddart *et al*. 2001). Wagner and Stoddart (1972) reported that coyote predation was a major source of jackrabbit mortality in the Curlew Valley of Utah that may have caused a decline in the local jackrabbit population.

Henke (1995) reviewed literature concerning coyote-prey interactions and concluded that short-term coyote removal efforts (<6 months per year) typically did not result in increases of small mammal prey species populations. This finding is supported by Gese (2005) in which local coyote removal of up to 60 to 70% of the population for two consecutive years in a 131 mi^2 study had no observable impact on local lagomorph abundance. Some of the reason for this lack of impact may have been attributable to the fact that coyote pack size and density in the project area returned to pre-removal levels within 8 months of removal. Henke (1995) also concluded that long-term intensive coyote removal (nine months or longer per year) could, in some circumstances, result in changes to the rodent and rabbit species composition in the area where removals occurred, which could lead to changes in plant species composition and forage abundance. This conclusion was based on a previous study (Henke 1992) conducted in the rolling plains area of Texas that involved one year of pretreatment and two years of treatment. Removals occurred year-round and resulted in a sustained reduction in the coyote population of approximately 48%. After the initiation of coyote removal, species richness and rodent diversity declined in treatment areas and relative abundance of badgers, bobcats, and gray foxes increased. However, sustained reduction in coyote populations (and presumably other mesopredators) after restoration of wolf populations resulted in increases in the number of voles within 3 km of wolf dens (Miller *et al*. 2016).

Ripple and Beschta (2007) and Ripple and Beschta (2012) examined trophic cascade involving wolves, aspen and elk in Yellowstone National Park. The study documented the first significant growth of aspen on the northern winter range in the park (Ripple and Beschta 2007). They claimed their findings were consistent with a behaviorally-mediated and density mediated trophic cascade. They presented data showing wolf population increase with a concurrent elk population decrease and growth response from aspen. Additionally, as elk populations decreased bison and beaver increased, possibly due to increased forage from grass and aspen growth (Ripple and Beschta 2012). However, while Ripple and Beschta (2007, 2012) documented population responses from bison and beaver and growth of grasses and forbes during a time period of elk population decline, the elk population decline was not from wolf predation. Vucetich et al. (2005) and White and Garrott (2005) analyzed the extent wolf predation contributed to elk population decline from 17,000 to 8,000 animals on northern range in Yellowstone National Park. The elk population in Yellowstone National Park declined due to legal hunting outside the park and weather (Vucetich et al. 2005). Wolf predation on elk in the park was compensatory (Vucetich et al. 2005). White and Garrott (2005) also documented the large effect legal hunting had on reducing the elk population in Yellowstone National Park. Additionally, they recommended a reduction in female elk harvest to not accelerate the decrease in elk numbers. The previous authors documented a correlation not a cause and effect (Ripple and Beschta 2007:515).

Some individuals have expressed concerns that activities such as WS-Colorado's PDM would cause disruptions to trophic cascades or irruptions in prey populations, such as rodents or rabbits, by eliminating or substantially reducing top predators (Prugh *et al*. 2009, Crooks and Soule´ 1999, Ritchie and Johnson 2009, Estes *et al*. 2011, Bergstrom *et*

al. 2014). WS-Colorado has reviewed these studies but, for the most part, they are not applicable to the types of PDM proposed for Colorado, because they involve the complete absence of apex consumers from the system (*e.g.*, Berger *et al.* 2001, Bechta and Ripple 2006, Frank 2008, Gill *et al*. 2009, Ripple *et al*. 2010, Gill *et al*. 2009, Ripple *et al*. 2013; Estes 2011). In some instances, impacts have also been observed in cases where the predators were substantially reduced over an extended period of time (*e.g.*, Henke *et al*. 1992, 1999 and Wallach *et al*. 2010 discussed above). An impact sustained over a period of decades was found at a site in Zion National Park which was largely avoided by cougars due to high human activity (Ripple and Beschta 2006). The decrease in cougars resulted in increases in mule deer, and associated increases in herbivory on riparian cottonwoods. Ultimately, this resulted in decreased cottonwood regeneration in the riparian area, increases in bank erosion, and reduction in both terrestrial and aquatic species abundance. However, this is another example of dramatic and long-term population reduction, which is not analogous to WS-Colorado PDM.

As discussed in this EA, WS-Colorado only conducts PDM when and where it is needed. When direct management of a depredating animal(s) is needed, efforts focus on management of the specific depredating animal or local group of animals. WS-Colorado does not strive to eliminate or remove predators from any area on a long-term basis, no predators or prey would be extirpated, and none would be introduced into an ecosystem. As discussed in detail in Section 4.1.1, impacts are generally temporary and in relatively small or isolated geographic areas compared to overall population distributions. Therefore, we conclude that the impacts of WS-Colorado actions are not of sufficient magnitude or scope to result in ecosystem-level shifts in trophic cascades. Most removal of predators for PDM by WS-Colorado involves removal of a small percentage of individuals of the total population from relatively isolated locations. This level of removal is not of sufficient magnitude to result in substantive reductions in predator species abundance. The only species taken by the WS-Colorado program in sufficient numbers to result in substantive short-term local population reductions are coyotes.

Given the patchy and limited scope of WS-Colorado PDM actions, repopulation of areas where PDM is conducted occurs relatively quickly, often within a year of the removals. As noted above in the section on biodiversity and ecosystem resilience, removals are not expected to result in long-term reductions in pack density or the number of coyotes, despite potential reductions in the age structure of the population (Gese 2005).

In the study by Gese (2005) a combination of aerial shooting and trapping removed approximately 44-61% and 51-75%, respectively, of an estimated coyote population from a 131 mi^2 project over the first and second year of a two-year study. Removals resulted in substantial reductions in coyote pack size and an associated decrease in density, but both pack size and density rebounded to pre-removal levels within 8 months. Radio collar data and shifts in age structure support the hypothesis that the coyotes colonizing the area after control were non-territorial individuals, which included yearlings from adjacent reproducing pairs of coyotes. The coyote population in the removal area had a younger age structure than the control area. Home range size did not vary for coyotes remaining after coyotes in adjacent territories were removed. Mean litter size did not differ substantially after the first year of winter and spring coyote removals, but increased the second year. Average litter size was correlated to the density of coyotes entering the breeding season. Increases in available prey the second year of the removals also have influenced coyote reproductive success, with a significant positive correlation between prey per coyote and litter size. However, lagomorph (i.e., rabbits) abundance increased in both the area with coyote removal and the control area without coyote removal and was not the result of coyote removals. The seasonality of the coyote removal in the Gese (2005) study was similar to that which occurs in WS-Colorado, but the proportion of the coyote population removed in the Gese (2005) study was likely higher than typically occurs in Colorado.

Similarly, red foxes are highly mobile, and PDM actions are patchy in nature. Because of strong compensatory density feedback, primarily through immigration (Lieury *et al*. 2015), removals are not expected to result in long-term reductions in fox. Given the above factors, we believe it is unlikely that PDM actions by WS-Colorado would result in unintended adverse impacts on ecosystems through perturbation of trophic cascades.

4.1.2.1l Impact of PDM on prey populations.

Rabbit and rodent populations normally fluctuate substantially in multi-year cycles. Keith (1974) concluded that: 1) during cyclic declines in prey populations, predation has a depressive effect, further decreasing prey populations and holding them for some time at relatively low densities; 2) prey populations may escape this low point when predator populations decrease in response to low prey populations; and 3) because rabbit and rodent populations increase at a faster rate than predator populations, factors other than predation must initiate the decline in populations.

Wagner and Stoddart (1972) and Clark (1972) independently studied the relationship between coyote and black-tailed jackrabbit populations in northern Utah and southern Idaho. Both concluded that coyote populations respond to an abundance of jackrabbits by shifting their diet toward jackrabbits. Conversely, when a broad range of prey species is available, coyotes generally feed on all species available; therefore coyote populations may not vary with changes in the availability of a single prey species (Knowlton 1964, Clark 1972).

Wagner (1988) reviewed the impacts of predators on prey populations, and concluded that such impacts vary with the locale. In some ecosystems, prey species such as snowshoe hares increase to the point that vegetative food sources are depleted despite predation. In others (*e.g.*, jackrabbits in the Great Basin), coyotes may limit jackrabbit density, and food shortages do not seem to limit jackrabbit abundance. Wagner and Stoddart (1972) reported that coyote predation was a major source of jackrabbit mortality and may have caused a decline in jackrabbit numbers in the Curlew Valley in Utah.

Henke (1995) reviewed literature concerning coyote-prey interactions and concluded that short term (≤6 months per year) coyote removal typically does not result in increases in small mammal prey species populations, but that longer term intensive coyote removal (9 months or longer per year) can in some circumstances result in changes in rodent and rabbit species composition, which may lead to changes in plant species composition and forage abundance. The latter conclusion was based on one study (Henke 1992) which was conducted in the rolling plains of Texas. Whether such changes would occur in all ecosystems is unknown. But even if they would, the following mitigating factors should serve to minimize these types of environmental impacts:

1. Most PDM actions in localized areas of the State would not be year-round, but would occur for short periods after damage occurs (corrective control), or for short periods (typically less than 20 days per year) just before and during calving and lambing seasons (preventive control).

2. WS-Colorado typically conducts PDM in less than 1.5% of the land area of Colorado in any year, and takes only a small percentage (< 2%) of the state's population of coyotes in any one year. Thus, any potential impacts would be small or negligible, and limited to isolated areas.

Other prey species of coyotes include white-tailed, mule deer, and pronghorn (antelope). Local short term predator population reductions may enhance deer and pronghorn populations (see Chapter 1). This could be either a beneficial or detrimental effect, depending upon whether local deer populations were at or below the capacity of the habitat to support them. However, because WS-Colorado only conducts PDM on less than 1.5% of the land area of the state and takes less than 2% of the coyote population in any

one year, it is unlikely that positive effects on deer or pronghorn populations would be significant, except in isolated areas where PDM was designed to produce such results, at the request of CPW. If CPW or a Tribe requested coyote removal for the purpose of enhancing pronghorn or deer herds, an increase in local populations would be desired and considered a beneficial impact on the human environment. In those situations, it is likely that coyote control would be more intense, and longer-lasting, but would end when herd management goals were met. Even in such a scenario, it is unlikely that impacts would be significant over major portions of the state.

In general, it appears that predators prolong the low points in rodent population cycles and spread the duration of the peaks. Predators generally do not "control" rodent populations (Keith 1974, Clark 1972, Wagner and Stoddart 1972). It is more likely that prey abundance controls predator populations, especially a species such as the lynx which exhibits a classic predator-prey relationship with the snowshoe hare. The USFWS (1979, p. 128) concluded that "*WS* Program activities have no adverse impacts to populations of rodents and lagomorphs."

4.1.2.1m Direct, Indirect, and Cumulative Impacts Under Alternative 1. Direct impacts of PDM conducted by WS-Colorado on non-target wildlife species are negligible due to the low number of non-target animals that would likely be taken under this Alternative.

PDM conducted by WS-Colorado may have the potential to marginally benefit several federal and state listed T&E species. The benefits from PDM would likely be to individuals, rather than local populations. These species include the black-footed ferret, piping plover, least tern, plains sharp-tailed grouse, lesser prairie-chicken, and Gunnison's sage-grouse. Management of coyotes would benefit introduction of black-footed ferrets by increasing survival of released animals. Piping plover and least tern populations have benefitted from red fox and raccoon removal by increasing survival of nesting hens and juveniles, resulting in higher productivity and population growth. For the 3 prairie grouse species, habitat loss is the primary cause of population decline, and lower habitat quality makes these species susceptible to predation.

PDM conducted by WS-Colorado under this Alternative is expected to result in no indirect impacts to non-target species. Cumulative impacts under this Alternative are also expected to be negligible. Private citizens probably take more non-target wildlife than WS-Colorado due to less training and experience. Even with this additional take by private citizens, cumulative impacts on non-target populations is negligible. CPW monitors non-game wildlife populations statewide, and would take corrective action if negative impacts were detected.

4.1.2.2 Alternative 2 - No Federal WS PDM.

Direct, Indirect, and Cumulative Impacts: Under this alternative, WS-Colorado would not provide assistance with PDM and, therefore, WS-Colorado would have no effect on non-target or T&E species from the use of PDM methods. CPW and CDA would probably still provide some level of professional PDM assistance, but without federal involvement, and would continue to take minimal numbers of non-targets, proportionate to the decrease in state and federal efforts. Private efforts to reduce or prevent depredations would increase the most under this alternative. This would result in less experienced persons implementing PDM methods leading to a greater take of non-target wildlife (potentially including T&E species) than under the current program or any of the other Alternatives. Similar to WS PDM, private individuals could take coyotes and other predators year-round. Private landowners would increase the number of trapping exemptions claimed requiring more time and effort by CPW personnel. Even though, resource owners would need to notify CPW of their trapping exemptions, private individuals would not be restricted to WS SOPs such as WS's self-imposed restrictions (i.e., not setting traps closer

than 30 feet to livestock carcasses to avoid capturing scavenging birds or using pan-tension devices to exclude smaller animals). Therefore, hazards to raptors, including bald eagles, and other non-targets could be greater under this alternative. As described in 2.3.3, the hypothetical use of chemical toxicants could impact non-target species populations, including T&E species. It is, therefore, likely that more impacts to non-target species would occur under this alternative than the current program.

4.1.2.3 Alternative 3 - Technical Assistance Only.

Direct, Indirect, and Cumulative Impacts: Alternative 3 would not allow WS-Colorado to conduct direct operational PDM. Therefore, WS-Colorado would not have any direct impact on non-target or T&E species. Under this alternative, CDA and CPW would likely provide some level of professional assistance with PDM. However, private PDM efforts would likely increase in proportion to any reduced effort in PDM by WS-Colorado. Although technical support from WS-Colorado might lead to more selective use of PDM methods by private parties than that which could occur under Alternative 2, private efforts to reduce or prevent depredations could result in less experienced persons implementing PDM methods leading to greater take of non-target wildlife and T&E species as discussed under Alternative 2. This alternative would have the potential for increased adverse impacts resulting from WS-Colorado not providing quality PDM and the compensatory actions of private individuals. Presumably, many service recipients would become frustrated with WS-Colorado's failure to resolve their wildlife damage, and would go elsewhere for assistance. Higher variability in the level and scope of PDM activities could occur without a full IWDM program, and this could have a greater negative effect on some local wildlife species (including T&E species).

4.1.2.4 Alternative 4 - Lethal PDM Methods Used Only for Corrective Control.

Direct, Indirect, and Cumulative Impacts: Alternative 4 would not allow WS-Colorado to conduct preventive operational PDM. For many individual damage situations, this alternative would be similar to the current program because producers often do not contact WS-Colorado until damage has already occurred. WS-Colorado conducts proactive control for a few predators because most predators cause only sporadic damage. WS-Colorado conducts preventive control primarily for coyotes where the area has had historic damage and the population level is such that damage is expected to reoccur. Preventive damage management for coyotes is often conducted with aerial predator management. Wagner and Conover (1999) concluded that the need of traps, snares, and M-44's for corrective control was lower at sites with preventive aerial predator management than sites without preventive aerial predator management. Foothold traps, snares, and M-44s have a higher risk of capturing a nontarget species than aerial predator management. Therefore, WS-Colorado is likely to have more impacts from these methods to nontargets, than under the Proposed Action Alternative. Therefore, risks to nontarget species by WS-Colorado PDM activities would probably be slightly greater under this alternative.

This alternative would also have the potential for increased adverse impacts resulting from private individuals. Presumably, WS-Colorado PDM recipients that are anticipating damage in historic loss areas and become frustrated with WS-Colorado's failure to prevent predator damage from occurring, would turn elsewhere for assistance. These increased private PDM activities could lead to potentially similar impacts as those described under the No Program Alternative. However, technical support on damage prevention might lead to more selective use of PDM methods by private parties than that which are likely to occur under Alternative 2. Impacts and potential risks from illegal chemical toxicant use under this alternative would probably be the same as those under Alternatives 2 and 3. Therefore, it is concluded that more nontargets, potentially T&E species, could be taken under this alternative than under Alternative 1, the Current Program, but less than Alternative 2.

4.1.3 Impacts on Public Safety and Pets.

4.1.3.1 Alternative 1 - Continue the Current Federal PDM Program. The use of PDM methods by WS-Colorado poses little potential hazard to WS-Colorado employees themselves or to the public because all methods and materials are consistently used in a manner known to be safe. This assessment included potential risks to WS-Colorado employees, the public, nontarget animals including pets. While some of the materials and methods used by WS-Colorado have the potential to represent a threat to health and safety if used improperly, problems associated with their mis-use have rarely occurred. This favorable record is due to training and certification programs for the use of PDM methods such as the M-44 (CDA tests applicators) and compliance with chemical use, firearms (mandatory firearms training every 2 years - WS Directive 2.615), and aviation safety (pilot and gunner training). The proper use of PDM methods and safety is stressed through training and policies. The risk to the public is further reduced because most WS-Colorado PDM methods are used mostly in areas where public access is limited. Additionally, warning signs are prominently posted to alert the public when and where, in the general area, toxic devices or traps are deployed. WS-Colorado coordinates with cooperators or landowners about where and when PDM methods are to be used, thereby decreasing the likelihood of conflicts with the public. The issue of safety was discussed in Chapter 2, and SOPs to minimize potential impacts on safety were discussed in Chapter 3.

WS-Colorado PDM activities are also not likely to negatively affect the public in terms of "Environmental Justice" and "Executive Order 12898". "Environmental Justice" and "Executive Order 12898" relate to the fair treatment of people of all races, income and culture with respect to the development, implementation and enforcement of environmental laws, regulations and policies. Environmental justice is a priority within USDA, APHIS, and WS. Also, all APHIS-WS activities are evaluated for their impact on the human environment and compliance with Executive Order 12898 to ensure Environmental Justice.

Under the current program alternative, PDM methods could be used to resolve complaints involving predators that represent a risk to public health and safety. Recent projects involving predators that represented a human health and safety risk, such as those described in 2.3.3, were effectively resolved using PDM methods such as traps and firearms.

4.1.3.1a Human Safety Consequences of Aerial Predator Management Accidents.

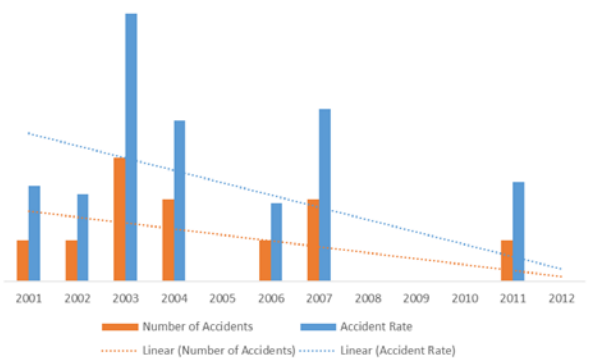
Major issues related to aviation accidents include the loss of aircraft, and risks to the public and crew members. Accidents have been associated with WS aerial operations and are a major concern to WS and to the public. WS's use of aircraft is quite different from general aviation (GAV) use. The environment in which WS conducts aerial predator management is inherently a higher risk environment than that for GAV. Low-level flights introduce hazards such as power lines and trees, and the safety margin for error during maneuvers is diminished compared to high-level flights. As such, WS's aerial predator management program is more similar to the "Aerial Application" portion of GAV, which includes crop-dusting and other low-level flight. In 1998, WS commissioned an independent review of its aerial predator management operations as a result of several accidents. The panel made several recommendations to WS regarding enhanced aviation safety, and these recommendations were implemented by the development of WS's Aviation Safety Program. This program supports aerial activities, and recognizes that an aggressive overall safety and training program is the best way to prevent accidents. WS agency pilots and contractors are highly skilled and highly experienced, with commercial pilot ratings, and they have passed proficiency tests in the flight environment encountered by WS. Pilot training includes the use of simulators, and WS contract pilots are now being screened more thoroughly and held to the same standards as agency-employed pilots to

help reduce their accident rate, which used to be substantially higher than that of WS-employed pilots (WS 2005). WS pilots, gunners, and ground crews are trained in hazard recognition, and shooting is only conducted in safe environments. All of these have helped to lower the WS aviation accident rate, and make aerial predator management safer for WS employees and the public. Federal aviation regulations require pilots to fly a minimum distance of 500 feet from structures and people, and all employees involved in these operations are mindful of this. Because of the remote locations in which WS conducts aerial operations, the risk to the public from aviation operations or accidents is extremely minimal.

We analyzed aviation accidents beginning in 2001 because that was when most of the independent review panel recommendations were implemented, and ending in 2010 because those were the most recent GAV figures we could find which included aerial application statistics. The aviation industry standard for expression of accidents is the number of accidents per 100,000 hours flown, and all accident rate data will be reported this way, though the units will generally be omitted for simplicity.

Because WS-Colorado flies such a low number of hours annually (641 hours/year on average during FY10-14), it is statistically invalid to analyze accidents on a statewide basis. It is more appropriate to analyze WS aviation accidents nationwide. At the national level, WS hours flown annually ranged from 14,452 in FY01 to as many as 26,112 in FY09. Total hours flown during FY01-10 was 171,454, with an average of 17,145. Even these number are very low comparted to GAV numbers, which averaged just over 25,000,000 during this timeframe, but they provide the best basis for comparison.

Figure 10. Trends of WS aerial predator management accidents and accident rates from 2001 through 2012.



Nationwide, WS had an accident rate of 6.3 (accidents per 100,000 hours flown), which is below the GAV rate of 6.8 (NTSB 2014). However, as noted above, the low-level flying conducted by WS is inherently more dangerous than most GAV flying. As such, this lower accident rate demonstrates WS's superior safety record over GAV. The aerial application portion of GAV had an accident rate of 7.5, which is comparable flying. WS's accident rate of 6.3 was significantly lower than this rate, which is another indication of WS's superior safety record. Moreover, this rate is much lower than the rate of 10.8 reported in the prior EA (WS 2005). However, WS strives for zero aviation accidents, and the implementation of our Aviation Safety Program, and its Aviation Training Center, have been successful in dramatically decreasing the WS accident rate since 2001 (Figure 10). Both the number of accidents per year, and the accident rate (the more useful number) have been steadily decreasing since 2001. In fact, during FY08-12, with the WS Aviation Training Center fully operational, the WS accident rate has dropped to 1.16, which is markedly lower than the general aviation rate of 6.85 during this timeframe.

Some of WS's accidents have involved pilot error whereas others were directly related to mechanical failure. Of the accidents between 1996 and 2012, 14 were due to pilot error, 6 were due to mechanical failure, and 2 due to unknown causes. WS built the WS Aviation Training Center with the goal of reducing pilot error accidents to zero. Pilots are being trained to deal more effectively with different types of mechanical failures. WS complies with all Federal Aviation Administration issued Service Bulletins, Airworthiness Directives, aircraft manufacturing recalls, and similar documents. Notably, WS has been responsible for notifying the Federal Aviation Administration of 2 discrepancies in these

documents, and one involving turbine engines was issued to the public in an Airworthiness Directive.

WS concludes that the accident rate is within or below the norms of aviation and have not involved the general public. The risks are determined to be low, and expected to remain low in the foreseeable future. WS flight crews understand and accept these risks when they agree to participate in aerial predator management. WS will continue to strive to further reduce these risks.

4.1.3.1b Potential Public Safety Impacts from Aircraft Accidents. We also considered the potential for aircraft accidents (associated with WS-Colorado's aerial predator management operations) to cause catastrophic ground fires and pollution as a result of spilled fuel and oil. Information was obtained from Mr. Norm Wiemeyer, Chief, Denver Field Office of the National Transportation Safety Board (the agency that investigates aviation accidents).

-Catastrophic Ground Fires: Mr. Wiemeyer stated he had no recollection of any major fires caused by any government aircraft; he has been in his position since 1987. In addition, there are no reports of fires caused by WS aircraft in other states. The period of greatest fire danger typically occurs during the summer months, but WS ordinarily conducts few, if any, aerial predator management operations during the summer months.

-Fuel Spills and Environmental Hazard from Aviation Accidents: The National Transportation Safety Board stated that aviation fuel is extremely volatile and will evaporate within a few hours or less to the point that even its odor cannot be detected (N. Wiemeyer, National Transportation Safety Board, pers. comm., 2000). Jet A fuel does not pose a large environmental problem if spilled. It is a straight chained hydrocarbon with little benzene present and microbes would quickly break-down any spill residue through aerobic action (J. Kuhn, Montana Department of Environmental Quality, pers. comm., 2001). The quantities used by WS aircraft are relatively small (52 gallon maximum in a fixed-wing aircraft and 91 gallon maximum in the helicopters used by WS), and during much of each flight the amount of fuel on board would be considerably less than these maximum amounts. In some cases, not all of the fuel would be spilled. Thus, there should be little environmental hazard from unignited fuel spills.

-Oil and Other Fluid Spills: For privately owned aircraft, the aircraft owner or his/her insurance company is responsible for clean-up of spilled oils and other fluids, but only if required by the owner or manager of the property on which the accident occurred. In the case of BLM, USFS, and National Park Service lands, the land managing agency generally requires soil to be decontaminated or removed and properly disposed of. With the size aircraft used by WS, the quantities of oil capable of being spilled in any accident are small [6-8 quarts maximum for reciprocating (piston) engines and 3-5 quarts for turbine engines] with minimal chance of causing environmental damage. Aircraft used by WS are single engine models, so the greatest amount of oil that could be spilled in one accident would be about 8 quarts.

-Petroleum Biodegradation: Petroleum products degrade through volatilization and bacterial action, particularly when exposed to oxygen (EPA 2000). Thus, small quantity oil spills on surface soils can be expected to biodegrade readily. Even in subsurface contamination situations involving underground storage facilities, which would generally be expected to involve larger quantities than would ever be involved in a small aircraft accident, EPA guidelines provide for "natural attenuation" or volatilization and biodegradation to mitigate environmental hazards (EPA 2000). Thus, even where oil spills in small aircraft accidents are not cleaned up, the oil does not persist in the environment or persists in such small quantities that no significant hazard exists. Also, WS's accidents generally would occur in remote areas away from human habitation and

drinking water supplies. Thus, the risk to drinking water appears to be exceedingly low or nonexistent.

4.1.3.1c Potential Impacts on Public Safety from Mountain Lions Attacking People.

Mountain lions are symbol of wilderness and majesty for some people concerned with the lion's well-being. While mountain lions rarely attack people, the cause of the attacks are sometimes related to disease, malnutrition of the lion or are thought to occur because the human's passive behavior simulated prey. Attacks on humans are unrelated to whether legal mountain lion hunting seasons occur within a state (Beier 1991). In California, where hunting of mountain lions has been banned since 1972, there are still attacks on people. Some attacks are fatal. From 1986 to 2014, there were 14 attacks on people in California, 3 attacks were fatal (CA Fish and Wildlife 2016). The number of incidents involving people and mountain lions in California ranged from 127 to 214 from 2009 to 2013 (CA Fish and Wildlife 2016).

Beier (1991) documented an increase in mountain lion attacks on people in the western United States, especially during the 1970's and 1980s'. These increases in attacks on people were concurrent with increases with attacks on livestock in California by mountain lions (Fitzhugh and Gorenzel 1986). During this time period of increasing attacks on people there was no mountain lion hunting season in California.

There are many factors involved in understanding mountain lion attacks on people (Mattson et al. 2011). Models were developed to explain variation in odds lions would attack and injure or kill a human. Cougars that are young (<2.5 years) or unhealthy are more likely to be involved in close encounters with humans. In close encounters, female mountain lions are more likely to attack humans than male mountain lions. When a mountain lion attacks a human, adult lions are more likely to kill the human (32% versus 9% of attacks). Killing the close encounter mountain lion, which happened 82% of the time, or yelling, throwing objects and increasing stature substantially lessened odds of attack. People who moved quickly or erratically were more likely to be attacked or killed. The lowest likelihood of avoiding injury with mountain lions was to remain stationary (Coss et al. 2009). Children are more likely than single adult humans to be attacked. Coss et al (2009) determined that mountain lions were assessing immobility in humans as mountain lion assess other prey. This assessment suggests that mountain lions are assessing prey inattention or disablement and hence greater vulnerability. Overall attacks by mountain lions (4-6 per year in the U.S. and Canada) compared to African or Asian lions, tigers and other big cats or wolves (hundreds to thousands per year) (Mattson et al. 2011).

Whether Wildlife Services captures and/or kills mountain lions to protect livestock, pets, people, or other resources will not influence mountain lions to attack people. Mountain lions have attacked and on rare occasion killed persons in Colorado. Some of the most recent incidents happened in urban/suburban environments where hunting does not occur.

4.1.3.1d Effects from the Use of Lead Ammunition in Firearms.

Questions have arisen about the deposition of lead into the environment from ammunition used in firearms to remove wildlife causing damage (*e.g.*, predators killing livestock). As described in Chapter 3, the lethal removal of coyotes, bears, red fox, mountain lions or other predatory wildlife with firearms by WS-Colorado to alleviate damage or threats would occur using a handgun, rifle, or shotgun.

The take of coyotes by WS-Colorado using firearms would occur primarily from the use of shotguns. However, the use of rifles would be employed in some situations (*e.g.*, calling and shooting, decoy dogs, and shooting). Other wildlife depredating livestock would likely be taken with rifles. To reduce risks to human safety and

property damage from bullets passing through coyotes and other predatory animals, the use of shotguns and rifles would be applied in such a way (*e.g.*, caliber, bullet weight, distance) to minimize bullets passing through target animals.

However, deposition of lead into soil would occur if, during the use of a shotgun or rifle, the projectile passes through a target animal, if misses occur, or if the target animal carcass was not retrieved. Laidlaw *et al.* (2005) reported that, because of the low mobility of lead in soil, all of the lead that accumulates on the surface layer of the soil is generally retained within the top 20 cm (about 8 inches).

Another concern is that lead from bullets deposited in soil from shooting activities would contaminate ground water or surface water from runoff. Stansley *et al.* (1992) studied lead levels in water that was subjected directly to high concentrations of lead shot accumulation because of intensive target shooting at several shooting ranges. Lead did not appear to "*transport*" readily in surface water when soils were neutral or slightly alkaline in pH (*i.e.*, not acidic), but lead did transport more readily under slightly acidic conditions. Although Stansley *et al.* (1992) detected elevated lead levels in water in a stream and a marsh that were in the shot "*fall zones*" at a shooting range, the study did not find higher lead levels in a lake into which the stream drained, except for one sample collected near a parking lot. The authors believed the lead contamination near the parking lot was due to runoff from the lot, and not from the shooting range areas. The study also indicated that even when lead shot was highly accumulated in areas with permanent water bodies present, the lead did not necessarily cause elevated lead levels in water further downstream. Muscle samples from two species of fish collected in water bodies with high lead shot accumulations had lead levels that were well below the accepted threshold standard of safety for human consumption (Stansley *et al.* 1992).

Craig *et al.* (1999) reported that lead levels in water draining away from a shooting range with high accumulations of lead bullets in the soil around the impact areas were far below the "*action level*" of 15 parts per billion as defined by the EPA (*i.e.*, requiring action to treat the water to remove lead). The study found that the dissolution (*i.e.*, capability of dissolving in water) of lead declines when lead oxides form on the surface areas of the spent bullets and fragments (Craig *et al.* 1999). Therefore, the transport of lead from bullets or shot distributed across the landscape was reduced once the bullets and shot formed crusty lead oxide deposits on their surfaces, which served to naturally reduce the potential for ground or surface water contamination (Craig *et al.* 1999). These studies suggest that, given the very low amount of lead being deposited and the concentrations that would occur from WS-Colorado's PDM activities, in addition to most other forms of dry land small game hunting in general, lead contamination of water from such sources would be minimal to nonexistent.

4.1.3.1d Direct, Indirect, and Cumulative Impacts on Public Safety and Pets:

The use of PDM methods by WS-Colorado pose little potential direct hazard to WS-Colorado employees themselves or to the public, because all methods and materials are consistently used in a manner known to be safe. Many SOPs are in place to mitigate impacts to public safety and pets. We analyzed numerous other public safety concerns, and found no evidence to support them. Many SOPs have been implemented within the last 2 decades to reduce the risk of PDM conducted by WS-Colorado to negatively impact pets. Under Alternative 1, we anticipate negligible risk to pets.

Potential indirect impacts, including the deposition of lead in the environment, are anticipated to be negligible. However, WS-Colorado must be vigilant in maintaining safe procedures and SOPs; otherwise, some of the public safety concerns may become real.

WS is a leader in the field of WDM, and we serve as a role model for how to conduct PDM in a manner that is safe for people and pets. We demonstrate, teach, and publish articles on how to conduct PDM. The cumulative impact of this information transfer should result in lower impacts to human safety and pets.

4.1.3.2 Alternative 2 - No Federal WS PDM.

Direct, Indirect, and Cumulative Impacts: Under this alternative, WS-Colorado would not provide assistance with PDM; therefore, there would be no direct impact by WS PDM on public safety, pets, or "environmental justice and executive order 12898." CDA and CPW would probably still provide some reduced level of PDM without federal assistance, and private efforts to reduce damage would likely increase. Compared to the current program alternative (Alternative 1), Alternative 2 would likely result in increased negative effects on human safety. This would result from untrained and unlicensed individuals using PDM methods and toxicants, both legal and illegal. As discussed earlier, it is possible that frustration caused by the inability to reduce losses could lead to illegal use of chemical toxicants with unknown impacts on public safety. In addition, private individuals are not accountable and could conduct PDM irresponsibly without any oversight. Of the four alternatives, Alternative 2 would have the greatest potential for negative impacts on public safety and pets.

In addition to some of the problems noted above, WS-Colorado would not be able to respond to predator complaints involving human health and safety. Depending on their level of effort, CPW may be able to respond in a timely manner. Human health and safety problems associated with predators could increase slightly, but some damage problems could either go unresolved or be handled by private individuals with similar risks described above. Unresolved threats to human health and safety would result in a negative impact on human safety under Alternative 2.

CDA or CPW could still issue aerial predator management permits to the public. The number of these permits, and the amount of flying conducted under these permits would likely increase in accord with the decrease in WS-Colorado aerial predator management because producers know that this method is effective. Low-level flying has inherent risks associated with it. The number of accidents during aerial predator management would likely increase because private pilots would most likely have less experience and less training than WS pilots, and would not likely work under a robust aviation safety program such as that of WS.

4.1.3.3 Alternative 3 - Technical Assistance Only.

Direct, Indirect, and Cumulative Impacts: Under this Alternative, WS-Colorado would provide advice or guidance on PDM techniques and methods, but would not conduct any direct operational PDM in attempting to assist in resolving damage complaints. Therefore, WS-Colorado would not have any direct impact on public safety or pets in Colorado. This Alternative would be almost identical to Alternative 2, except that those people receiving technical assistance would be more apt to conduct PDM with less risk to the public. So this Alternative would have fewer negative consequences than Alternative 2, but more than Alternative 1.

4.1.3.4 Alternative 4 - Lethal PDM Methods Used Only for Corrective Control.

Direct, Indirect, and Cumulative Impacts: Under Alternative 4, WS-Colorado would not conduct preventive operational PDM. As discussed previously, this work would likely be conducted instead by CDA, CPW, and private individuals/entities. The potential for WS-Colorado to impact public safety and pets would not be appreciably different from Alternative 1, because such impacts would be minimal. Most preventive work by WS-

Colorado is focused on areas of historic loss of livestock to coyotes and red fox. Much of this work is conducted with aerial predator management in concert with PDM on the ground. Under Alternative 4, PDM, including aerial predator management, would likely be implemented in these historic loss areas by individuals with less experience than WS-Colorado personnel, resulting in greater impacts on public safety. However, many private citizens would involve WS-Colorado after damage had occurred. Therefore, it is believed that fewer would become frustrated to the point of using illegal methods. These increased private PDM activities would lead to potentially similar impacts as those described under the No Program Alternative (Alternative 2), but only for a small portion of the projects. Impacts and hypothetical risks from illegal chemical toxicant use under this alternative would probably be similar to or slightly higher than the proposed action (Alternative 1). Under Alternative 4, impacts on public safety and pets would be lower than Alternatives 2 and 3; however, the impacts would be higher under all of these Alternatives than under the proposed action (Alternative 1).

4.1.4 Effects of PDM on Sociocultural Resources.

Wildlife is generally regarded as providing economic, recreational, and aesthetic benefits (Decker and Goff 1987), and the mere knowledge that wildlife exists is a positive benefit to many people. Some members of the public have expressed concerns that PDM could result in the loss of aesthetic benefits to the public, resource owners, or local residents. Aesthetics is the philosophy dealing with the nature of beauty, or the appreciation of beauty. Therefore, aesthetics is truly subjective in nature, and dependent on what an observer regards as beautiful.

4.1.4.3 Alternative 1 - Continue the Current Federal PDM Program.

WS-Colorado PDM activities occur on a relatively limited proportion of the total land area in Colorado, and the proportion of various predator species' populations removed through WS-Colorado PDM activities is typically low (Section 4.1.1). In localized areas where WS-Colorado removes some portion of the predator population, dispersal of predators from adjacent areas typically contributes to repopulation of the area within a few weeks to a year, depending on the level of predator removal and predator population levels in nearby areas. Most of the species potentially affected by WS-Colorado PDM activities are relatively abundant, but are not commonly observed because many of these species are secretive and nocturnal. The likelihood of getting to see or hear a predator in some localized areas could be temporarily reduced as a result of WS-Colorado PDM, but because there is already a low likelihood of seeing a predator, this temporary local reduction in public viewing opportunity would not likely be noticeable in most cases. Impacts of WS-Colorado PDM on overall predator populations would be relatively low under any of the alternatives being considered in this EA, and opportunities to view, hear, or see evidence of predators would still be available over the vast majority of public land areas of the state because WS-Colorado conducts PDM on a small percentage of BLM and USFS lands.

4.1.4.1a Impact of PDM on Private Hunting Opportunities, and Recreational and Commercial Fur Harvest.

Another issue that was discussed was the purported impact that PDM would have on sportsmen. Game and non-game wildlife populations are not significantly impacted by WS PDM take, allowing hunters ample opportunities for pursuit during seasons set by CPW. Recreational trapping of predators with foot-hold traps and snares was banned in Colorado by the passage of Amendment 14. WS PDM is highly directed to target individuals and species in a given area, mostly on private lands, and can be conducted in low to high density predator areas. Typically, WS works on a property until damage is controlled. This can take longer than sportsmen would tend to stay or be allowed to legally harvest in a given area. Additionally, WS only conducts PDM in a small portion of Colorado (usually less than 5% of the State). Private fur harvesters tend to hunt where furbearer populations

are high. When the only monetary benefit is fur value, they cannot make a profit by pursuing individual depredating coyotes in local areas where numbers are low. In addition, furs are only prime in the winter months and are not of value at other times of year when PDM is frequently needed. The typical strategy of private fur takers is to hunt the more easily lured animals in a population, which tend to be the younger and less experienced animals, and then move on to other areas. With coyotes, older individuals are the most prone to being livestock and wild ungulate killers (Connolly *et al*. 1976, Gese and Grothe 1995). Thus, offending animals would not likely be removed by private fur takers, which means depredation losses would often be about as severe as they would without private fur harvest. This issue remains basically the same under all of the alternatives.

There may be a marginal decrease in recreational coyote hunting opportunities. This decrease would be marginal because take by WS-Colorado was less than 5% of sportsman harvest of coyotes in FY10-14, and we expect similar percentages under Alternative 1. Moreover, most coyote take by WS-Colorado (79% in FY10-14) is on private land, where the landowners generally value livestock protection over coyote hunting opportunities. And even on public lands, livestock owners would likely be inclined to manage predation by coyotes regardless of the Alternative chosen. This Alternative may also result in a marginal decrease in recreational fox hunting opportunities (red fox, gray fox, and swift fox). This impact is expected to be minimal because WS-Colorado takes a very small fraction of the number of foxes taken by sportsmen. Alternative 1 may also result in a miniscule decrease in the number of bobcats which could be taken by sportsmen. This effect would be miniscule, because WS-Colorado take was less than 0.4% of sportsman harvest in FY10-14, and we do not expect that percentage to change significantly. See Section 4.1.1 for a detailed analysis of the impacts to these target predator species.

4.1.4.1b American Indian and Cultural Resource Concerns.

The National Historic Preservation Act of 1966, as amended, requires federal agencies to evaluate the effects of any federal undertaking on cultural resources and determine whether they have concerns for cultural properties in areas of these federal undertakings. In most cases, WDM activities have little potential to cause adversely affects to sensitive historical and cultural resources. If an individual PDM activity with the potential historic resources is planned under an alternative selected as a result of a decision on this EA, then site-specific consultation as required by Section 106 of the NHPA would be conducted as necessary.

The Native American Graves and Repatriation Act of 1990 provides protection of American Indian burials and establishes procedures for notifying Tribes of any new discoveries. Senate Bill 61, signed in 1992, sets similar requirements for burial protection and Tribal notification with respect to American Indian burials discovered on state and private lands. If a burial site is located by a WS-Colorado employee, the appropriate Tribe or official would be notified. PDM activities will only be conducted at the request of a Tribe or their lessee and, therefore, the Tribe should have ample opportunity to discuss cultural and archeological concerns with WS-Colorado. However, in consideration of Colorado's Native Americans, WS-Colorado has included all of the recognized Tribes in Colorado on the mailing list for this EA to solicit their comments.

4.1.4.2 Alternative 2 - No Federal WS PDM.

<u>Direct, Indirect, and Cumulative Impacts</u>: Under this Alternative, WS-Colorado would not conduct PDM, so there would be no direct impact on sociocultural resources by WS-Colorado. However, CPW, CDA, and private individuals/entities would likely conduct some increased level of PDM, so indirect impacts would be higher. Cumulatively, these indirect impacts would likely exceed the impacts under Alternative 1 due to less training and experience, and fewer available PDM methods, such as aerial predator management and M-44s. Amendment 14 to the Colorado Constitution would further restrict the

methods available to private entities. Thus, the cost of PDM under this Alternative would likely be higher. Livestock losses would likely increase due to the decreased level of PDM.

4.1.4.3 Alternative 3 - Technical Assistance Only.

-Direct, Indirect, and Cumulative Impacts: Under this Alternative, WS-Colorado would not conduct any direct PDM, so there would be no direct impacts by WS-Colorado. However, CPW, CDA, and private individuals/entities would likely conduct some increased level of PDM, so indirect impacts would be higher. The indirect and cumulative impacts of this Alternative would be similar to Alternative 2 (no federal program), as described above.

4.1.4.4 Alternative 4 - Lethal PDM Methods Used Only for Corrective Control.

Direct, Indirect, and Cumulative Impacts: Under this Alternative, WS-Colorado would not conduct preventive PDM; however the direct impacts by WS-Colorado would be similar to Alternative 1, because those impacts were negligible. Some increased PDM by CPW, CDA, and private individuals/entities would likely occur, but not to the level under Alternative 1. Thus, indirect impacts would be substantially higher than Alternative 1 because PDM programs would be more expensive, less effective, and livestock losses would likely increase greatly. One of the most effective tools to prevent livestock losses is aerial predator management, which is preventive in nature, and this tool would not be largely unavailable. Cumulative impacts would be higher than Alternative 1 due to these higher indirect impacts.

4.1.5 Effects of PDM, Especially Aerial Predator management Activities, on the Use of Public Lands for Recreation.

Recreation encompasses a wide variety of outdoor entertainment in the form of consumptive and non-consumptive uses. Consumptive uses of public lands include activities such as hunting, fishing, and rock-hounding. Non-consumptive uses include activities such as bird watching, photography, camping, hiking, biking, rock climbing, winter sports, and water sports. Recreationists are members of the general public that use public lands for one of the above or other activities. Recreation on private lands is restricted by landowners and, thus, should not be impacted as much as on public lands. PDM is conducted mostly for the protection of livestock on grazing allotments in these areas. These areas are typically removed from high public-use areas.

4.1.5.1 Alternative 1 - Continue the Current Federal PDM Program.

Most recreationist concerns regarding PDM center around perceived impacts on hunting, photography, wildlife viewing, and enjoyment of seclusion. The issue was discussed in Chapter 2 and WS-Colorado's SOPs were addressed in Chapter 3. WS-Colorado conducts PDM mainly on two classes of public lands in Colorado: BLM and USFS. The potential impacts of PDM on these lands are discussed below, including the potential impact of PDM of SMAs, including WAs and WSAs.

4.1.5.1a Areas exposed to WS aerial predator management.

From FY10-FY14, WS-Colorado flew an average of 621 hours over an average of 2,600 mi^2 (yearly range 1,900 to 3,200 mi^2) of properties that were under WS-Colorado agreements in Colorado, or about 2.5% (range 1.8 to 3.1%) of the land area of the State in any given year. WS-Colorado aerial predator management activity is minor in terms of geographic scope because more than 97% of the land area in the State is not exposed to any such activity. Of the hours flown in that 5 year period, 71% occurred over private lands, 26% over BLM lands, 3% over USFS lands, and less than 1% over other lands (primarily State owned lands). The amount of time spent flying over the properties where aerial predator management was conducted averaged 4 minutes/mi^2 in any given year. Therefore, on the small proportion of the landscape exposed to aerial predator

management, such overflights occur during only a tiny fraction of the time in an entire year.

Table 9 shows data on aerial predator management hours for the counties in which aerial predator management occurred in FY10-14. WS-Colorado conducts more aerial predator management in northwest Colorado than in any other portion of the State due to its higher numbers of domestic sheep which tend to need more protection from coyote predation than other types of livestock. About 48%, 10%, and 13% (total of 71%) of WS-Colorado aerial predator management hours occurred in Moffat, Rio Blanco, and Routt Counties, respectively, during FY10-14. Lesser amounts occurred in several counties in north-central (Grand County), west-central (Mesa, Delta, Montrose, Eagle, Gunnison, and San Miguel, Counties), south-western (Montezuma County), south-central (Alamosa, Fremont, and Huerfano Counties), and eastern (Adams, Arapahoe, Baca, Bent, Cheyenne, Crowley, El Paso, Elbert, Kiowa, Larimer, Las Animas, Lincoln, Morgan, Otero, Prowers, Pueblo, Washington, and Weld Counties) portions of Colorado.

The average land area flown per year in Moffat County was 962mi^2, which is 20% of the total area of Moffat County (range 18% to 21%). In Rio Blanco County, the average land area flown per year was 148mi^2, which is 4.6% of the total area of Rio Blanco County (range 3.6% to 5.6%). The average land area flown per year in Routt County was 175mi^2, which is 7.4% of the total area of Routt County (range 5.2% to 9.8%). Therefore, even in these counties of Colorado which had the majority of WS-Colorado aerial predator management activities, 80% to more than 95% of the land area was not exposed to any WS-Colorado aerial predator management in a typical year.

4.1.5.1b PDM on BLM Lands.

WS-Colorado conducted PDM on 45 (1.9%) of the 2,339 BLM grazing allotments in Colorado during FY10-14. These allotments covered an average of 627,000 (5.8%) of the 10.8 million acres of BLM lands in Colorado[17] (Table 23). As previously discussed, WS-Colorado actually conducts PDM on only about 1/5 of the total lands under agreement each year (see Chapter 1 for discussion). As such, the actual BLM acreage with PDM is estimated at 1.2% of BLM lands. These numbers demonstrate that WS-Colorado conducts PDM on a very small percentage of BLM lands, and that more than 98% of the area of BLM lands, and of BLM grazing allotments are not subject to WS-Colorado PDM in any typical year. WS-Colorado spent an average of 958 hours annually in the conduct of PDM on BLM lands during this timeframe. There are 8,760 hours in a year, perhaps half of which are during daylight. Assuming that most recreational use of public lands occurs during daylight hours, less than 22% of this time was exposed to WS-Colorado PDM over the entirety of BLM lands in Colorado. And much of this PDM was conducted during the winter and early spring, when recreational use is more limited. WS-Colorado PDM averaged 275 person-day visits per year during FY10-14. A “person-day visit” is defined as one person from WS-Colorado visiting BLM land for PDM work on one day. This does not imply a full day of work, but rather, and indication of the frequency of WS visits for PDM work. In fact, the average time spent on BLM property per visit was about 3½ hours. The vast majority of PDM is also conducted on grazing allotments, which are not commonly used for recreation. PDM conducted outside of grazing allotments is generally for alleviating threats to human safety.

Average WS-Colorado PDM take on BLM lands during FY10-14 was 158 coyotes, 6 red foxes, and 2 black bears per year. BLM manages 10.8 million acres in Colorado, which is about 16% of the land area in Colorado. Compared to the statewide averages (Table 14),

[17] Total area of BLM grazing allotments in the state was estimated at 10,818,387 acres based on data obtained from the BLM Colorado State Office. Total BLM administered land (surface acres) within the borders of Colorado is 8,331,848 acres. However, some acreage in Utah along the CO-UT border, and some non-BLM land that is intermingled with BLM-administered land is included in both the former number and the individual allotment acreages used to calculate the number of acres flown by WS. We were unable to separate out these types of acreage, so the former number was used to calculate the percentage.

the take on BLM lands was only 7% of total take for coyotes and red fox, and 3% for black bear. As discussed earlier, most WS-Colorado PDM, and most predator take, occurs on private lands. These numbers reflect that trend; predator take on BLM lands (maximum of 7% of total take) was much lower than the proportion of land in Colorado managed by BLM (16%). Because most (84%) of our PDM on BLM lands was conducted on the Little Snake, Uncompahgre Basin, and White River RAs, further analysis focuses on these three RAs (Table 23).

In the Little Snake RA, WS-Colorado spent an average of 345 hours over 126 person-day visits per year conducting PDM. This work was conducted on agreements which covered 349,151 acres of BLM lands, which is 27% of the acreage of the RA. As discussed earlier, WS-Colorado actually conducts PDM on only about 1/5 of the land under agreement for PDM work, so we estimate that WS-Colorado conducted PDM on about 5.4% of the lands in this RA. This RA has the highest potential for impact because more PDM was conducted here than on any other RA. However, even on this RA, more than 94% of the lands were not subject to PDM. Furthermore, the higher level of PDM on this RA reflects the higher numbers of sheep grazed on these lands. And whereas sheep grazing is not inconsistent with recreation, sheep grazing habitat is not popular for many recreations activities, such as hiking, camping, mountain biking, fishing, sight-seeing, horseback riding, off-road-vehicle use, and most hunting. There are 364 grazing allotments in the Little Snake RA, and WS-Colorado conducted PDM on 17 (4.7%) of them. Average WS-Colorado predator take in this RA was 89 coyotes, 3 red fox, and 1 black bear per year (Table 23).

In the Uncompahgre Basin RA, WS-Colorado spent an average of 175 hours over 59 person-day visits per year conducting PDM. This work was conducted on agreements which covered 87,738 acres of BLM lands, which is 18% of the acreage of the RA. Because WS-Colorado conducts PDM on only about 1/5 of the land under agreement, the actual proportion of these lands with PDM is estimated at 3.6%. There are 157 grazing allotments in the Uncompahgre Basin RA, and WS-Colorado conducted PDM on 13 (8.3%) of them. Average WS-Colorado predator take in this RA was 33 coyotes and 2 red fox per year (Table 24).

In the White River RA, WS-Colorado spent an average of 287 hours over 58 person-day visits per year conducting PDM. This work was conducted on agreements which covered 54,699 acres of BLM lands, which is 3.8% of the acreage of the RA. Because WS-Colorado conducts PDM on only about 1/5 of the land under agreement, the actual proportion of these lands with PDM is estimated at less than 1%. There are 153 grazing allotments in the White River RA, and WS-Colorado conducted PDM on 7 (4.6%) of them. Average WS-Colorado predator take in this RA was 20 coyotes and 1 black bear per year (Table 24).

Table 24. Summary of WS-Colorado predator damage management activities on Bureau of Land Management lands in Colorado during federal Fiscal Year 2010-14
Numbers are the annual averages of these five years.

BLM Resource Area	PDM Hours	Person-Day Visits	Total Acres	Acres Under Agreement for PDM	Estimated Acres with PDM	Grazing Allotments	Allotments with PDM	Coyote Take	Red Fox Take	Black Bear Take
Little Snake	345	126	1,300,000	349,151 (27%)	69,830 (5.4%)	364	17 (4.7%)	89	3	1
Uncompahgre Basin	175	59	483,077	87,738 (18%)	17,548 (3.6%)	157	13 (8.3%)	33	2	0
White River	287	58	1,455,900	54,699 (3.8%)	10,940 (0.8%)	153	7 (4.6%)	20	0	1
All Other Colorado RAs	151	32	7,579,410	135,332 (1.8%)	27,066 (0.4%)	1,826	8 (0.4%)	16	1	0
All BLM Lands	**958**	**275**	**10,818,387**	**626,920 (5.8%)**	**125,384 (1.2%)**	**2,500**	**45 (1.9%)**	**158**	**6**	**2**

In all other Colorado RAs combined, WS-Colorado spent an average of 151 hours over 32 person-day visits per year conducting PDM. This work was conducted on agreements which covered 135,332 acres of BLM lands, which is 1.8% of the acreage of these RAs. Because WS-Colorado conducts PDM on only about 1/5 of the land under agreement, the actual proportion of these lands with PDM is estimated at less than 0.5%. There are 1,826 grazing allotments in these RAs, and WS-Colorado conducted PDM on 8 (0.4%) of them.

Average WS-Colorado predator take in these RAs was 16 coyotes and 1 red fox per year (Table 24).

-Aerial Predator Management on BLM Lands: WS-Colorado conducted aerial predator management on an average of only 26 (range 23-28), or 1% of the 2,500 BLM grazing allotments in the State per year during FY10-14. The land area of BLM grazing allotments exposed to WS-Colorado aerial predator management averaged 461,000 acres (range 414,000-499,000) annually during FY10-14, which is 4.3% of the total BLM lands in Colorado. Because WS-Colorado conducts PDM on only about 1/5 of the land under agreement, the actual proportion of these lands with aerial predator management is estimated at less than 1%. Therefore, in terms of acreage, more than 99% of the BLM lands were not exposed to any WS-Colorado aerial predator management operations in any one year. Over the entire five-year period of FY10-14, WS-Colorado flew a total of 44 BLM allotments (but never more than 28 in any one year), 33 (75%) of which saw less than three WS-Colorado flights per year on average (Table 25). The remaining 11 allotments (25%) saw between 3 and 9 flights per year on average. In any given year, some allotments were flown more frequently, but no allotment was flown on more than 18 days in any one year. Thus, even on the most frequently flown allotments, WS-Colorado aerial predator management occurred on less than 5% of the days of the year. Moreover, the average flight time on any BLM allotment was 0.9 hours on any given day; thus, the amount of time spent flying over any BLM allotment was considerably less than 5%. As noted above, potential conflicts with recreational use are even lower than these numbers would suggest, because most of this work was conducted in winter and early spring, when recreational use is more limited; and all of this work was conducted on grazing allotments, where recreational use is also more limited.

Because the most intensive WS-Colorado aerial predator management during FY10-14 occurred in the Little Snake, Uncompahgre, and White River RAs, we focus further analysis on those areas.

In the Little Snake RA, there are 364 grazing allotments managed by BLM. WS-Colorado conducted aerial predator management on an average of 12 (range 10-13), or 3% of these allotments per year. Therefore, about 97% of the allotments in the Little Snake RA were not exposed to any aerial predator management by WS-Colorado in a typical year. On a land area basis, the acreage of allotments flown per year ranged from about 275,000 to 350,000, which is approximately 15% of the total acreage of grazing allotments in the Little Snake RA. And because only about 1/5 of the total acreages on WS-Colorado aerial predator management agreements are actually flown, we estimate that only about 3% of BLM lands in the Little Snake RA were actually flown by WS-Colorado in any typical year. Therefore, 97% of the land area of this RA is not exposed to any aerial predator management in a typical year.

Twenty allotments in the Little Snake RA were exposed to aerial predator management by WS-Colorado at some time within the five-year timeframe FY10-14. Of those, 14 (70%) were exposed to less than 3 flights per year on average. The remaining 6 allotments (30%) saw an average of less than 9 flights per year. Although some allotments were flown more times within any given year, no allotment was flown more than 18 times in any one year.

In the Uncompahgre Basin RA, there are 157 grazing allotments managed by BLM. WS-Colorado conducted aerial predator management on an average of 8 (range 7-10), or 5% of these allotments per year. Therefore, about 95% of the allotments in the Uncompahgre Basin RA were not exposed to any aerial predator management by WS-Colorado in a typical year. On a land area basis, the acreage of allotments flown per year ranged from about 31,000 to 80,000, which is approximately 6.4% to 16.6% of the total acreage of the Uncompahgre Basin RA (483,077 acres). Because WS-Colorado conducts PDM on only about 1/5 of the land under agreement, the maximum proportion of these lands with PDM

is estimated at 3.3%. Therefore, more than 96% of the land area of this RA is not exposed to any aerial predator management in a typical year.

Ten allotments in the Uncompahgre Basin RA were exposed to aerial predator management by WS-Colorado at some time within the five-year timeframe FY10-14. Of those, 6 (60%) were exposed to less than 3 flights per year on average. The remaining 4 allotments (40%) saw averages of less than 7 flights per year. Although some allotments were flown more times within any given year, no allotment was flown more than 9 times in any one year.

On the White River RA, there are 153 grazing allotments managed by BLM. WS-Colorado conducted aerial predator management on an average of 4 (range 3-5), or 2.6% of these allotments per year. Thus, more than 97% of the allotments in the White River RA were not exposed to any WS-Colorado aerial predator management in a typical year. On a land area basis, the acreage of allotments flown per year ranged from about 41,000 to 62,000, which is 3% of the total acreage of grazing allotments in the White River RA. Because WS-Colorado conducts PDM on only about 1/5 of the land under agreement, the actual proportion of these lands with PDM is estimated at less than 1%. Therefore, more than 99% of the land area of this RA is not exposed to any aerial predator management in a typical year.

Table 25. WS-Colorado aerial predator management time and days flown on Bureau of Land Management lands in Colorado during federal Fiscal Year 2010-14.

BLM Resource Area	Allotment	Number	Aerial Predator Management Hours						Days Flown					
(RA)	Name	of Acres	FY10	FY11	FY12	FY13	FY14	Average	FY10	FY11	FY12	FY13	FY14	Average
Glenwood	Bocco Mountain	4,040	1.0	0	0.9	0	0	**0.4**	1	0	1	0	0	**0.4**
	East Castle	9,307	2.0	2.2	0	0	0	**0.8**	2	1	0	0	0	**0.6**
	State Bridge	5,699	1.7	0	1.9	0	0	**0.7**	2	0	2	0	0	**0.8**
Subtotal Glenwood RA		**19,046**	4.7	2.2	2.8	0.0	0.0	**1.9**	5.0	1.0	3.0	0.0	0.0	**1.8**
Grand Junction	Badger Wash	60,000	0	0	0	0	3.8	**0.8**	0	0	0	0	3	**0.6**
	East Salt Creek	30,000	0	0	0	0	3.0	**0.6**	0	0	0	0	3	**0.6**
	Prairie Canyon	58,000	0	0	0	0	1.9	**0.4**	0	0	0	0	3	**0.6**
Subtotal Grand Junction RA		**148,000**	0.0	0.0	0.0	0.0	8.7	**1.7**	0.0	0.0	0.0	0.0	9.0	**1.8**
Gunnison	Sapinero Mesa	**5,160**	1.4	5.1	0	1.5	0	**1.6**	1	2	0	1	0	**0.8**
Little Snake	Buck Mountain	923	0	0	0	0.5	0	**0.1**	0	0	0	1	0	**0.2**
	Cedar Springs	19,319	9.1	0	0	0	0	**1.8**	10	0	0	0	0	**2.0**
	Cold Springs	33,548	1.2	2.0	0	0	0	**0.6**	1	2	0	0	0	**0.6**
	Duffy Mountain	8,545	0.2	3.0	1.0	1.0	2.4	**1.5**	1	6	2	1	4	**2.8**
	Elkhorn Creek	2,265	0	0.5	0	0	0	**0.1**	0	1	0	0	0	**0.2**
	Fortification	4,413	1.2	6.6	3.8	11.5	4.5	**5.5**	2	7	6	18	9	**8.4**
	Greasewood	19,858	0	0.8	3.2	0.6	0.5	**1.0**	0	1	3	1	1	**1.2**
	Hdq Moffat	3,077	0	0	0	0	2.0	**0.4**	0	0	0	0	1	**0.2**
	Mud Spring Gulch	978	0	1.0	1.3	0	0	**0.5**	0	2	1	0	0	**0.6**
	Nipple Peak	4,449	5.9	5.0	2.3	2.0	0.2	**3.1**	5	6	3	3	1	**3.6**
	Nipple Rim	39,677	0	0	1.4	3.3	3.0	**1.5**	0	0	1	2	3	**1.2**
	Pole Gulch	16,317	0	0	2.0	2.9	0.8	**1.1**	0	0	1	4	2	**1.4**
	Powder Wash	29,967	6.1	13.4	13.6	5.8	1.0	**8.0**	5	9	10	5	1	**6.0**
	Red Wash Moffat	15,758	0	0	1.0	0	0.7	**0.3**	0	0	1	0	1	**0.4**
	Sand Wash	64,809	16.7	10.3	21.8	3.5	1.0	**10.7**	11	9	14	4	1	**7.8**
	Sheepherder Spring	84,491	8.7	9.1	6.6	7.1	0	**6.3**	7	7	6	3	0	**4.6**
	Shell Creek	7,880	0	0	1.5	0	0.6	**0.4**	0	0	3	0	1	**0.8**
	Snake River	51,710	6.6	4.7	5.7	7.8	10.3	**7.0**	8	5	8	8	11	**8.0**
	Spitzie Draw	21,074	1.2	1.0	0	0	0	**0.4**	1	1	0	0	0	**0.4**
	State Line	6,373	0	0	0	0	0.6	**0.1**	0	0	0	0	1	**0.2**
Subtotal Little Snake RA		**435,431**	56.9	57.4	65.2	46.0	27.6	**50.6**	51.0	56.0	59.0	50.0	37.0	**50.6**
San Juan	Yellow Jacket	**5,727**	0	0	0	0.5	0	**0.1**	0	0	0	1	0	**0.2**
Uncompahgre Basin	Alkali Flats	35,439	2.5	0	1.1	0	0	**0.7**	2	0	2	0	0	**0.8**
	Canal	10,482	0.4	2.0	0.5	0.9	1.4	**1.0**	1	2	1	1	3	**1.6**
	Deer Basin/Midway	11,360	0.3	1.9	0.7	0	0	**0.6**	1	1	1	0	0	**0.6**
	Lower Escalante	2,240	0.2	0	1.1	0.8	1.9	**0.8**	1	0	2	1	3	**1.4**
	Sandy Wash	7,224	0.3	0.3	0.9	0.3	1.3	**0.6**	1	1	2	1	3	**1.6**
	Shavano	2,016	0	0	0.2	0	0	**0.0**	0	0	1	0	0	**0.2**
	Smith Mountain	3,477	0	0.8	0.5	1.7	2.2	**1.0**	0	3	2	6	7	**3.6**
	South of Town	3,391	1.4	2.1	2.5	2.8	2.8	**2.3**	4	5	6	8	7	**6.0**
	Sulphur Gulch	468	0.2	1.1	1.8	1.5	2.2	**1.4**	1	4	6	6	7	**4.8**
	Upper Peach Valley	3,727	2.4	3.4	3.1	3.8	3.2	**3.2**	5	6	7	9	7	**6.8**
Subtotal Uncompahgre Basin RA		**79,824**	7.7	11.6	12.4	11.8	15.0	**11.7**	16.0	22.0	30.0	32.0	37.0	**27.4**
White River	Banta Flats	17,871	1.2	1.0	1.6	9.0	3.8	**3.3**	1	2	1	5	3	**2.4**
	Boise Creek	8,247	5.0	8.2	5.5	7.3	10.2	**7.2**	2	5	4	6	7	**4.8**
	Horse Draw	14,717	2.0	2.3	4.0	0	0.1	**1.7**	2	2	2	0	1	**1.4**
	Johnson-Trujillo	20,930	0	1.5	0	1.0	0	**0.5**	0	2	0	1	0	**0.6**
	Kourlis H	574	4.8	0	0	0	0	**1.0**	4	0	0	0	0	**0.8**
	Red Wash Rio	8,026	0.4	0	0	0	0	**0.1**	1	0	0	0	0	**0.2**
Subtotal White River RA		**70,365**	13.4	13.0	11.1	17.3	14.1	**13.8**	10.0	11.0	7.0	12.0	11.0	**10.2**
All BLM Lands		**763,553**	84.1	89.3	91.5	77.1	66.8	**81.8**	83	92	99	96	97	**93.4**

Six allotments in the White River RA were flown by WS-Colorado within the five-year period FY10-14. Of these, 5 (83%) were exposed to less than 3 flights per year on average. The other allotment was exposed to less than 5 days of aerial predator management per year on average. Whereas some allotments saw more flights in any given year, no allotment was flown more than 7 times in any year.

These data show that both the amount of time spent flying over BLM allotments, and the percentage of land actually flown each year are extremely low. We conclude that the impacts to BLM lands from aerial predator management are not significant.

4.1.5.1c PDM on USFS Lands.

WS-Colorado conducted PDM on an average of 50 (2.3%) of the 2,155 USFS grazing allotments per year in Colorado during FY10-14. These allotments covered an average of 313,087 (2.9%) of the 10.9 million acres of USFS lands in Colorado (Table 26). As previously discussed, WS-Colorado actually conducts PDM on only about 1/5 of the total lands under agreement each year (see Chapter 2 for discussion). As such, the actual USFS acreage with PDM is estimated at less than 1% of USFS lands. These numbers

demonstrate that WS-Colorado conducts PDM on a very small percentage of USFS lands, and that more than 99% of the area of USFS lands, and more than 97% of USFS grazing allotments are not subject to WS-Colorado PDM in any typical year. WS-Colorado spent an average of 1,616 hours annually in the conduct of PDM on USFS lands during this timeframe. Much of this PDM was conducted during the winter and early spring, when recreational use is more limited due to weather and poor accessibility (*i.e.*, snowy or muddy roads). WS-Colorado PDM averaged 322 person-day visits per year during FY10-14. One person from WS-Colorado visiting USFS land for PDM work on one day is defined as a person-day visit. This does not imply a full day of work, but rather, and indication that WS-Colorado personnel visited USFS lands on a particular day. In fact, the average time spent on USFS property per visit was about 5 hours. The vast majority of PDM is also conducted on grazing allotments, which are not commonly used for recreation. PDM conducted outside of grazing allotments is generally for alleviating threats to human safety.

Table 26. Summary of WS-Colorado predator damage management activities on United States Forest Service lands in Colorado during federal Fiscal Year 2010-14. Numbers are the annual averages of these five years.

	PDM Hours	Person-Day Visits	Total Acres	Acres under Agreement for PDM	Estimated Acres with PDM	Grazing Allotments	Allotments with PDM	Coyote Take	Red Fox Take	Black Bear Take
Routt NF	870	185	935,782	116,611 (12.5%)	23,322 (2.5%)	139	25 (18%)	81	1	8
White River NF	184	39	1,462,365	51,051 (3.5%)	10,210 (0.7%)	135	8 (5.9%)	31	0	3
GMUG NF	257	39	3,161,900	66,974 (2.1%)	13,395 (0.4%)	159	8 (5.0%)	13	0	6
All Other NF/NGs	305	59	5,339,953	78,451 (15%)	15,690 (0.3%)	1,722	9 (0.5%)	28	0	2
All USFS Lands	**1,616**	**322**	**10,900,000**	**313,087 (2.9%)**	**62,617 (0.6%)**	**2,155**	**50 (2.3%)**	**153**	**1**	**19**

NF, National Forest; GMUG NF, Grand Mesa, Uncompahgre, and Gunnison National Forests; NG, National Grassland

Average WS-Colorado PDM take on USFS lands during FY10-14 was 153 coyotes, 1 red fox, and 19 black bears per year. USFS manages 10.9 million acres in Colorado, which is about 16% of the land area in Colorado. Compared to the statewide averages (Table 14), the take on USFS lands was only 7% of total predator take, 7% for coyotes and 1% for red fox. As discussed earlier, most WS-Colorado PDM, and most predator take, occurs on private lands. These numbers reflect that trend; predator take on BLM lands (7% of total predator take) was much lower than the proportion of land in Colorado managed by USFS (16%). Black bear take on USFS lands represented a higher proportion of the statewide take of this species (26%) than would be expected based on land area (16%). This is likely due to differences in habitat types. Black bears prefer heavily forested habitats, and USFS manages 47% of Colorado's forests (Colorado State Forest Service 2016). BLM manages only 17% of Colorado's forests (Colorado State Forest Service 2016); much of the BLM land in Colorado is prairie. Private lands comprise 30% of Colorado's forests (Colorado State Forest Service 2016), and have more prairie/pasture land. Because most (81%) of our PDM on USFS lands was conducted on the Routt, White River, and GMUG (Grand Mesa, Uncompahgre and Gunnison) NFs, further analysis focuses on these three NFs (Table 26).

On the Routt NF, WS-Colorado spent an average of 870 hours over 185 person-day visits per year conducting PDM. This work was conducted on agreements which covered 116,611 acres, which is 12.5% of the acreage of this NF. Because WS-Colorado actually conducts PDM on only about 1/5 of the land under agreement for PDM work, we estimate that WS-Colorado conducted PDM on about 2.5% of the lands in the Routt NF. This NF has the highest potential for impact because more PDM was conducted here than on any other NF in Colorado. In fact, WS-Colorado conducted more PDM on this NF than all other NFs and NGs combined (54% of PDM hours). However, even on this NF, more than 97% of the lands were not subject to PDM. Furthermore, the higher level of PDM on this NF reflects the higher numbers of sheep grazed on these lands. And whereas sheep grazing is not inconsistent with recreation, sheep grazing habitat is not popular for many recreations activities, such as hiking, camping, mountain biking, fishing, sight-seeing, horseback riding, off-road-vehicle use, and most hunting. Thus, the specific areas where WS-Colorado conducted PDM were less likely to interfere with recreation. There are 139 grazing allotments in the Routt NF, and WS-Colorado conducted PDM on 25 (18%) of them. Average WS-Colorado predator take in this NF was 81 coyotes, 1 red fox, and 8 black bears per year (Table 26).

On the White River NF, WS-Colorado spent an average of 184 hours over 39 person-day visits per year conducting PDM. This work was conducted on agreements which covered 51,051 acres, which is 3.5% of the acreage of this NF. Because WS-Colorado conducts PDM on only about 1/5 of the land under agreement, the actual proportion of these lands with PDM is estimated at less than 1%. There are 135 grazing allotments in the White River NF, and WS-Colorado conducted PDM on 8 (5.9%) of them. Average WS-Colorado predator take in this NF was 31 coyotes and 3 black bears per year (Table 26).

The Grand Mesa, Uncompahgre, and Gunnison (GMUG) NFs are co-managed by USFS, so they are combined for our analyses also. On the GMUG NF, WS-Colorado spent an average of 257 hours over 39 person-day visits per year conducting PDM. This work was conducted on agreements which covered 66,974 acres, which is 2.1% of the acreage of this NF. Because WS-Colorado conducts PDM on only about 1/5 of the land under agreement, the actual proportion of these lands with PDM is estimated at less than 0.5%. There are 159 grazing allotments in the GMUG NF, and WS-Colorado conducted PDM on 8 (5.0%) of them. Average WS-Colorado predator take in this NF was 13 coyotes and 6 black bears per year (Table 26).

On all other Colorado NFs and NGs combined, WS-Colorado spent an average of 305 hours over 59 person-day visits per year conducting PDM. This work was conducted on agreements which covered 78,451 acres, which is 15% of the acreage of these NFs/NGs. Because WS-Colorado conducts PDM on only about 1/5 of the land under agreement, the actual proportion of these lands with PDM is estimated at 3%. There are 1,722 grazing allotments in these NFs/NGs, and WS-Colorado conducted PDM on 9 (0.5%) of them. Average WS-Colorado predator take in these NFs/NGs was 28 coyotes and 2 black bears per year (Table 26).

-Aerial Predator Management on USFS Lands: Table 27 shows WS-Colorado aerial predator management activity on USFS NFs and NGs in Colorado. WS-Colorado conducted aerial predator management on an average of 13 (range 12 to 16) USFS grazing allotments per year during FY10-FY14, which was less than 1% of the 2,155 total USFS grazing allotments in the State. Therefore, more than 99% of USFS grazing allotments are not exposed to any WS-Colorado aerial predator management in any typical year. On a land area basis, the total acreage of USFS allotments flown ranged from about 60,000 to 90,000 acres per year. Even the highest acreage constitutes less than 1% of the 10.9 million acres of USFS lands in Colorado. Because only about 1/5 of the total acreages on WS-Colorado agreements are actually flown, we estimate that the amount of USFS lands actually flown by WS-Colorado in any typical year is well below 0.5%. Thus, more than 99% of USFS lands were not exposed to any WS-Colorado aerial predator management in a typical year.

The average number of days flown per year on any USFS allotment ranged from 0.4 to 6.6 flights. Of the 17 allotments flown at some time over the five-year period FY10-14, 10 (59%) were exposed to fewer than 3 flights per year on average. The other 7 allotments (41%) were flown between 3 and 7 times per year. Although some allotments were flown more times within any given year, no allotment was flown on more than 15 days in any one year. This constitutes a very small fraction (at most 4%) of the 365 days in a year. Moreover, the average flight time on any USFS allotment was 0.7 hours per flight-day; thus, the amount of time spent flying over any USFS allotment was considerably less than 4%.

Most (92%) of WS-Colorado aerial predator management on USFS lands occurred on just two NFs - the Routt and White River in northwest Colorado. On the Routt NF, WS-Colorado flew on an average of 9 (range 7 to 11) grazing allotments per year, which is about 6% (range 5 to 8%) of the 139 grazing allotments on the Routt NF. On a land area basis, the total acreage of allotments flown on the Routt NF ranged from about 33,000 to

47,000 per year. These acreages constitute 3.5% to 5.0% of the 935,782 acres of USFS grazing allotments on the Routt NF. Thus, at least 95% of the grazing allotment area was not exposed to any WS-Colorado aerial predator management in a typical year. In fact, because only about 1/5 of the total acreages on WS-Colorado aerial predator management agreements are actually flown (see Chapter 2 for discussion), it is likely that 99% of Routt NF lands were not exposed to aerial predator management by WS-Colorado in any typical year.

Table 27. WS-Colorado aerial predator management time and days flown on United States Forest Service lands in Colorado during federal Fiscal Year 2010-14.

USFS Forest and Ranger District	Allotment Name	Number of Acres	Aerial Predator Management Hours						Days Flown					
			FY10	FY11	FY12	FY13	FY14	Average	FY10	FY11	FY12	FY13	FY14	Average
Comanche Grasslands		15,084	2.3	4.0	0.7	6.0	0	**2.6**	2	4	1	2	0	**1.8**
Routt National Forest Hahn's Peak Bear's Ear District	California Park	3,291	1.5	0.2	2.0	8.2	3.4	**3.1**	2	1	2	14	5	**4.8**
	E. Quaker Mountain	4,670	2.6	0	0.5	3.0	1.6	**1.5**	5	0	1	7	3	**3.2**
	Hole in the Wall	2,295	0	1.0	0.6	0.9	1.4	**0.8**	0	1	1	3	2	**1.4**
	Johnson Creek	3,495	3.1	2.7	2.0	2.2	2.1	**2.4**	5	5	3	5	5	**4.6**
	Potholes	3,141	9.2	4.9	2.1	5.9	3.6	**5.1**	0	8	4	15	6	**6.6**
	Sawmill Creek	2,246	0	0	0	1.1	1.5	**0.5**	0	0	0	3	3	**1.2**
	Sawtooth	5,038	0	1.1	1.0	1.0	0.5	**0.7**	0	2	1	3	1	**1.4**
	Slater-Adams	1,120	1.4	0	1.0	2.2	2.6	**1.4**	2	0	2	3	4	**2.2**
	Slide Mountain	4,475	2.7	3.1	0	4.2	3.6	**2.7**	6	6	0	10	8	**6.0**
	Stewardship	13,240	1.5	3.0	6.0	5.6	2.6	**3.7**	3	3	7	9	4	**5.2**
	W. Quaker Mountain	4,128	0	0	0	0.4	0.4	**0.2**	0	0	0	1	1	**0.4**
Subtotal Routt NF		47,139	22.0	16.0	15.2	34.7	23.3	**22.2**	23	26	21	73	42	**37.0**
White River National Forest Blanco District	Aldrich Lake	3,084	1.8	2.6	1.0	2.7	0	**1.6**	3	5	1	4	0	**2.6**
	Lost Park	2,615	3.5	0	0	2.1	0	**1.1**	5	0	0	3	0	**1.6**
	Milk Creek	7,261	5.9	7.6	2.3	3.6	2.5	**4.4**	7	9	3	5	2	**5.2**
	Sawmill Mountain	4,995	0	3.0	1.0	2.1	2.0	**1.6**	0	5	1	3	2	**2.2**
	Three Points	3,253	2.5	0.5	0	0	0	**0.6**	2	1	0	0	0	**0.6**
Subtotal White River NF		21,208	13.7	13.7	4.3	10.5	4.5	**9.3**	17	20	5	15	4	**12.2**
All USFS Lands		83,431	38.0	33.7	20.2	51.2	27.8	34.2	42	50	27	90	46	51.0

On the White River NF, WS-Colorado flew on an average of 3 (range 2 to 4) grazing allotments per year, which is about 1.5 to 3% of the 135 allotments on that NF. Therefore, at least 97% of allotments were not exposed to any aerial predator management in a typical year. On a land area basis, the total acreage of allotments flown on the White River NF ranged from about 12,000 to 19,000 per year. These acreages constitute 0.8% to 1.3% of the 1,462,365 acres of USFS grazing allotments on the White River NF. Because only about 1/5 of the total acreages on WS-Colorado agreements are actually flown, we estimate that less than 0.5% of White River NF lands were flown in any year. Thus, more than 99.5% of these NF lands were not exposed to any WS-Colorado aerial predator management in a typical year.

The only other NF grazing allotments in the State that where WS-Colorado conducted aerial predator management were on the Comanche National Grassland in the Pike/San Isabel NF (0 to 2 allotments flown per year). Total acreage of allotments flown per year ranged from 0 to 15,000, which is 0 to 1% of the total acreage of grazing allotments on the Pike/San Isabel NF. The total grazing allotment acres on the Comanche Ranger District (Comanche NG) is 413,616; therefore, the acres flown ranged from 0 to 3.6% of that NG.

4.1.5.1d Effects of PDM on Unique Characteristics of Geographic Areas.

A number of different types of Federal lands occur within the analysis area such as Wilderness Areas (WAs), Wilderness Study Areas (WSAs), Future Planning Areas (FPAs), National Conservation Areas, National Historic Sites, and Areas of Critical Environmental Concern (ACECs). All of these land types currently have special designations because of their unique characteristics and may require special considerations for conducting PDM. These are collectively referred to as Special Management Areas (SMAs). WS-Colorado recognizes that some persons interested in SMAs may feel that any PDM activity in these areas adversely affects aesthetics, natural qualities, values, or the ecosystem. But many SMAs have allowed grazing since long before their designation as an SMA, and continue to allow it. Current laws and regulations allow the public and WS-

Colorado to conduct PDM activities in SMAs under certain limitations. As such, WS-Colorado has conducted PDM on some of these areas. However, PDM on SMAs includes only a few grazing allotments for the protection of livestock in recent years, and we do not anticipate any substantial increase in the future. PDM in SMAs is only a very minor component of the current PDM program. WS-Colorado complies with internal guidelines and policies when conducting PDM in these areas. WS-Colorado also abides by all federal and state laws, regulations, and policies set forth for these SMAs (*e.g.*, the Wilderness Act) to minimize any effect on the public. Currently, private individuals using firearms and trail hounds can sport hunt or conduct PDM in most SMAs under CPW or CDA regulations. These activities are not restricted by BLM or USFS in most SMAs.

WS-Colorado recognizes that some individuals interested in SMAs may feel that any PDM activities in these areas adversely affect their aesthetic and natural qualities, value, and the ecosystem. This issue was discussed in Chapter 2, and WS-Colorado's SOPs to ensure no adverse effects in SMAs were covered in Chapter 3. WS-Colorado abides by all associated laws, regulations, and policies (*e.g.*, the Wilderness Act) to minimize any effect on the public while conducting PDM as allowed to reduce damage in the SMAs. WS-Colorado also complies with WS guidelines and policies when conducting PDM in these areas. PDM is only conducted in designated WAs or WSAs when allowed by the legislation that designated the WA, or under regulations and policies developed by USFS or BLM for PDM in these areas. WS-Colorado generally conducts PDM on only a few SMA grazing allotments for the protection of livestock. During FY10-14, WS-Colorado conducted PDM on 2 SMAs: the Flat Tops WA and the Weminuche WA, both on USFS land. In the Flat Tops WA, WS-Colorado worked in approximately 1 mi^2 of the WA in pursuit of black bears and mountain lions which had killed livestock outside of the wilderness. No predators were taken within the WA. In the Weminuche WA, WS-Colorado used calling and shooting to target coyotes, and trail dogs to target black bear in efforts to limit sheep losses from these predators. WS-Colorado agreements on the Weminuche WA cover approximately 38 mi^2 of the WA; however, as discussed in Chapter 1, the land area actually worked was likely less than 1/5 of the total area under agreement (<7.6 mi^2). No aerial predator management by WS-Colorado occurred on any SMAs during FY10-14. On all SMAs in Colorado, a total of two coyotes were killed during FY10-14 (average of 0.4 coyotes per year). The Current Program Alternative has a minimal effect on SMAs, such as WAs, WSAs, campgrounds, research natural areas, trailheads, and National Conservation Areas.

<u>BLM SMAs</u>: WS-Colorado PDM in WAs, WSAs, and other SMAs conforms with all federal and state laws and regulations that have been determined to apply to WS-Colorado activities. WS-Colorado PDM in SMAs has occurred only to a very minor degree in the current program and the need for such activity in SMAs is expected to remain minor. The BLM has not imposed any restrictions on most PDM methods in any SMAs in the State. Previously, the only exception was in the BLM Interim Management Policy and Guidelines for Lands Under Wilderness Review (BLM 1995a), which established several restrictions on PDM in WSAs[18]. That policy did not purport to restrict the use of other PDM methods, including those that are also involved in sport hunting and private or state agency PDM activities, such as the use of firearms or trail hunting dogs. Therefore, the use of such methods under WS authorities would be consistent with BLM management direction in such areas. BLM revised its policy for management of WSAs in 2004 (C. McCluskey, Senior Wildlife Specialist, BLM, pers. comm. 2005), and we are awaiting final interpretation of the effect of the policy changes. WS-Colorado did not conduct aerial predator management in any of the WSA portions of BLM grazing allotments associated with WSAs during FY10-14.

[18] For example, requirements to target individual offending animals and to obtain BLM State Director approval before aerial hunting may occur. These requirements were eliminated by policy revision in 2004.

WS-Colorado coordinates annually with the BLM, which provides the BLM with the opportunity to identify any conflicts that WS-Colorado activities might have with established management plans or goals for SMAs. If WS-Colorado activities are found to conflict with such management plans or goals, then WS-Colorado will either avoid conducting the activity or engage in further NEPA analysis as appropriate in coordination with the BLM. During FY10-14, WS-Colorado did not conduct any PDM activities in BLM SMA's.

USFS SMAs: WS-Colorado follows policies outlined in the USFS Manual, particularly Section 2323, and the National MOU between USFS and WS-Colorado when conducting PDM in USFS SMAs such as WAs, WSAs, and FPAs. Additionally, the LRMP provides guidance for USFS to determine if PDM objectives are compatible with land management objectives. For example, WS-Colorado does not conduct PDM in USFS specially designated areas (*e.g.*, trailheads, campgrounds), except for emergency human health situations. Proposed WS-Colorado PDM plans are reviewed by USFS during the work planning process to ensure that there are no conflicts with the LRMP. Therefore, we expect no potential for WS-Colorado PDM to have any adverse effect on wilderness characteristics or management objectives of SMAs. Proposed PDM in USFS SMAs is primarily limited to grazing allotments with a limited buffer zone for the protection of livestock, but could also occur on occasion for the protection of wildlife if requested by CPW. PDM in SMAs would not impair the values of such areas and the intent of Congress designating them as such.

WS-Colorado PDM activity on USFS SMAs has been very limited. During FY10-14, WS-Colorado conducted PDM on 2 USFS SMAs: the Flat Tops WA and the Weminuche WA. In the Flat Tops WA, WS-Colorado worked in approximately 1 mi^2 of the WA in pursuit of black bears and mountain lions which had killed livestock outside of the wilderness. No predators were taken within the WA. In the Weminuche WA, WS-Colorado used calling and shooting to target coyotes, and trail dogs to target black bear in efforts to limit sheep losses from these predators. Two coyotes were killed during FY10-14 (average of 0.4 coyotes per year). WS agreements on the Weminuche WA cover approximately 38 mi^2 of the WA; however, the land area actually worked was likely less than 1/5 of the total area under agreement (<7.6 mi^2). No aerial predator management by WS-Colorado occurred on any FS WAs during FY10-14.

Summary of Potential Impacts to SMAs in Colorado: Colorado has many SMAs. A list of the majority of SMAs in Colorado is provided in Table 28. These areas were analyzed to determine potential impacts of the current WS-Colorado program on their unique characteristics. The various SMAs are managed for the protection of certain qualities or values such as biological (*e.g.*, sensitive plant or animal species), ecological (*e.g.*, riparian, rangeland), cultural, historical, scenic, geological, paleontological, or recreational. Many of these resource values do not have the potential to be impacted by the PDM methods that WS-Colorado might use on such areas (*e.g.*, aerial predator management, ground-based shooting). PDM as conducted by WS-Colorado does not have an impact on ecological, cultural, historical, geological, paleontological, or plant resources because habitat is not impacted by WS-Colorado during PDM. WS-Colorado PDM also does not impact amphibians, fish, or invertebrates in Colorado. PDM has no potential to affect scenic qualities and has only minor potential to affect aesthetic and recreational qualities of SMAs because WS-Colorado works on relatively few SMAs, and such work is limited in scope and duration, as discussed in this section. Although WS-Colorado has the potential to take some species of birds and mammals during PDM, WS-Colorado is not likely to impact these species under the current program (see Sections 4.1.1 and 4.1.2).

Several SMAs have been set aside for wildlife protection, especially big game wintering areas. Other protected wildlife species which are found on some of the SMAs include T&E species (Table 11) and sensitive species (Table 29). If an SMA has been specifically designated to protect a wildlife species that could potentially be impacted by PDM, then

special restrictions might be needed. In general, PDM has not been necessary in these areas, primarily because livestock are not often allowed to graze on them. However, PDM may be conducted on such areas if the need arises, especially during a human health and safety crisis. Similar to other types of BLM and USFS SMAs discussed above, sport hunting and PDM by private individuals using firearms and trail hounds generally is not restricted in these areas. The land management agency is responsible for identifying any conflicts that PDM might have with the management of an SMA in the

Table 28. Special Management Areas (SMAs) in Colorado (list is not intended to be comprehensive).

COLORADO WILDERNESS AREAS / NATIONAL PARKS / HISTORIC SITES		
Bents Old Fort National Historic Site (NPS)	Greenhorn Mountain (22,040 acres, San Isabel NF)	Never Summer (20,747 acres, Arapaho, Routt NFs)
Black Canyon of the Gunnison National Park (15,599 acres, NPS, Gunnison NF, Uncompahgre RA)	Gunnison Gorge (17,700 acres, Gunnison NF, Uncompahgre RA)	Platte River (23,492 acres, Routt NF)
Black Ridge Canyons (Grand Jct RA)	Holy Cross (122,797 acres, San Isabel, White River NF)	Powderhorn (61,510 acres, Gunnison NF, Gunnison RA)
Buffalo Peaks (43,410, Pike, San Isabel NFs)	Hunter - Fryingpan (81,866 acres, White River NF)	Ptarmigan Peak (12,594 acres, Routt, White River NFs)
Byers Peak (8,913 acres, Arapaho, Routt NFs)	Indian Peaks (73,291 acres, Arapaho, Roosevelt NFs)	Raggeds (64,992 acres, Gunnison, White River NFs)
Cache La Poudre (9,238 acres, Roosevelt NF)	La Garita (128,858 acres, Gunnison, Rio Grande NFs)	Rawah (73,068 acres, Roosevelt, Routt NFs)
Collegiate Peaks (166,938 acres, White River, San Isabel, Gunnison NF)	Lizard Head (41,193 acres, San Juan, Uncompahgre NFs)	Rocky Mountain National Park (210,000 acres, NPS)
Colorado National Monument (NPS)	Lost Creek (119,790 acres, Pike NF)	Sand Creek Massacre National Historic Site (NPS)
Comanche Peak (66,791 acres, Roosevelt NF)	Maroon Bells - Snowmass (181,117 acres, Gunnison, White River NFs)	Sangre De Cristo (226,420 acres, Rio Grande, San Isabel NFs)
Curecant National Recreation Area (NPS)	Mesa Verde National Monument (8,100 acres, NPS)	Sarvis Creek (47,190 acres, Routt NF)
Dinosaur National Park (210,000 acres, NPS)	Mount Evans (74,401 acres, Arapaho, Pike NFs)	South San Juan (158,790 acres, Rio Grande, San Juan NFs)
Eagles Nest (132,906 acres, Arap., White River NFs)	Mount Massive (30,540 acres, San Isabel NF)	Uncompahgre (102,721 acres, Uncompahgre NF)
Flat Tops (235,035 acres, Routt, White River NFs)	Mount Sneffels (16,565 acres, Uncompahgre NF)	Vasquez (12,986 acres, Arapaho, Routt NFs)
Florissant Fossil Beds National Monument (NPS)	Mount Zirkel (159,935 acres, Routt NF)	Weminuche (492,418 acres, San Juan, Rio Grande NFs)
Fossil Ridge (31,534 acres, Gunnison NF)	Neota (9,924 acres, Roosevelt, Routt NFs)	West Elk (176,172 acres, Gunnison NF)
Great Sand Dunes National Park/Preserve (33,450 acres, NPS, San Isabel NF)		
WILDERNESS STUDY AREAS AND FUTURE PLANNING AREAS		
Adobe Badlands (Uncompahgre RA)	Dominguez Canyon (Grand Jct, Uncompahgre RAS)	Rio Grande (La Jara RA)
American Flats (Gunnison RA)	Flat Tops Addition - Hack Lake (Glenwood RA)	Roan Plateau (Grand Jct RA)
Bangs Canyon (Grand Jct RA)	Granite Creek (Uncompahgre RA)	Roubideau (Uncompahgre NF/RA)
Beaver Creek (Royal Gorge RA)	Grape Creek (Royal Gorge RA)	San Luis Hills (La Jara RA)
Black Mountain/Windy Gulch (White River RA)	Great Sand Dunes Addition (La Jara RA)	Sewemup Mesa (Grand Jct RA)
Browns Canyon (Royal Gorge RA)	Gunnison Gorge (Uncompahgre RA)	Skull Creek (White River RA)
Bull Canyon (White River RA)	Handies Peak (Gunnison RA)	Snaggletooth (San Juan RA)
Bull Gulch (Glenwood RA)	Hunter Canyon (Grand Jct RA)	South Shale Ridge (Grand Jct RA)
Camel Back (Uncompahgre RA)	James Peak SMA (Arapaho NF)	Tabeguache SMA (Uncompahgre NF/RA)
Cahone Canyon (San Juan RA)	Little Bookcliffs (Grand Jct RA)	The Palisade (Grand Jct RA)
Castle Peak (Glenwood RA)	Mares Tail -Squaw/Papoose Canyons (San Juan RA), Maroon Bells-Snowmass Additions (Glenwood RA)	Thompson Creek (Glenwood RA)
Cold Springs Mountain (Little Snake RA)	McIntyre Hills (Royal Gorge RA)	Troublesome (Kremmling RA)
Cross Canyon (San Juan RA)	McKenna Peak (San Juan RA)	Unaweep (Grand Jct RA)
Cross Mountain (Little Snake RA)	Oil Springs Mountain (White River RA)	Vermillion Basin (Little Snake RA)
Deep Creek (Glenwood RA)	Piedra SMA (San Juan NF)	Weber-Menefee Mountains (San Juan RA)
Demaree Canyon (Grand Jct RA)	Pinion Ridge (White River RA)	West Elk Addition (Gunnison RA)
Diamond Breaks (Little Snake RA)	Platte River Addition (Kremmling RA)	Willow Creek (White River RA)
Dinosaur National Monument Additions - Ant Hills, Chew Winter Camp, Peterson Draw, Tepee Draw, Vale of Tears (Little Snake RA)	Redcloud (Gunnison RA)	Yampa River (Little Snake RA)
Dolores River Canyon (San Juan, Uncompahgre RAS)		
NATURAL AREAS BY COUNTY		
ALAMOSA - Zapata Falls	GRAND - Kremmling Cretaceous Ammonite Locality, Paradise Park	MONTEZUMA - McElmo
BACA - Comanche Grassland, Shell Rock Canyon	GUNNISON - Gothic, Mexican Cut, Mount Emmons Iron Bog, and South Beaver Creek	MONTROSE - Escalante Canyon, Fairview, San Miguel River at Tabeguache Creek
BOULDER - Colorado Tallgrass Prairie, South Boulder Creek, White Rocks	HINSDALE - Redcloud Peak, Slumgullion Earthflow	PARK - High Creek Fen, Saddle Mountain, Treasurevault Mountain
CHAFFEE - Droney Gulch	HUERFANO - Cucharas Canyon	RIO BLANCO - Black Gulch, Coal Draw, Coal Rim, Deer Gulch, Duck Creek, Dudley Bluffs, East Douglas, Lower Greasewood Creek, Raven Ridge, South Cathedral Bluffs, Yanks Gulch / Upper Greasewood Creek
CLEAR CREEK - Mount Goliath	JACKSON - East Sand Dunes, North Park	RIO GRANDE - Elephant Rocks
CONEJOS - Rajadero Canyon	JEFFERSON - Dakota Hogback, Ken-Caryl Ranch	ROUTT - California Park
CUSTER - Brush Creek Fen	LARIMER - Blue Mountain - Little Thompson, Owl Canyon, Pinyon Grove, Jimmy Creek, Park Creek, Sand Creek, Specimen Mountain, and West Creek	SAGUACHE - Indian Spring, Mishak Lakes
DELTA - Needle Rock	LOGAN - Tamarack Ranch	SUMMIT - Mosquito Pass
DOLORES - Narraguinep	MESA - Badger Wash, Fruita Paleontological Locality, Gateway Palisade, Gunnison Gravels, Pyramid Rock, Rabbit Valley, Rough Canyon, and Unaweep Seep	TELLER - Dome Rock
DOUGLAS - Castlewood Canyon, Roxborough State Park	MINERAL - Wheeler Geologic	WELD - Chalk Bluffs
EL PASO - Aiken Canyon, Hurricane Canyon	MOFFAT - Cross Mountain Canyon, Irish Canyon, Limestone Ridge, Lookout Mountain	YUMA - Bonny Prairie
FREMONT - Arkansas Canyonlands, Garden Park Fossil Locality, High Mesa Grassland, Indian Springs Trace Fossil Locality, and Mini-Wheeler (Stirrup Ranch Geologic), Phantom Canyon		

interagency coordination work planning process. For example, if the land management agency determines that an area with special management emphasis is to be closed to all access and/or the use of firearms, or to all low level flights, then WS-Colorado would abide by those restrictions unless provided with a special exemption.

Table 29. Sensitive mammal and bird species found in Natural Areas and other Special Management (SMAs) in Colroado. WS-Coorado conducts little predator damage management on SMAs in Colorado and methods are restricted by Amendment 14. The only species impacted by PDM is the swift fox. Data from Rondeau *et al.* 2011.

Species	Scientific Name	CNHP State Rank	Where Found	Habitat	When Found	Effects of PDM
MAMMALS						
Cliff Chipmunk	*Tamias dorsalis*	S2	Moffat Co.	Pinyon-juniper	All year	0
Dwarf Shrew	*Sorex nanus*	S2	Central Foothill	Woods	All year	0
Ord's Kangaroo Rat	*Dipodomys ordii priscus*	S3	Moffat Co.	Open sandy	All year	0
Pygmy Shrew	*Sorex hoyi montanus*	S2	Jackson Co.	Wooded open	All year	0
Silky Pocket Mouse	*Perognathus flavus sanluisi*	S3	San Luis Valley	Shortgrass	All year	0
White-tailed Prairie Dog	*Cynomys leucurus*	S4	Northwest	Prairie	All year	0
Brazilian Free-tailed Bat	*Tadarida brasiliensis*	S1	Scattered sites	Caves-bldgs.	Summer	0
Swift Fox	*Vulpes velox*	S3	Eastern Colo.	Plains	All year	-, 0, +
BIRDS						
American peregrine falcon	*Falco perearinus anatum*	S3	Western Colo.	Variety	All year	0
Black swift	*Cypseloides niger*	S3	Western Colo.	Cliffs	Summer	0
Bobolink	*Dolichonyx oryzivorus*	S3	North-central	Grassland	Breed	0
Columbian sharp-tailed grouse	*Tympanuchus phasianellus columbianus*	S2	Western Colo.	Grass-shrublands	All year	0, +
Grace's warbler	*Dendroica gracioe*	S3	Southwest	Pine-oak	Breed	0
Gray vireo	*Vireo vicinior*	S2	Western Colo.	Pinyon-juniper	Breed	0
Greater sandhill crane	*Grus canadensis tabida*	S2	Northwest	Marsh-grassland	Breed S	0, +
Lewis's woodpecker	*Melanerpes lewis*	S4	Western Colo.	Open woodlands	All year	0
Northern sage-grouse	*Centrocercus urophasian us*	S4	Northwest	Sage	All year	0, +
Ovenbird	*Seiurus aurocapillus*	S2	Eastern Colo.	Decid. oldgrowth	Breed	0
Prairie falcon	*Falco mexicanus*	S4	Statewide	Prairie	All year	0
Sage sparrow	*Amphispiza belli*	S2	Western Colo.	Sage	Breed	0
White-faced ibis	*Plegadis chihi*	S2	Statewide	Marsh-grassland	Breed	0, +
Black-necked stilt	*Himantopus mexicanus*	S3	Statewide	Wetlands	Breed	0, +
Boreal owl	*Aegolius funereus*	S2	North-central	Boreal forest	All year	0
Brown-capped rosy-finch	*Leucosticte australis*	S3	Western Colo.	Alpine	All year	0
Ferruginous hawk	*Buteo regalis*	S3	Statewide	Open Prairie	All year	0
Greater prairie-chicken	*Tympanuchus cupido*	S3	Northeast	Grassland	All year	0, +
McCown's longspur	*Calcarius mccownii*	S3	North-central	Grassland	Breed	0
Mountain plover	*Charadrius montanus*	S2	Eastern Colo.	Prairie	Breed	0
Northern goshawk	*Accipiter gentilis*	S3	Western Colo.	Forest	All year	0
Northern pygmy-owl	*Glaucidium gnoma*	S3	Western Colo.	Woodlands	All year	0
Veery	*Catharus fuscescens*	S3	Western Colo.	Moist woods	Breed	0
White-tailed ptarmigan	*Lagopus leucurus*	S4	Central Colo.	Alpine	All year	0, +
White-winged crossbill	*Loxia leucoptera*	S1	Western Colo.	Conifer forest	Winter	0
Willow flycatcher	*Empidonax traillii*	S4	Statewide	Riparian woods	Breed	0
Wilson's phalarope	*Phalaropus tricolor*	S4	Statewide	Wetland	Breed	0

CNHP = Colorado Natural Heritage Program — Effects of PDM: (-), negative; (+), positive; 0, no effect

State Rank (relative rarity or endangerment in the state): S1- Critically imperiled; S2- Imperiled; S3-Rare; S4-Widespread, but long- term concern

Table 29 lists the species being monitored in Natural Areas in Colorado. Of these, the only species with the potential to be negatively impacted by WS-Colorado PDM is the swift fox. Such impacts would be minor, as discussed in Section 4.1.1. WS-Colorado PDM is restricted in these areas to target-specific methods; thus, WS-Colorado PDM does not negatively impact such sensitive species. In fact, WS-Colorado PDM may benefit some of these species. Of the species listed, WS-Colorado PDM could potentially benefit 8 species by removing predators that prey on them or their nests.

4.1.5.1e Conclusions for Direct, Indirect, and Cumulative Impacts on Recreation on Public Lands under Alternative 1.

The above information shows that WS-Colorado PDM activities on BLM and USFS lands in Colorado has been infrequent, of short duration, and covered a very small proportion of these lands. WS-Colorado aerial predator management on BLM and USFS lands in Colorado has also been infrequent, of short duration, and over a small proportion of the total BLM and USFS lands in the State. Even within the specific BLM RAs and USFS NFs where WS-Colorado conducted the most PDM and the most aerial predator management, the vast majority of the land area was not exposed to aerial predator management flights or other PDM activities, and these actions were limited to only a small fraction of time in any year. Most recreationists are totally unaware of PDM actions, and the quality of their outdoor experience is unaffected. Thus, WS-Colorado has little impact on most recreational uses.

WS-Colorado uses work planning coordination with the BLM and USFS to further lessen the potential for impacts on recreation on public lands, including SMAs. During such coordination, the Federal land managers, and CPW personnel, inform WS-Colorado about specific locations where mitigation or restrictions on WS-Colorado PDM activities might be necessary to reduce or eliminate the potential for adverse effects on specific resources. For example, high-use recreational areas are identified and avoided when WS-Colorado conducts PDM. Furthermore, upland game and other high-use hunting areas are delineated by CPW, USFS, or BLM. If WS-Colorado works in these areas, control equipment is removed a week or more prior to the hunting season as appropriate. WS-Colorado does not conduct PDM in high-use recreational areas except for the purposes of human health and safety protection. High use recreation and other sensitive areas are identified at the site specific level on WS WP maps, which are modified as new damage situations arise. Human safety zones, planned PDM areas, and restricted or coordinated PDM areas are identified through interagency communications. We rely on these processes to assist in avoiding substantive adverse effects on recreational opportunities or other relevant components of the human environment.

Game and non-game wildlife populations are minimally impacted by WS-Colorado's take on public lands (Sections 4.1.1 and 4.1.2), allowing hunters ample opportunity for pursuit. Recreationists interested in wildlife viewing and photography opportunities also have ample areas on public lands in Colorado which are suitable for seeing abundant wildlife. In fact, WS-Colorado PDM activities may benefit certain wildlife populations thereby increasing recreational opportunities.

Potential conflicts with recreationists are further minimized due to the inherent nature of PDM. WS-Colorado conducts PDM on public lands almost entirely for the protection of sheep and cattle on grazing allotments. Many of these areas are generally not used extensively by recreationists. Most recreational areas are set aside for that specific purpose, and grazing is not allowed. The highest seasonal PDM activity for the protection of livestock immediately precedes or coincides with lambing and calving, which is mostly in the spring. During these times (later winter and early spring), aerial predator management is the method of choice, because of limited access due to wet or snow covered roads. Many recreationists, as well as WS-Colorado Specialists, do not have access to these public lands due to these natural limitations.

It should be noted that this analysis slightly overestimates the impact on these public lands, because data were included for all WS agreements which include any BLM or USFS land. Many properties worked by WS-Colorado included private land as well as adjacent public lands leased by the producers. In these cases, some of the PDM work was conducted on private land, and some on public land; however, our analysis was not able to differentiate these land classes in most cases. As such, most of the work conducted on these private lands is included in our analysis of these public lands.

WS-Colorado expects annual variation in the specific allotments and acreages on which PDM is conducted, and in the numbers of predators taken, much like the yearly variations in this analysis. However, WS-Colorado does not anticipate any substantive future increases these acreages, numbers of allotments, frequency, or duration of PDM on public lands. We also do not anticipate any substantive increase in the number of predators taken in the future. As such, we do not expect any future adverse impacts on recreation on public lands due to PDM.

4.1.5.2 Alternative 2 - No Federal WS PDM.

Under this alternative, WS-Colorado would not provide assistance with PDM; therefore, there would be no direct Federal impact on recreation. However, CDA and CPW would probably provide some level of direct PDM assistance, and PDM by private individuals and entities would likely increase. State-conducted PDM would similarly affect recreation as described under the Current Program Alternative (Alternative 1), except that potential impacts would decrease in proportion to the likely decreased effort provided by State programs. Private efforts to reduce or prevent depredations would likely increase in proportion to the loss of government (State and Federal) assistance. This would likely result in less experienced persons implementing PDM methods, leading to a potentially greater impact on recreation than described under Alternative 1 (the Current Program). As discussed relevant to other issues, it is possible that the frustration caused by the inability of less experienced persons implementing PDM to reduce losses could lead to the illegal use of chemical toxicants which, in turn, could impact recreationists and their pets. This activity could also have minor impacts on game species, as described for predators in 4.1.1.2 and nontarget species in 4.1.2.2. Aerial predator management would probably decrease under this alternative, because it requires pilots experienced with low level flying, and a permit from CDA or CPW. Therefore, recreationists would be minimally affected by this PDM method. Even if CDA and CPW issued several more permits, the effects (barring illegal activities) would likely be similar to those in section 4.1.5.1. However, the loss of this effective tool for PDM would likely lead to increased PDM efforts, along with increased risks for all of the potential impacts described above. In addition, PDM activities in lieu of aerial predator management may cause damage to the environment due to the use of off-road vehicle. This is because much of the environment is sensitive to disturbance and vehicles can leave long-lasting scars, especially when vehicles are used during the wet season, when PDM is most needed due to lambing season. These scars can be an eyesore to recreationists. Therefore, slightly greater negative impacts are likely under this alternative when compared to Alternative 1 (the Current Program).

The current program has been determined to have minimal effects on the SMAs, and similar levels of legal PDM on SMAs under this Alternative would also have minimal effects. However, this Alternative might have a negative effect on SMAs for the same reasons described elsewhere with no Federal PDM program: increased PDM due to lower efficacy, and the use of improper or illegal methods. As such, this Alternative would likely have a greater negative effect on SMAs than the Current Program (Alternative 1).

4.1.5.3 Alternative 3 - Technical Assistance Only.

Under this alternative, WS-Colorado would not have any direct impact on recreational use of public lands in Colorado. However, this Alternative would cause many of the same problems discussed for Alternative 2: increased PDM activities due to lower efficacy, and the use of improper or illegal methods. The potential for negative impacts would be reduced compared to Alternative 2, because those receiving advice from WS-Colorado could make wiser choices when conducting PDM on public lands. However, this Alternative would likely result in slightly greater negative impacts on recreation than

would the Proposed Action (Alternative 1). Impacts to SMAs would likely be somewhere between Alternative 1 and Alternative 2.

4.1.5.4 Alternative 4 - Lethal PDM Methods Used Only for Corrective Control.

Direct actions by WS-Colorado would minimally affect recreationists under this Alternative (similar to Alternative 1). In areas where lethal preventive control would have been used by WS-Colorado under Alternative 1, PDM would likely be implemented by resource owners or private contractors instead. Under Alternative 4, aerial predator management would be used less because it is the most common preventive method used by WS-Colorado. Instead, private individuals/entities would likely conduct most preventive PDM, which would likely further increase the negative impact on recreation for the reasons discussed under Alternatives 2 and 3: increased PDM activities due to lower efficacy, use of improper or illegal methods, and increased off-road vehicle use. These additional impacts would likely be lower than under Alternatives 2 and 3, because WS-Colorado would still conduct lethal control after damage has occurred. More losses would likely be incurred by resource owners without aerial predator management (Wagner 1997, Wagner and Conover 1999), and therefore, even more PDM efforts would be expended following these higher losses. The overall impacts on recreation under Alternative 4 would likely be lower than under Alternative 2, but higher than under Alternative 1.

4.1.6 Humaneness and Ethical Perspectives

Humaneness and animal welfare as it relates to killing or capturing wildlife is an important and very complex issue that can be interpreted in a variety of ways. Schmidt (1989) indicated that vertebrate pest damage management for societal benefits could be compatible with animal welfare concerns if "*the reduction of pain, suffering, and unnecessary death is incorporated in the decision making process.*" However, defining "pain" and "suffering" can be challenging. In fact, it has been noted that "*neither medical nor veterinary curricula explicitly address suffering or its relief*" (California Department of Fish and Game 1991). Suffering has been described as a "*highly unpleasant emotional response usually associated with pain and distress.*" However, it has also been noted that suffering "*can occur without pain*" and that "*pain can occur without suffering*" (AVMA 1987). Suffering implies a duration of time; thus, an animal would experience "*little or no suffering where death comes immediately*" (California Department of Fish and Game 1991), such as from a well-placed gunshot. Defining pain is an even greater challenge. Wild mammals clearly experience pain, but detecting such pain can be difficult. Pain experienced by individual animals from the same stimulus probably ranges from little or no pain to significant pain (California Department of Fish and Game 1991). The American Veterinary Medical Association (AVMA) has also noted that "*individuals can differ in their perceptions of pain intensity as well as in their physical and behavioral responses to it*" (AVMA 2013). Altered physiology and behavior can be indicators of pain, and identifying the causes that elicit pain responses in humans would "*probably be causes for pain in other animals*" (AVMA 1987).

The AVMA has described euthanasia as "*ending the life of an individual animal in a way that minimizes or eliminates pain and distress*" (AVMA 2013). Some people would prefer that only accepted methods of euthanasia be used when killing any animal, including wild and feral animals. Indeed, WS strives to use the most humane methods practical in order to minimize such pain or distress. However, as noted by the AVMA (2013), "*the quickest and most humane means of terminating the life of free-ranging wildlife in a given situation may not always meet all criteria established for euthanasia*." They have also stated that "*For wild and feral animals, many of the recommended means of euthanasia for captive animals are not feasible. In field circumstances, wildlife biologists generally do not use the term euthanasia, but use terms such as killing, collecting or harvesting, recognizing that a distress-free death may not be possible*" (AVMA 2001). The distinction here is between a distress-free death, and a humane death which minimizes pain and distress. Some individuals and groups are opposed to some of the PDM actions of WS. However, WS personnel are experienced and professional in their use of PDM methods. This experience and professionalism allows WS personnel to use equipment and techniques that are as

humane as possible within the constraints of current technology. In fact, this is consistent with another description of euthanasia: "*the humane termination of an animal's life*" (AVMA 2013). In fact, professional PDM activities are often more humane than nature itself (*e.g*., death from starvation) because these activities can produce quicker deaths that cause less suffering.

Stress has been defined as the effect of physical, physiologic, or emotional factors (stressors) that induce an alteration in an animal's base or adaptive state. Responses to stimuli vary among animals based on the animals' experiences, age, species, and current condition. Not all forms of stress result in adverse consequences for the animal, and some forms of stress serve a positive, adaptive function for the animal. Eustress describes the response of animals to harmless stimuli which initiates responses that are beneficial to the animal. Neutral stress is the term for response to stimuli which have neither harmful nor beneficial effects to the animal. Distress results when an animal's response to stimuli interferes with its well-being and comfort (AVMA 2007).

The AVMA states *"... euthanasia is the act of inducing humane death in an animal*" and that "*...that if an animal's life is to be taken, it is done with the highest degree of respect, and with an emphasis on making the death as painless and distress free as possible"* (AVMA 2013). Additionally, euthanasia methods should minimize any stress and anxiety experienced by the animal prior to unconsciousness. Although use of euthanasia methods to end an animal's life is desirable, as noted by the AVMA, *"For wild and feral animals, many of the recommended means of euthanasia for captive animals are not feasible. In field circumstances, wildlife biologists generally do not use the term euthanasia, but terms such as killing, collecting, or harvesting, recognizing that a distress- free death may not be possible."* (AVMA 2001).

AVMA (2013) notes, "*While recommendations are made, it is important for those utilizing these recommendations to understand that, in some instances, agents and methods of euthanasia identified as appropriate for a particular species may not be available or may become less than an ideal choice due to differences in circumstances. Conversely, when settings are atypical, methods normally not considered appropriate may become the method of choice. Under such conditions, the humaneness (or perceived lack thereof) of the method used to bring about the death of an animal may be distinguished from the intent or outcome associated with an act of killing. Following this reasoning, it may still be an act of euthanasia to kill an animal in a manner that is not perfectly humane or that would not be considered appropriate in other contexts. For example, due to lack of control over free-ranging wildlife and the stress associated with close human contact, use of a firearm may be the most appropriate means of euthanasia. Also, shooting a suffering animal that is in extremis, instead of catching and transporting it to a clinic to euthanize it using a method normally considered to be appropriate (e.g., barbiturates), is consistent with one interpretation of a good death. The former method promotes the animal's overall interests by ending its misery quickly, even though the latter technique may be considered to be more acceptable under normal conditions (Yeates 2010). Neither of these examples, however, absolves the individual from her or his responsibility to ensure that recommended methods and agents of euthanasia are preferentially used.*"

AVMA (2013) recognizes that there is "*an inherent lack of control over free-ranging wildlife, accepting that firearms may be the most appropriate approach to their euthanasia, and acknowledging that the quickest and most humane means of terminating the life of free-ranging wildlife in a given situation may not always meet all criteria established for euthanasia (*i.e., *distinguishes between euthanasia and methods that are more accurately characterized as humane killing). Because of the variety of situations that may be encountered, it is difficult to strictly classify methods for termination of free-ranging wildlife as acceptable, acceptable with conditions, or unacceptable. Furthermore, classification of a given method as a means of euthanasia or humane killing may vary by circumstances. These acknowledgments are not intended to condone a lower standard for the humane termination of wildlife. The best methods possible under the circumstances must be applied, and new technology and methods demonstrated to be superior to previously used methods must be embraced.*

Multiple federal, state, and local regulations apply to the euthanasia of wildlife. In the United States, management of wildlife is primarily under state jurisdiction. However, some species (e.g., migratory birds, endangered species, marine mammals) are protected and managed by federal agencies or through collaboration between state and federal agencies. Within the context of wildlife management, personnel associated with state and federal agencies and Native American tribes may handle or capture individual animals or groups of animals for various purposes, including research. During the course of these management actions, individual animals may become injured or debilitated and may require euthanasia; in other cases, research or collection protocols dictate that some of them be killed. Sometimes population management requires the lethal control of wildlife species, and the public may identify and/or present individual animals to state or federal personnel because they are orphaned, sick, injured, diseased (e.g., rabid), or becoming a nuisance."

Animal welfare organizations are concerned that some methods used to manage wildlife damage expose animals to unnecessary pain and suffering. Research suggests that with methods such as restraint in foothold traps, changes in the blood chemistry of trapped animals indicate "stress." Blood measurements of fox indicate that this is the case for fox that have been held in traps (Gorajewska *et al*. 2015). The situation is likely to be similar for other animals caught in traps, snares, or chased by dogs.

The killing of predators during the spring months also has the potential to result in litters of coyotes, red fox, and badgers becoming orphaned. When WS-Colorado conducts aerial shooting activities during the April-June period, aerial shooting crews will sometimes kill one or both of a pair of coyotes that likely have a den of pups in the vicinity. WS-Colorado's field personnel typically search both from the air and on the ground in a concerted effort to locate the den in these cases in order to dispatch the pups, typically through the use of EPA-registered den fumigant gas cartridges. If the den cannot be located, pups may sometimes be fed and cared for by one or more members of a social group of coyotes associated with that den (Bekoff and Wells 1982). There are likely some cases where the killing of coyotes, red fox, or other predators may result in the orphaning of young animals that are still dependent on parental care. The only way to totally avoid this circumstance would be to refrain from conducting any predator removal efforts during this period of time. Unfortunately, this is also the period during which some of the most serious predation problems occur, such as coyotes killing young lambs to feed their pups (Till and Knowlton 1983).

Selectivity of wildlife damage methods is related to the issue of humaneness in that greater selectivity results in less potential suffering of non-target animals. Methods vary in their selectivity for non-target animals. The selectivity of each method is augmented by the skill and discretion of the WS Specialist applying the technique and by specific measures and modifications designed to reduce or minimize non-target captures. All WS-Colorado Specialists are trained in techniques to minimize the risk of capturing non-target wildlife.

Analysis of this issue must consider not only the welfare of the animals captured, but also the welfare of humans, livestock, and some T&E species if damage management methods are not used. For example, some individuals may perceive techniques used to remove a predator that is killing or injuring pets or livestock as inhumane, while others may believe it is equally or more inhumane to permit pets and livestock that depend upon humans for protection to be injured or killed by predators. Use of livestock guarding animals is commonly considered a humane management alternative, but in some areas, livestock guarding animals and dogs used to pursue mountain lions or black bears may also be injured or killed.

The challenge in coping with this issue is how to achieve the least amount of animal suffering with the constraints imposed by current technology. WS-Colorado personnel are concerned about animal welfare. WS-Colorado is aware that techniques like snares and traps are controversial, but also believes that these activities are being conducted as humanely and responsibly as practical. WS and the NWRC are striving to bring additional nonlethal damage management alternatives into practical use and to improve the selectivity and humaneness of management devices. Until

new findings and products are found practical, a certain amount of animal suffering could occur when some methods are used in situations when nonlethal damage management methods are not practical or effective. WS-Colorado supports the most humane, selective, and effective damage management techniques and would continue to incorporate advances into program activities. WS-Colorado Specialists conducting predator damage management are highly experienced professionals skilled in the use of management methods and committed to minimizing pain and suffering. WS Program Directives, SOPs, and training work to ensure that WS-Colorado's PDM methods are used in a manner that is as humane as possible and selective. Other practices which help to improve the efficacy, selectivity, and humaneness of WS-Colorado's use of PDM methods include implementing Trapping Best Management Practices where appropriate for PDM actions and complying with regulations on trap check intervals.

Wildlife Values and Ethical Perceptions of PDM

Ethics can be defined as the branch of philosophy dealing with values relating to human conduct with respect to the rightness or wrongness of actions and the goodness and badness of motives and ends (Costello 1992). Individual perceptions of the ethics of PDM and the appropriateness of specific management techniques depend on the value system of the individual. These values are highly variable (Schmidt 1992, Teel *et al*. 2002), but can be divided into some general categories (Kellert and Smith 2000, Kellert 1994 Table 3-10). An individual's values on wildlife may have components of various categories and are not restricted to one viewpoint. The tendency to hold a particular value system varies among demographic groups.

Views on ethics of wildlife management also often contain an emotional component that can be variable depending on location and species being considered, can change over time, or can be inconsistent (Haider and Jax 2007, Littin *et al*. 2004). Various types of viewpoints can influence ethics and value systems. For example, one major factor influencing value systems is the degree of dependence on land and natural resources as indicated by rural residency, property ownership, and agriculture or resource dependent occupations (Kellert 1994). People in these groups tend to have a higher tendency for utilitarian and dominionistic values. Socioeconomic status also influences wildlife values with a higher occurrence of naturalistic and ecologistic value systems among college educated and higher income North Americans (Kellert 1994). Age and gender also influence value systems with a higher occurrence of moralistic and humanistic values among younger and female test respondents (Kellert 1980, 1994).

A recent study by (George *et al*. 2016) replicated the research of (Kellert 1985) evaluating human uses and values toward animals. The study found that favorable ratings for predators (coyotes and wolves) had increased since the study by Kellert with positive attitudes towards these species increasing 47% and 42% respectively and that overall attitudes towards wildlife appeared to be shifting from more dominionistic and utilitarian values to more mutualistic values in which the wildlife are viewed as part of an extended family deserving of caring and compassion and wherein the value of predators in ecosystems is valued. This shift is consistent with success of recent ballot measures intended to improve animal welfare through regulation of domestic animal housing standards and legislation banning or placing severe restrictions on use of devices such as foothold traps.

Individual relationships with the species in question still appear to influence attitudes towards wildlife. For example, Treves (2013) found that public attitudes towards wolves may be increasingly negative among residents of areas occupied by wolves, especially those negatively impacted by wolves. Increasing urban residence has been increasingly associated with positive attitudes towards wildlife, and positive attitudes of this population likely outnumber opinions from more rural areas. However, like livestock producers in areas with wolves, attitudes of urban/suburban residents may be influenced by experiences in their area. George *et al*. (2016) noticed a decrease in positive attitudes towards raccoons and hypothesized that one of the potential reasons could be increased conflicts with raccoons (property damage, health and safety concerns) that are experienced in urban/suburban areas.

Many philosophies on human relationships with animals can be considered relative to ethical perceptions of PDM techniques. Some of the more prevalent philosophies are discussed here, although there may be others that influence wildlife management decisions.

One philosophy, animal rights, asserts that all animals, both human and nonhuman, are morally equal. Under this philosophy, no use of animals (for research, food and fiber production, recreational uses such as hunting and trapping, zoological displays, and animal damage management, etc.) should be conducted or considered acceptable unless that same action is morally acceptable when applied to humans (Schmidt 1989).

Another philosophy, animal welfare, does not promote equal rights for humans and nonhumans but focuses on reducing pain and suffering in animals. Advocates of this philosophy are not necessarily opposed to utilitarian uses of wildlife, but they are concerned with avoiding all unnecessary forms of animal suffering. However, the definition of what constitutes unnecessary is highly subjective (Schmidt 1989). In general, only a small portion of the U.S. population adheres to the animal rights philosophy, but most individuals are concerned about animal welfare.

A third philosophy takes the view that overpopulation of an animal species (whether natural, man-induced, or artificial) leads to increased animal suffering when the population suffers malnutrition, disease outbreaks of epidemic proportion, or populations crashes due to exceeding the environmental carrying capacity. Advocates for this approach suggest that it is man's obligation to manage animal populations in a manner that reduces potential suffering to a minimal level (Beauchamp and Frey 2011). Similarly, some individuals may feel that humans have a moral obligation to correct environmental impacts that result from the human introduction of invasive species or species which have become extremely abundant due to their ability to thrive in human-altered environments.

When evaluating issues relating to the ethics of conserving or controlling nature, another approach is to consider the reason for the action as the determination of whether the action is ethical or not. In this approach, one model involves assessing actions from the point of view of humans only (anthropocentric) or from a more general view of all living organisms (biocentric) that considers any harm to living creatures that can be avoided as immoral (Haider and Jax 2007). These approaches have been considered for conservation decisions, but could also be applied to PDM decisions such as those discussed in this EA.

A simple model for determining the ethics of a potential action proposes assessing whether the action is necessary, and whether it is justified. In this model, if "yes" is the answer to both questions, the action is ethical (Littin and Mellor 2005). Although the considerations relating to each of these questions may involve several factors, only the two basic questions need to ultimately be answered using this model.

Yet another approach developed a set of six major criteria that can be used to design a pest control program that is ethically sound (Littin *et al*. 2004). The six major criteria are:

1. The goals, benefits, and impacts of action must be clear.
2. The action should only be taken if goals can be achieved.
3. The most effective methods must be used to achieve goals.
4. The methods must be used in the best ways possible.
5. The goals must be assessed.
6. Once goals are achieved, processes should be in place to maintain results.

Using this model, an ideal project is one that follows all six criteria above (a "gold standard" project). If not all can be followed, an ethically sound pest control program can still be conducted if the project is conducted in a way that moves toward to the "gold standard". With unlimited funding and time available, achieving a "gold standard" project may be possible. The challenge in coping with this type of model is how to achieve the best project (as close to the "gold standard" as possible) with the least amount of animal suffering within the constraints imposed by current

technology and funding. The need for action is established in Chapter 1 of this EA. There are individuals who contest that the need for action is of sufficient scale to warrant management; however, state and federal agencies and elected representatives, have, through promulgation of regulations which permit the actions proposed in this alternative and allocation of funding to PDM, determined that there is sufficient need for action. Project objectives are established through consultation with cooperators. WS-Colorado uses the WS Decision model to select methods that are effective and appropriate for the given location. WS-Colorado personnel are trained in the safe and effective use of PDM methods, and the IWDM strategy and WS Decision model would be used to maximize program efficacy while also minimizing risk of adverse environmental effects. The WS Decision model includes project monitoring and ongoing revision of management actions as needed throughout the process. All WS-Colorado activities include consultation with cooperators on short-term strategies to address the problem and long-term approaches to reduce or eliminate the risk of recurring problems.

The issue of ethics is evolving over time (Perry and Perry 2008), but no one commonly-accepted standard in combination, may provide additional consideration of the ethics of a proposed action. WS has numerous policies, directives, and SOPs that provide direction to staff reinforcing the achievement of the most appropriate and effective wildlife damage management program possible. Many of these guidance documents incorporate aspects of the ethical considerations discussed above. Directives pertaining to WS' activities may be located using the WS home page at http://www.aphis.usda.gov/wildlifedamage.

4.1.6.1 Alternative 1 – Continue the Current Federal PDM Program.

Under Alternative 1, WS-Colorado would continue the current program of integrated and adaptive PDM, using the Decision Model, SOPs, and WS policies and directives. Alternative 1 would be unacceptable to Animal Rights advocates, individuals with strong humanistic and moralistic values, and to others with strong emotional or spiritual bonds with certain wildlife species. Some individuals assert that killing the offending animal is not the response of a moral or enlightened society. Response of other individuals and groups would vary depending on individual assessments of the need for damage management, risk to the target animal population, risk to non-target species and individuals, the degree to which efforts are made to avoid or minimize the pain and suffering associated with the various management techniques, and the perceived humaneness of individual methods. Increasing portions of the population showing mutualistic values (Georges *et al*. 2016) will be concerned regarding humaneness of individual method and potential for any level of lethal PDM to adversely impact predator populations and ecosystems.

Selectivity of PDM methods is related to the issue of humaneness in that greater selectivity results in less perceived suffering of non-target animals. The selectivity of each method is based, in part, on the skill and discretion of the WS-Colorado Specialist in applying such methods and also on specific measures and modifications designed to reduce or minimize non-target captures. The humaneness of a given WDM method is based on the human perception of the pain or anxiety caused to the animal by the method. How each method is perceived often varies, depending on the person's familiarity and perception of the issue. The selectivity and humaneness of each alternative are based on the methods employed and who employs them under the different alternatives. With the passage of Amendment 14, the pool of experienced private predator trappers is diminishing because recreational trapping is no longer allowed; this would increase the number of inexperienced trappers using PDM methods.

Schmidt and Brunson (1995) conducted a public attitude survey in which respondents were asked to rate a variety of WDM methods on humaneness (1=not humane, 5= humane) based on their individual perceptions of the methods. Their survey found that the public believes that nonlethal methods such as animal husbandry, fences, and scare

devices were the most humane, and that traps, snares, and aerial predator management were the least humane.

In comparison, under the No Federal Program Alternative, the federal portion of WS-Colorado would not employ methods viewed by some as inhumane and, thus, have no program effect on humaneness. However, CDA and CPW would probably still provide some level of hands on professional PDM assistance, but without federal supervision. They would continue to use the PDM methods considered inhumane by some, though perhaps at lower levels. Additionally, WS-Colorado personnel would no longer receive training from federal sources, nor would the program benefit from federal research focused on improved humaneness, selectivity, and non-lethal methods. Moreover, private individuals that have experienced resource losses, but are no longer provided professional assistance from WS-Colorado, would likely conduct lethal PDM on their own, and the use of foothold traps, snares, and shooting by private individuals would probably increase. This could result in less experienced persons implementing PDM methods such as traps without modifications like pan-tension devices that exclude smaller non-target animals. Increased take and suffering of both non-target and target wildlife would likely be the result. Therefore, it was concluded that the No Federal Program Alternative would result in the highest potential for negative PDM effects (WS 1997b, 1999a, 2001). Additionally, it is possible that frustration caused by the inability of resource owners to reduce losses could lead to the illegal use of chemical toxicants, which would result in increased animal suffering.

PDM methods used by private individuals may also be more clandestine. Members of the public that perceive some PDM methods as inhumane would be less aware of PDM activities being conducted by private individuals, because private individuals would not be required to provide information under mandatory policies or regulations similar to those applied to WS-Colorado. Thus, the perception of inhumane activities could be reduced, although the actual occurrence of PDM activities may increase.

Under the No Federal PDM Alternative, livestock predation rates would be expected to increase. Therefore, more domestic animals, including livestock and pets, would suffer inhumanely from injuries caused by predation than under the current program.

The ‘No Federal Program’ alternative would likely result in more negative impacts with regard to humaneness than the current program. The other alternatives analyzed in this EA were also analyzed in the previous EA (WS 2005b) and found to lie between the Current Program and No Federal Program Alternatives. These will not be discussed further, but are used as a factor to help determine the appropriate SOPs to maximize selectivity and humaneness.

4.1.6.2 Alternative 2 – No Federal PDM Program.

Under this alternative, WS-Colorado would not offer PDM, and methods viewed by some persons as inhumane would not be used by WS-Colorado. Thus, there would be no direct effect from the program on humaneness. Assuming some aspects of PDM for black bears or mountain lions would be responded to by CPW, there would be no change in humaneness. Private individuals would no longer receive training from WS-Colorado, nor would federal research efforts focused on improved humaneness, selectivity, and nonlethal methods be implemented into PDM in Colorado. Private individuals experiencing resource losses, who are no longer provided professional assistance from WS-Colorado, could conduct lethal PDM on their own. This could have the potential for increased and unnecessary pain and suffering to target and non-target species. Use of foot-hold traps, snares, and shooting by private individuals would probably increase. This could result in less experienced persons implementing PDM methods, such as traps, without modifications like the under pan-tension device that excludes smaller non-target animals. Greater take and suffering of non-target wildlife could result. It is hypothetically possible

that frustration caused by the inability of resource owners to reduce losses could lead to illegal use of toxicants. The illegal use of toxicants could result in increased animal suffering.

PDM actions taken by individuals would probably be less humane than with the federal program in Alternative 1 for other reasons. WS-Colorado is accountable to public input, and interest groups often focus their attention and opposition to PDM activities employed by WS-Colorado. PDM methods used by private individuals may be clandestine. The people that perceive some PDM methods as inhumane would be less aware of PDM activities being conducted by private individuals mostly because the private individuals would not be required to provide information under any policies or regulations similar to those followed by WS-Colorado. Thus, the perception of inhumane activities would probably be reduced, although the actual occurrence of PDM activities may increase.

Under this alternative, predation rates would be expected to increase above the current level. There would likely be an initial decline in PDM statewide in the early years of implementation of this alternative; therefore, more domestic animals, including livestock and pets, would suffer inhumanely from injuries caused by predators than under the current program.

Therefore, this alternative would likely result in more negative impacts with regard to humaneness than the predator damage without professional training and guidance, and more domestic animals would be killed or injured by predators.

This alternative may be more acceptable to animal rights activists and to a wider range of animal welfare on incomplete information because the public, agencies, and tribes would no longer have access to data on the full magnitude of PDM actions in the state. Use of lethal methods would persist but agencies and tribes would have less information to use to monitor cumulative impacts on target and non-target species population and ecosystems. Livestock producers and others who receive services from WS-Colorado would likely perceive this alternative as an unethical restriction of their access to legally available PDM techniques from professional, accountable WS-Colorado Specialists. They may perceive this alternative as an imposition of additional costs of livestock production, resulting in unacceptable losses. People concerned about the use of public resources to reduce damage (*e.g.*, enhance profits) on private and public lands may find this alternative preferable to Alternative 1, primarily because no federal tax money would be used to fund PDM to support livestock producers using public lands or to increase the abundance of popular wildlife species (*e.g.*, mule deer, Gunnison sage grouse) on public and private lands.

4.1.6.3 Alternative 3 – Technical Assistance Only.

Under this alternative, WS-Colorado would provide only technical assistance to people who request assistance with predator damage. This includes verbal or written consultation on alleviating predator damage management in a variety of manners, such as animal husbandry, animal behavior modification, and habitat management, lethal and non-lethal tools. However it would be up to the person receiving the information to choose a strategy and implement it. Private individuals experiencing resource losses, who are no longer provided operational assistance from WS-Colorado, could conduct lethal PDM on their own even without receiving technical assistance from WS-Colorado. This could increase the potential for unnecessary pain and suffering to target and non-target species. Use of foot-hold traps, snares, and shooting by private individuals would probably increase under this alternative. This could result in less experienced persons implementing PDM methods, such as traps, without modifications like the under pan-tension device that excludes smaller non-target animals, or not using modern traps that meet BMP humaneness standards. Greater take and suffering of non-target wildlife could result. It is hypothetically possible that frustration caused by the inability of resource

owners to reduce losses could lead to illegal use of toxicants. The illegal use of toxicants could result in increased animal suffering.

PDM actions taken by individuals would probably be less humane than when implemented by WS-Colorado in Alternative 1 for other reasons. WS-Colorado is accountable to public input, and interest groups often focus their attention and opposition to PDM activities employed by WS-Colorado. PDM methods used by private individuals may be clandestine. The people that perceive some PDM methods as inhumane would be less aware of PDM activities being conducted by private individuals mostly because the private individuals would not be required to provide information under any policies or regulations similar to those followed by WS-Colorado. Thus, the perception of inhumane activities would probably be reduced, although the actual occurrence of PDM activities may increase.

Under this alternative, predation rates would be expected to increase above the current level. There would likely be an initial decline in PDM statewide in the early years of implementation of this alternative; therefore, more domestic animals, including livestock and pets, would suffer inhumanely from injuries caused by predators than under the current program.

Therefore, this alternative would likely result in more negative impacts with regard to humaneness than the current program. This is primarily due to the fact that more private individuals would attempt to alleviate predator damage without professional training and guidance, and more domestic animals would be killed or injured by predators.

This alternative may be more acceptable to animal rights activists and to a wider range of animal welfare advocates because WS-Colorado would not be operationally involved in PDM. However, this perception may be based on incomplete information because the public, agencies and tribes would no longer have access to data on the full magnitude of PDM actions in the state. Use of lethal methods would persist but agencies and tribes would have less information to use to monitor cumulative impacts on target and non-target species population and ecosystems. Livestock producers and others who receive services from WS-Colorado would likely perceive this alternative as an unethical restriction of their access to legally available PDM techniques from professional, accountable WS-Colorado Specialists. They may perceive this alternative as an imposition of additional costs of livestock production, resulting in unacceptable losses. People concerned about the use of public resources to reduce damage (*e.g.*, enhance profits) on private and public lands may find this alternative preferable to Alternative 1, primarily because no federal tax money would be used to fund PDM to support livestock producers using public lands.

4.1.6.4 Alternative 4 – Lethal PDM Methods Used Only for Corrective Control.

The amount of suffering by target and non-target wildlife under this alternative would initially be less than under the proposed action because fewer animals would be taken if proactive preventive activities by WS-Colorado were allowed. However, private individuals would increase their use of foot-hold traps, snares, and shooting for preventive control activities where producers feel WS-Colorado could not resolve a damage problem in a timely manner because nonlethal control measures needed to be implemented first. However, private individuals would not be allowed to use these methods on public lands due to Amendment 14 to the Colorado Constitution. Currently, no private aerial predator management is conducted in Colorado. Aerial predator management under this Alternative may increase, but it is unlikely to increase to levels similar to Alternative 1, because it is not allowed on public lands by private individuals. Lack of preventive predation management with aerial predator management may also result in increases in WS-Colorado's use of traps and snares for corrective PDM and associated risks to non-target species. Suffering of livestock because of injuries caused by predation would likely increase under this alternative because PDM actions by WS-Colorado could not be

implemented until after the onset of depredation and after nonlethal methods were proven insufficient. Use of these methods is limited to 30 days per year under Amendment 14 to the Colorado Constitution, and if the livestock depredation issues were not resolved during this period, livestock suffering would continue due to ongoing predation.

Alternative 4 would still be unacceptable to animal rights advocates and many individuals because it permits lethal removal of predators and because of the risks associated with likely increases in use of traps and snares. However, a larger number of animal welfare advocates would find this alternative more acceptable than the current program because it provides an assurance that predators would not be killed unless a nonlethal alternative has been tried. Livestock producers may perceive this alternative as an unjustified imposition of additional costs of production, and potentially, additional losses to resource owners may be borne (since most livestock producers already implement some form of nonlethal protective measures and need assistance when those have failed). Individuals concerned about the use of public resources to enhance private profit are unlikely to perceive this alternative as an improvement over Alternative 1.

4.2 SUMMARY AND CONCLUSION

The Current Program (Alternative 1) has the lowest overall negative environmental consequences, combined with the highest positive effects. It is therefore the Preferred Alternative (Table 27). Impacts associated with the activities analyzed in this EA are not expected to be "significant" under this Alternative. Based on the analysis in this EA, impacts of the PDM methods and strategies utilized in the Current Program are very limited. The addition of those impacts to other associated impacts of past, present, and reasonably foreseeable future actions would not result in cumulatively significant environmental impacts. All PDM activities that may take place will comply with relevant laws, regulations, policies, orders, and procedures (including the ESA, Migratory Bird Treaty Act, and FIFRA). This EA will remain valid until WS and other appropriate agencies determine that new actions or new alternatives, having substantially different environmental effects, must be analyzed; or until changes in environmental policies, the scope of the PDM Program, or other issues trigger the need for additional NEPA analysis. This EA will be reviewed periodically for its continued validity, including regular monitoring of the impacts of WS-Colorado PDM activities on populations of both target and non-target species.

Table 30. Summary of the environmental consequences of each Alternative relative to each Issue.

Issue #	Issue Description	Alternative 1 Current Program	Alternative 2 No Federal Program	Alternative 3 Nonlethal Only	Alternative 4 Lethal for Corrective Only
1	Target Species: Coyote	0	0	0	0
	Target Species: Red Fox	0	0	0	0
	Target Species: Striped Skunk	0	0	0	0
	Target Species: Raccoon	0	0	0	0
	Target Species: Black Bear	0	-	-	0
	Target Species: Mountain Lion	0	-	-	0
	Target Species: Other	0	-	-	0
2	Nontarget Species	0	- - / 0	- - / 0	- / 0
	T&E Species	- / + +	- - / 0	- - / 0	- / +
3	Public Safety	- / +	- -	- -	-
4	Hunting, Recreation and Fur Harvest	0	0	0	0
5	Impact on Public Lands	- / +	- -	- -	-
	SMAs	0	-	-	0
6	Humaneness	0	-	-	-

Definition of Impacts: "- -" = highly negative; "-" = slightly negative; "0" = no impact; "+" = slightly positive; "+ +" = highly positive.

CHAPTER 5 RESPONSE TO COMMENTS PROVIDED DURING PUBLIC COMMENT PERIOD

1. **The EA failed to consider and alternative where fewer animals are killed.**

   The EA analyzed several alternatives where WS may take fewer animals, including a No Federal WS PDM program (Alternative 2), a Technical Assistance Only Alternative (Alternative 3), and to some extent, the Corrective Control Only when Lethal PDM Methods are Used (Alternative 4). While WS may take fewer animals under all of these alternatives, WS believes that after a period, non-WS entities will largely fill the void left by WS or WS will be asked to conduct additional corrective control (under Alternative 4). While some of WS's methods, such as M-44s, would not be available to non-federal entities, others, such as trapping and shooting, may be used more prolifically to compensate for the lack of the more effective methods. WS does not have any authority to permit or restrict other entities from taking the species that are included in this analysis.

2. **EA failed to consider climate change.**

   Climate change is discussed in section 2.3.12 of the EA.

3. **More analysis of compensation for predator loss should have been considered – would compensation reduce the need for ranchers to use lethal control, how many producers receive compensation, does the presence of compensation for bear and lion losses cause false claims of depredation for money?**

   WS discussed compensation programs in Section 3.2.1 of the EA. Because Wildlife Services has no authority to implement a compensation program, additional analysis is outside the scope of the Purpose and Need of the EA. The EA does discuss a reduction in take resulting from less WS-involvement under Alternative 2,

   While WS cannot implement a compensation program, compensation programs actually decrease incentives to livestock producers to limit predation by implementing non-lethal/preventative management methods, instead sacrificing livestock to carnivores for money. The State of Colorado does not reimburse damage caused by coyotes or bobcats. As the EA states, CPW may reimburse ranchers for bear and mountain lion damages, but that does not mean the offending animals will not subsequently be captured to prevent them from causing more claims. CPW may opt to deny a claim if it cannot be sufficiently substantiated, so WS-Colorado does not have a reason to believe that the reimbursement program results in false claims. In FY15, CPW provided compensation for 279 claims of property/pets/livestock/agriculture damage by game species, totaling $987,754, which is a 28% increase over the previous 5-year average. CPW attributes this to increasing bear damage. Additional information on CPW's Game Damage Program can be found by contacting CPW or at http://cpw.state.co.us/aboutus/Pages/GameDamage.aspx.

4. **The EA lacks a cost: benefit analysis on any level. Livestock losses are low and a PDM program is not warranted.**

When identifying site specific strategies for use by the cooperator, WS employees take into consideration factors such as the cost of implementing the method relative to factors such as the size of the operation, magnitude of the conflict and likelihood that the incident will recur. However, the cost of management may sometimes be secondary because of overriding environmental, legal, public health and safety, animal welfare or other concerns.

WS-Colorado has had an effective PDM program in place for decades. Therefore, livestock losses in Colorado are the losses that occur with this PDM program in place and losses are expected to be low. Furthermore, livestock producers generally do not wait for losses to accumulate to a high level before taking PDM action before requesting assistance from WS-Colorado or other entities, but often, for the protection of the livestock under their care, attempt to act before such losses become unacceptable. The reports of livestock losses in the EA do not reflect the losses that might have occurred had actions not been taken to limit losses

Comparisons of livestock losses to existing program costs in a system with an ongoing PDM program are not a valid measure of the efficacy of the PDM program. The issue is not the amount of PDM that occurs, but the level of loss prevented. Predicting the level of loss that might have occurred in the absence of a PDM program is challenging. Few producers are willing to allow predation to occur without responding, even if losses are compensated. Past studies that have attempted to assess losses in the absence of a PDM program have exceeded the level of compensation funding which precipitated a change in the experimental design of the projects (O'Gara et al. 1983).

5. **Cumulative effects were not analyzed, including effects of the PDM program including other wildlife damage management in the state, prairie dog damage management.**

The EA analyzed Cumulative Effects for each target species and each Issue Considered for Comparative Analysis. These analyses are in Chapter 4 of the EA. Prairie dog management is not included in this EA because prairie dogs are not predators.

6. **WS should provide site specific analysis of PDM in each area of the state (ecological zones, regions, SMAs) and provide take for each area to better describe the program.**

The issue of site specific analysis is discussed in Section 1.6.4 of the EA. Lead agencies have the discretion to determine the geographic scope of their analyses under the NEPA (CEQ 1508.25).

7. **EA fails to consider value of coyotes to ranchers because they eat animals such as jackrabbits that compete with cattle for food. One coyote eats enough jackrabbits to provide food for 2 cattle per year. Cattle sell for $800-$2,200. This financial impact should be considered.**

Jackrabbits are an important part of coyote diets, but not the only food item eaten so the calculations above likely overestimate the total impacts of coyote predation in terms of jackrabbits removed per year. Although coyotes are a primary predator for jackrabbits, other predator species in the EA's proposed project area also eat jackrabbits including mountain lions, bobcats, and various raptors (McAdoo and Young 1980). These predators may increase their take of jackrabbits in response to an increase in abundance resulting from the removal of coyotes, which may balance the impacts of coyote removal.

Additionally, because of the nature of coyote population dynamics, areas where coyotes are removed are relatively quickly re-colonized by new individuals (non-territorial individuals from the surrounding area) with reductions resulting from anticipated Colorado PDM activities not expected to last more than in one year. As noted in the Chapter 4 analysis of impacts on target species and ecosystems, the short-term, localized reductions in coyote abundance would not be of sufficient magnitude or duration to result in substantive shifts in prey populations and ecosystem function. Consequently, overall impacts on available forage are expected to be very low. WS-Colorado has received no requests for assistance with jackrabbit damage of any sort at least as far back as fiscal year 2004, which is strong evidence that, even with the current levels of PDM, jackrabbits populations have not been exacerbated as a result of the ongoing PDM activities within Colorado.

8. EA should consider impacts to riparian areas from increased ungulate grazing that results from PDM, as cited in Betcha and Ripple 2006.

The EA considered in Section 4.1.2.1d. WS-Colorado determined the situation presented in Betcha and Ripple 2006was not analogous to WS-Colorado's PDM due to the very long term and intensive population reduction in the study, which is not present in Colorado.

9. Public land grazers should not get government subsidized PDM because public grazing is already heavily subsidized. WS should end grazing on public lands.

Determinations to allow livestock grazing on public lands and the manner in which livestock grazing is managed on public lands have been made by Congress and State legislatures, and the applicable State and federal land management agencies, and not WS. WS lacks jurisdiction to allow or to prohibit livestock grazing on public lands. Because it has no ability to control that livestock grazing, NEPA's rule of reason does not require WS to analyze the impacts of livestock grazing as a connected action. Environmental impacts of livestock grazing on federal lands is already addressed by the applicable land management agency and is not relevant to this EA, as grazing on public lands is under the jurisdiction and authority of the relevant land management agency.

We understand that there is opposition to the use of federal land for livestock grazing, and that any associated lethal PDM may be more unacceptable. In authorizing WS to assist in resolving conflicts with wildlife and through allocation of funds for PDM, Congress has made the policy decision that PDM, including the actions proposed in this EA, is an appropriate sphere of federal action, and therefore provides appropriated funds to be used in addition to funds received from the cooperator requesting the assistance. Similarly, state and local government entities have also determined that funding the WS-Colorado PDM program was an appropriate allocation of public resources. WS understands that some people oppose Congress's funding priorities and decisions. WS also understands that some people oppose lethal PDM and that use of public funds for an activity they find unnecessary and morally reprehensible. As with many other issues relative to PDM, perspectives on this issue differ depending on the values and experiences of the individual. In contrast to some people's opposition to the PDM

activities, other individuals contend that the United States is responsible for assisting when damage by the public's wildlife adversely affects private property.
As noted above, The Federal Land Policy and Management Act of 1976 (Public Law 94-579; 94th Congress) provides federal policy on federal lands, including the BLM and DOI (FS), to include livestock grazing. 16 USC § 528 states, "It is the policy of the Congress that the national forests are established and shall be administered for outdoor recreation, *range*, timber, watershed, and wildlife and fish purposes . . . ." (Emphasis added). Congress has already decided that livestock grazing on public lands is one use among many for those lands.

WS does not subsidize livestock production nor does WS pay compensation for livestock losses. The role WS serves is to assist the American public (i.e., not just livestock producers, but the greater agricultural community, state and federal agencies, private and public organizations, educational centers, tribes, and the general public) to resolve conflicts that arise with wildlife, which are a publicly-owned resource. WS serves to provide federal leadership in resolving these conflicts and is publicly accountable for the work that is performed (e.g., all activities are summarized and made available to the public via the WS website, activities are inspected by the Office of Inspector General when they receive allegations of wrongdoing and whose findings are made available to the general public, and WS makes all planning decisions that are founded through the National Environmental Policy Act processes). The EA addresses cumulative effects of PDM along with grazing in Section 2.3.5 of the EA. Issues of whether or not livestock grazing on public lands is or should be subsidized are outside the scope of this EA.

10. EA does not address compensatory reproduction or efficacy of the PDM program.

The EA addresses compensatory reproduction in Section 2.3.4 of the EA.

WS has carefully reviewed publications cited by the commenter and determined that they do not demonstrate ineffectiveness of lethal control. Berger (2006) was discussed in Section 2.3.12. The study documented that some factors, including market price of lambs have greater impact on the sheep industry as a whole than costs associated with predation on livestock. The study does not provide information on the efficacy of lethal methods for individual producers who are experiencing damage.

The Bergstrom et al. (2013) (references by the commenter) has limited utility relative to the analysis in the EA. Bergstrom et al. (2013) mistakenly asserts that long-term reduction of predator populations is the goal of all modern PDM programs. Under this premise, Bergstrom et al. (2013) contend that WS lethal removals of predators are ineffective because they are not of sufficient intensity to cause long-term population reductions. As stated throughout the EA, the goal of WS-Colorado PDM actions is to reduce damage, not to cause long-term reductions in native predator populations. The EA addresses efficacy throughout the analysis, for methods and alternatives, and the Bergstrom article does not alter the agency's determination that the integrated PDM program implemented by WS-Colorado is effective. Because Bergstrom et al. (2013) addresses the long-term reductions in predator populations, while the purpose and need of

the EA, and the proposed alternatives, specifically contemplate short term reductions with impacts lasting less than one year, the Bergstrom et al. article is inapposite.

The Peebles et al. (2013) and Lambert et al. (2006) articles are also irrelevant to the analysis in the EA because they focus on sport hunting. WS-Colorado does not practice, and does not advocate, sport hunting as a method to reduce mountain lion predation on livestock, so these articles are inapposite (Peebles et al. 2013) concludes that sport hunting is ineffective to reduce mountain lion predation on livestock. Sport hunting is less focused on the individual animal than targeted PDM by WS-Colorado. When used to reduce wildlife conflicts, sport hunting (as evaluated by Peebles et al. 2013) is generally intended to reduce local or regional wildlife populations. In contrast, WS-Colorado very rarely conducts lethal removal of mountain lions (FY 2011-14 average < 4 per mountain lions year), and then only to remove the specific individual(s) addressed in the conflict. Similarly, Lambert et al. (2006) also focuses on sport hunting when they evaluated the relationship between mountain lion complaints and mountain lion population size and concluded that an increase in complaints was not necessarily an indicator of an increasing mountain lion population. Changes in population age and sex structure resulting from hunting was only one of several hypotheses presented by the authors for the increase in conflicts with cougars. However, as with Peebles et al. (2013), the primary factor driving the shift in the lion population was extensive sport hunting. Data in EA Section WS take of mountain lions ranged from 1 to 7 lions per year in contrast to 467-564 mountain lions per year by hunters. Future take of mountain lions for damage management by WS-Colorado is not anticipated to change substantially from past levels presented in the EA. Therefore, the proposed mountain lion take by WS-Colorado is not of sufficient magnitude to cause or contribute substantively to populations trends resulting from licensed hunting managed by the IDFG and will not result in an increase in conflicts with mountain lions.

WS-Colorado acknowledge that no one method, nonlethal or lethal, will be effective at all times or suitable for all situations. This is the primary reasoning behind WS' advocacy of Integrated Wildlife Damage Management alternatives that give preference to practical and effective nonlethal methods while still allowing access to the full range of legally-available PDM methods. Field personnel use the Decision Model (Slate et al. 1992, WS Directive 2.201) to determine the best approach to responding to or minimizing the potential for livestock losses and can develop effective site-specific management strategies that resolve conflicts while also minimizing risks of adverse impacts on the human environment.

Commenters also asked WS-Colorado to consider Wielgus and Peebles (2014), Harper et al. (2008), and Musiani et al. (2005). These studies are all specific to wolf damage management which is outside the scope of this EA. Nonetheless, we did review these studies for information which might be applicable to PDM as proposed in this EA. We have determined that all three studies are not of utility in assessing the efficacy of PDM actions conducted by WS-Colorado primarily because of disparities in the scale of the analysis and the scale of the intended impacts of PDM actions conducted by WS. Specifically, all three studies analyze impacts of wolf damage management actions at the regional scale. Use of lethal methods to reduce damage by and conflicts with predators as currently conducted and proposed by the WS program is primarily intended as a short-term strategy to reduce depredations at the specific locations where the conflict occurs. Given behavior of mammalian predators and the targeted nature of the management effort, these removals are not intended or expected to have regional-level impacts on

livestock losses (Bradley et al. 2015). Additional problems with study design, data analysis and findings of Wielgus and Peebles (2014) have also been identified during review by the NWRC (Memo from J. Young NWRC to J. Suckow, WS Western Regional Director, 8 July 2015). Difficulties with the analytical process used by Wielgus and Peebles (2014) were also identified by Poudyal et al. (2016). Consequently, we did not use findings from Wielgus and Peebles (2014) in the analysis.

11. Are predator removal studies illegal due to the trap ban and ban on spring bear hunts?

The studies are not illegal, and are, in fact, backed by both CPW and USFWS. It is legal for anyone to get a 30-day permit and trap on private lands to alleviate wildlife damage. WS-Colorado can use foot snares and culvert traps to live capture bears and lions on public or private lands. No permit is required for this based on guidance by CPW and the Colorado Department of Agriculture.

12. Predators should not be managed to protect game species.

Determinations of the need for PDM to enhance game species populations are made by CPW after consideration of habitat quality, climate, historic data for the populations, and other biological factors. When CPW sets population management objectives, objectives are set to be within historic norms and carrying capacity of the local environment. Therefore, efforts to assist CPW in restoring game species populations to target levels would, in essence, be restoring the environmental status quo and would not have significant environmental impacts.

13. Humanness should be discussed in detail.

Humanness and Ethical Perspectives are discussed in detail in Section 2.2.6, 3.3.2.6, and 4.1.6 of the EA.

14. WS should have a 24 hour trap check policy.

WS-Colorado has a 24 hour trap check policy for areas identified by USFWS for wolf protection.

WS strives to minimize the interval between trap checks to the maximum extent practicable under current circumstances. Due to logistical reasons, WS-Colorado's ability to assist cooperators would be substantially reduced if WS were required to adhere to a 24-hour trap check interval. On average, each WS-Colorado field employee is responsible for addressing the wildlife conflicts within nearly a 3,000 square mile area. Conflicts that arise may occur throughout that area, necessitating a lot of travel time to monitor equipment and to meet with cooperators to discuss new conflicts and possible solutions that do not require the placement of traps and snares. When necessary, the employee will place the minimum number of traps and/or snares necessary to resolve the conflict to keep their set equipment inventory minimized at any one time, most often less than 30 sets collectively throughout their area of responsibility. Also, the use of traps and snares are used about 4-5 months of the year in late winter or early spring and again in the fall.

WS works to reduce trap check intervals in remote areas through coordination with landowners, managers and herders to check traps when a WS employee cannot be present and research into the use of monitoring devices that notify WS employees when a trap has been triggered or an animal has been animal captured. Captured animals are often dispatched by the individual checking the equipment in the same fashion that WS dispatches animals. In doing so, most equipment is monitored and checked daily and traps will be checked every 3 days or less. However, data on trap checking by cooperators is not recorded in the MIS database. When delays in excess of 72 hours occur, delay is usually the result of emergencies, such as wildfires and weather (washed out access roads) and other events that may occur with little or no notice which prevent access to the site.

15. Does EA misrepresents public concern about humaneness when it addresses the idea of public concerns about "unnecessary pain"?

We understand that some members of the public consider any action which results in any level of pain or distress to an animal is unilaterally unacceptable. However, based on surveys showing that the public has a sliding scale relative to perceptions of the acceptability of PDM methods such as trapping, we do believe that the idea of "unnecessary pain" means different things to different people. For example, Jonker et al. (2009) documented that public acceptance of lethal methods increased as severity of beaver damage in Massachusetts was perceived to increase. In a survey of Colorado residents by Manfredo et al. (1999) the majority of respondents agreed that trapping was acceptable to prevent disease and to protect livestock, but unacceptable on the basis of providing recreation or making money.

16. WS employees don't report activities accurately.

All WS personnel are required to accurately report their field activities and technical assistance work they conduct while on official duty in the MIS including take of target and non-target animals (WS Directive 4.205). WS supervisors are required to review work tasks for accuracy and to monitor: 1) compliance with rules and regulations for the use of pesticides and other special tools and methods and 2) adherence to permits, regulations, laws and policies pertaining to WS actions. The 2015 report on the USDA Office of Inspector General Audit of the WS predator damage management program looked at the predator damage management program and transparency, among other issues. The audit concluded that WS was generally in compliance with all applicable laws. Of almost 30,000 entries in the management system, 98% were correct with discrepancies of 2% identified including both under- and over-reporting of take. Wildlife Services is committed to addressing OIG recommendations intended to reduce discrepancies.

17. EA should consider biodiversity and ecosystems, specifically trophic cascades and mesopredator release.

Section 4.1.2.1j of the EA addressed biodiversity and effects on ecosystems, while Section 4.1.2.1k addressed effects on trophic cascades, including mesopredator release.

18. WS is allowed to take 4 wolves per year based on an out dated (2004) Biological Opinion (BO), and took 3 wolves in Colorado recently. The BO is outdated and should be updated.

This is an incorrect statement. WS-Colorado has no BO that allows the take of any wolves, and WS-Colorado has not taken any wolves in at least the last 50 years. WS-Colorado has a new BO (2016) that includes provisions for wolf protection and USFWS has concurred that WS-Colorado is not likely to adversely affect grey wolves. The EA addresses measures to prevent take of T&E species in section 3.3.2.2a of the EA.
As prescribed in the EA and BA, in the event that WS personnel sight a wolf or find evidence that indicates their likely presence, such as scat or tracks, WS-Colorado will initiate mitigation measures recommended by the USFWS Wolf Recovery Team. Within the area where wolves or verified sign has been found and documented by WS-Colorado personnel, M-44s and neck snares will not be used, and foothold traps and leg-snares will be checked daily. WS-Colorado will implement further conservation measures by conducting no aerial predator damage management from September 1 to November 30 in areas where gray wolves are known to occur, converting to break-away body snares with stops that are checked daily, use thermal imagers or night vision when calling and shooting coyotes at night in areas where wolves are known to occur, and use sirens or calls that make prospective depredating coyotes howl or call back prior to calling and shooting coyotes in an area where wolves are known to occur. In addition, the USFWS Wolf Recovery Team will be notified. WS may assist the Wolf Recovery Team in trapping the wolf so that it can be examined.

19. WS provides services for free and this incentivizes ranchers to allow livestock to be killed.

WS-Colorado does not provide assistance for "free". A combination of federal, state, and/or cooperative dollars are used to support producers. In some cases, producers pay into a larger organization that in turn, pays WS-Colorado to support its constituency.

20. Lead should be analyzed for effects on raptors and scavengers.

The EA discusses effects of lead in several section, including Section 4.1.2 where effects on non-target species, including raptors and scavengers are addressed.

21. Wilderness Act does not authorize grazing.

The commenter is incorrect. Section 4(d)(4)(2) of the Wilderness Act states: ***Water resources and grazing. (4)*** *Within wilderness areas in the national forests designated by this Act, …* ***(2)*** *the grazing of livestock, where established prior to September 3, 1964, shall be permitted to continue subject to such reasonable regulations as are deemed necessary by the Secretary of Agriculture.*

22. WS should use non-lethal methods and host seminars on their use. Non-lethal methods should not only be applied by the landowner.

WS does use and recommend non-lethal methods and does host seminars to teach about their use. However, some non-lethal methods are left to the producer to use because of the nature of the method. For example - penning animals at night is a technique implemented by ranchers, and one that WS is not equipped or staffed to do. Fencing is another example of a non-lethal method that WS does not directly implement, but rather, advises landowners on, as WS employees are not trained in fence installation. Producer implementation of non-lethal methods helps reduce the cost of PDM, and may solve the problem entirely.

23. Washington state requires non-lethal control before lethal control can be used, and this is the correct way to conduct PDM.

Washington State only requires non-lethal methods before lethal methods in wolf depredation activities. It does not require such steps in damage situations involving any of the species that WS-Colorado is proposing to manage in this EA.

24. There should be a loss of 1% off the livestock inventory to predators before WS can use tax dollars to use lethal PDM.

Establishing a threshold of loss before money can be spent on PDM was considered in Section 2.3.1 of the EA and determined not to be a viable alternative because WS has a legal responsibility to respond to requests for PDM and it is program policy to aid requestors to minimize losses.

25. WS should conduct an EIS for Colorado and a new national PEIS.

We do not agree that an EIS is needed. WS-Colorado's proposed action will not result in widespread reductions in predator populations. Data presented in Chapter 4 and analyses of impacts on target predator populations, non-target species and ecosystems for each of the alternatives indicate that WS actions only involve a small portion of the land within the state and that impacts of WS-Colorado predator removals is within the sustainable harvest threshold for target species. Population reductions, particularly of coyotes, which are subject to the most intensive removal, will be localized and would only persist for a year or less before immigration, compensatory mortality and births among remaining animals restore populations to pre-removal levels (4.1.1.1a). Reasons for the scope of the analysis are as presented in Section 1.6. This EA emphasizes substantive issues as they relate to specific areas whenever possible. However, the issues that pertain to predator damage and resulting management are the same, for the most part, wherever they occur, and are treated as such. We have determined that a more detailed and more site-specific level of analysis would not substantially improve the decision-making process and pursuing a more site-specific and more detailed analysis might even be considered inconsistent with NEPA's emphasis on reducing unnecessary paperwork (Eccleston 1995). In terms of considering cumulative effects, one EA analyzing impacts for the entire State of Colorado provides a more comprehensive and less redundant analysis than multiple EAs covering smaller areas. WS-Colorado's determination to prepare an EA is consistent with APHIS NEPA implementing regulations (7 CFR Part 372) specifying the types of actions normally requiring an EA, but not necessarily an EIS.

One of the decisions to be based on this analysis is the determination of whether the proposed action or the other alternatives could potentially have significant direct, indirect or cumulative impacts on the quality of the human environment that would warrant the preparation of an EIS. If WS-Colorado makes a determination through this EA that the proposed action or the other alternatives could have a significant impact on the quality of the human environment, then WS-Colorado would publish a notice of intent to prepare an EIS and this EA would be the foundation for developing the EIS.

Regarding the comment that APHIS must prepare a new national PEIS, in the 22 years since the PEIS Record of Decision was issued, APHIS-Wildlife Services has initiated the phase out of any reliance on the 1994 PEIS. Today, most of APHIS-Wildlife Services

National Environmental Policy Act ("NEPA") documents are not tiered to the PEIS. No new APHIS-Wildlife Services NEPA documents signed after the date of this Notice will be tiered to the 1994 PEIS. This EA is not tiered to the 1994 PEIS. In the future, APHIS-Wildlife Services intends to revise or redo all of its NEPA documents that are currently tiered to the 1994 PEIS.

26. WS should consider a new Alternative: "The Humane and Public Accountability Alternative" (so named by the commenter). This alternative includes (1) the preparation of a new National PEIS, (2) asks WS to end use of "inhumane" management techniques immediately, including M44s and compound 1080, end DRC 1339 w/in 5 years, phase out all toxicants and poisons, immediately end aerial gunning, and says that all traps should be phased out over 5 years. It also (3) calls for WS to adopt a conservation mandate to ensure health of ecological communities, (4) require employees to document all activities, (5) and remove all financial incentive to kill.

(1) The preparation of an EIS and PEIS was addressed in the previous response.
(2) The humanness of WS methods are discussed in detail in Section 2.2.6, 3.3.2.6, and 4.1.6 of the EA.
(3) The items details in the commenters requires for a "conservation mandate" are already addressed in the EA. As WS-Colorado will not have a significant impact on any part of the human environment, and WS is already meeting the intent of the conservation mandate through the use of the Decision model and the SOPs detailed in the EA.
(4) Employees are already required to document all activities and take, and the 2015 Office of Inspector General report on their review of WS program operations found no problems with wildlife damage management activities or with WS' system for tracking controlled materials, and that WS' actions in these areas complied with all applicable federal and state laws and regulations (OIG 2015)
(5) The call for WS to stop charging for PDM because it would "reduce the incentive to kill" is deeply flawed. WS does not "develop markets" nor does it create programs "insulated from higher levels" to increase business, as the commenter claimed. WS is authorized by statute to enter into agreements with other entities, and it would not be able to meet its mandate to provide assistance if it did not charge a fee for service, and groups opposed to PDM usually prefer that cooperators pay for their PDM services instead of tax dollars being used.

The general idea behind the proposed alternative is to remove all tools and funding from PDM, essentially ending WS's involvement in PDM. This is what is proposed as Alternative 2 in the EA – the No Federal PDM Alternative where WS would not conduct any PDM, lethal, non-lethal, or provide technical assistance. The new alternative, as provided by the commenter, is not based on any new or additional science that shows that non-lethal, free programs can be effective at solving predator damage, and WS has considered the provided literature and found nothing that affects that analysis in the EA.

27. WS should adopt an assessment tool for animal welfare based on Sharp and Saunders 2008 and 2011, instead of relying on the Decision Model.

The Decision Model, as described and used by WS, is not a tool for assessing humaneness. The Decision Model is used to determine and evaluate PDM strategies.

WS-Colorado discusses and analyzes Humaneness in the EA separately in Sections 3.3.2.6 and 4.1.6.

28. WS does not disclose target take.

WS-Colorado provided take data for target and non-target species in Chapter 4 of the EA. WS also annually published Program Data Reports and makes those available on its website. Those reports detail WS's activities for every state program in the US.

29. WS releases non-targets even if they cannot survive due to injury.

This is an untrue statement. The EA addressed what WS Specialist do when the animal's health is in question. Specifically, "Non-target animals captured in foot-hold traps or foot snares are released at the capture site unless it is determined by WS-Colorado Specialists that the animal is not capable of self-maintenance" in Section 3.3.2.1 of the EA.

As noted in the EA, death and unintentional capture and release of non-target animals by WS-Colorado is very low. WS-Colorado personnel take careful note of the condition of captured non-target animals including responsiveness, and injuries. If the WS employee determines the animal is not likely to survive upon being released, it is euthanized on site. Not all animals released will die later, although the possibility of some capture mortality always exists with any live capture of wildlife. However, given the small number of non-target animals captured and released any mortality which may occur is not of sufficient magnitude to individually or cumulatively adversely impact target species populations.

30. Literature submitted indicates that this level of killing has contributed to the localized extinction of many North American species and has fundamentally altered ecosystems.

We have reviewed the literature submitted, and we do not agree. Impacts resulting from the removal of the individual animals as discussed in this EA indicates the proposed action will not result in significant alterations of target or non-target species populations, ecosystems, biodiversity, trophic cascades or ecosystem stability.

31. EA cannot tier or rely on the 1994 Programmatic EIS.

The EA does not tier to or rely on the 1994 PEIS. The APHIS Wildlife Services website addressed the discontinued use of the PEIS, and the statement can be viewed at: https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/programs/nepa.

32. WS did not consider a no PDM on public lands alternative.

Section 3.2.5 of the EA has been augmented to address no PDM on public lands alternative.

33. EA does not acknowledge the positive values of carnivores.

Section 2.2.4 of the EA acknowledges the sociocultural values of carnivores, specifically predators.

34. Ranchers should not be prioritized over wildlife on public lands. EA does not fully consider effects on recreation because people may still be upset even if they aren't in danger.

In general, public lands are managed by their land agencies, such as USDA-Forest Service or Bureau of Land Management, for multiple uses. WS does not establish priorities for land use on public lands.

35. WS says that private individual or other agencies will conduct PDM if it does not, however there is no proof.

WS-Colorado has a long history of conducting PDM in Colorado, so the presence of WS is likely to have reduced the need for other entities to do such work. However, it is legal for other entities to conduct most of the types of work that WS does in the state, and while there may be an initial lag in services available from non-WS entities, it is likely that the demand for PDM would not decrease and other entities would begin to conduct PDM for profit. It is also likely that in the absence of WS-Colorado, producers would conduct their own PDM, which is analyzed under Alternatives 2, 3, and4 in the EA. As discussed in Section 4.1.3.2, untrained or less proficient individuals conducting PDM may result in adverse effects to the environment

36. WS-Colorado may trap or poison lynx.

Lynx were analyzed in Sections 3.3.2.2a and 4.1.2.1c of the EA. WS has not taken a lynx in Colorado with the exception of one in response to a request from CPW officials to live-capture and translocate a lynx that had left lynx habitat and was found in a desert wash west of Grand Junction. Continuation of the current program with the applicable SOPs is not expected to result in any change in this trend.

37. Target population data is inadequate, does not consult CPW, and does not consider other forms of mortality (hunting, vehicles deaths, etc.).

CPW was consulted and the text has been updated to reflect the appropriate data sources.

38. PDM is ineffective because killing coyotes does not reduce the populations. Compensatory reproduction, emigrations, larger litters, and the release of reproductively repressed individuals make up for lethal control.

The commenter misunderstands the metric by which WS-Colorado is measuring the effectiveness of its lethal methods. In this EA, WS-Colorado identified its purpose and need for PDM as resolving the conflict, and not necessarily reducing predator populations. PDM is intended to solve immediate damages caused by predators when livestock or wildlife species are most vulnerable to predation, such as during calving, lambing or nesting seasons. Not all animals of a given species will prey on livestock. Consequently, when lethal removal is conducted, the goal is often to focus on removing the specific animal(s) associated with the problem and not necessarily to reduce population density. In many instances, predation is relieved with short-term control actions.

39. Livestock grazing harm sage grouse.

This issues is addressed in Section 1.3.2.6f.

40. WS should not kill mountain lions to protect humans. Mountain lions rarely attack humans.

WS agrees that mountain lions rarely attack humans, and states this in the EA. However, this EA analyzes the environmental impacts of removing mountain lions to protect human or pet safety, should the need arise. The issue is addressed in Section 1.3.2.5 and 2.2.3.

41. Hunting mountain lions exacerbates attacks on humans.

Section 4.1.3.1c of the EA analyzes this issue, and additional citations have augmented the original discussion.

42. EA does not address slow recruitment of black bears or their ecological services.

CPW has established criteria within state law to resolve bear conflicts. CPW uses a diversity of damage management methods within Colorado including local ordinances requiring the use of bear proof trash cans, educational information on CPW's website and brochures from their offices, trap and relocation of problem bears, hazing of problem bears, and issuing citations or arrests of individuals who feed bear thus creating human-bear conflicts. WS-Colorado also uses education to inform herders about Colorado law about bears and compliance with the law, as discussed in section. Also, Colorado Department of Agriculture published a brochure for agricultural producers in 2015 to educate them about laws pertaining to wildlife damage and where to go for assistance. The EA has been augmented in Section 1.3.1.2 to address population growth by bears in Colorado which is above objective in much of the state and the liberalization of hunting licenses for bears to address conflicts. Moreover, CPW has presented a report to the legislature about bear damage management in 2015 that the EA cited frequently. With regard to ecological services or niches, all wildlife provides services that benefit some human interest, but when there is damage, the public has rights enshrined in state law.

43. WS should use non-lethal methods and education more to resolve conflicts. Non-lethal methods should not only be implemented by landowners.

WS-Colorado does use and recommend non-lethal methods and does host seminars to teach about their use. WS-Colorado also provides education information routinely through technical assistance. Methods that WS uses and/or recommends are listed in Section 3.1.1.7 of the EA. Some non-lethal methods are left to the producer to use because of the nature of the method. For example - penning animals at night is a technique implemented by ranchers, and one that WS is not equipped or staffed to do. Fencing is another example of a non-lethal method that WS does not directly implement, but rather advises landowners to use.

44. Killings predators will not help ungulate herds because predation is not the cause of decline.

This was addressed in the EA in Section 1.3.2.6c. The cause of the decline in ungulate herds is not well understood, and the commenter provided no definitive evidence in support of the position that predation does not cause decline. The studies included in the EA are specifically designed to answer the questions about the effects of predation on ungulates. Forrester and Wittmer (2013) created three feedback patterns which can be

useful to classify ungulate population dynamics. The feedback pattern was developed to look at mule deer population dynamics, depending on the ecological context of the deer population (Table 7). This feedback pattern is useful to make preliminary judgments whether an ungulate population is subject to population declines caused ultimately by excessive predation. Additionally, a number of scientists called for research to assess if predation is the cause of an ungulate decline in Section 1.3.2.6d. Ballard *et al*. (2001) called for intensive radio telemetry and manipulative studies to identify if predation was a limiting factor. Monteith *et al* 2014) called for assessments to be made to quantify the influence of predation on large ungulates correctly by assessing the degree of compensatory or additive mortality on the nutritional capacity to young.

45. Every livestock kill should have forensic analysis conducted before lethal methods are applied for wolves.

WS-Colorado is not proposing any wolf PDM. Commenter makes several comments about the lack of need for wolf PDM. None of them are within the scope of the EA.

46. Wolves will regulate ungulate populations.

Commenter cited a study from Yellowstone National Park, where other studies showed hunting and weather actually regulated elk populations not wolves. However, WS-Colorado is not proposing to do any wolf PDM in the State, and this comment is outside the scope of this EA.

47. Ungulates are limited by nutritional carrying capacity, not predation.

WS recognizes that nutrition is a factor that affects ungulate populations, but it is not the only factor. This is discussed in depth in the EA in Section 1.3.2.6.

48. Mexican wolves should be allowed to mix with gray wolves in Colorado.

This is outside the scope of the EA and outside WS's authority. This EA does not cover wolf PDM. In addition, Wildlife Services does not have authority to determine the ESA status for any species of wolf.

49. In southwest Colorado the deer population is out of balance (over-abundant) since the "war on coyotes" began. (Commenter is from Durango area).

WS-Colorado is not conducting a war on coyotes. WS-Colorado resolves coyote-human conflicts in southwest Colorado, as it does elsewhere in the state, at the request of state and local entities and private individuals. There are many causes of deer abundance, including abundant hunting, etc. Decisions about whether ungulates are over-abundant are made by CPW, not WS-Colorado.

Mule deer populations in the Durango to Bayfield area, a suburban-urban corridor have been increasing over the last few years. The number of deer - human conflicts have been increasing with more deer vehicle collisions, complaints of deer browsing gardens and ornamental plants and, harassing of pets. La Plata County has produced several brochures to educate the public about managing deer damage. The Colorado Department of Transportation has constructed underpasses for deer to cross the highway from Durango to Bayfield while reducing deer-vehicle collisions. Like many urban -

suburban areas deer densities are increasing due to abundant food, little to no hunting mortality and reduced numbers of predators (e.g., coyotes and mountain lions). The U. S. Department of Agriculture, Wildlife Services program conducts no coyote population management to protect livestock in this area which would increase the number of deer fawns surviving to adulthood. In fact we conduct greater than 90% of coyote predation management in La Plata County on grazing allotments on the National Forest to protect livestock. About 60-70 coyotes are removed annually to protect sheep and cattle from predation. In contrast, hunters remove about 2,000 or more coyotes annually in La Plata County. Landowners remove additional coyotes to protect their resources and property. While the deer population is stable in La Plata County it is slightly below population objective according to Colorado Parks and Wildlife (S. Wait, Colorado Parks and Wildlife, pers. com.), however, there are local deer conflicts. These local conflicts with high deer density are not from coyotes being killed according to Colorado Parks and Wildlife.

50. WS-Colorado PDM is "super additive or multiplicative" to population.

The Commenter argues that WS-Colorado should not conduct PDM on apex predators because it results in "super additive or multiplicative mortality". We are not familiar with the term super additive, and the papers provided by the commenter in support of the claim do define or address the terms super additive or multiplicative. The effects of human-induced mortality on mountain lion populations in considered under Sections 4.1.1.1j, where direct, and cumulative impacts of PDM are analyzed. All mortality on mountain lions is considered by the state, and in the Salida mule deer-mountain lion study, the state is intentionally causing mortality to reduce the lion population as part of a research project. This is a measured research project by CPW to scientifically answer questions regarding the decline in mule deer populations. Cumulative lion take in Colorado is less than 11% over last 5 years which would keep the mountain lion populations at carrying capacity (Logan et al. 1996). This is analyzed in section 4.1.1.1j.

51. WS-Colorado negatively affects mountain lion population resilience and dynamics.

We disagree WS-Colorado analyzed the effects of its PDM program activities, along with cumulative effects, in section 4.1.1.1j.

52. Black bears are not a significant predator of mule deer.

We disagree. The EA cites bears are cited as predators of ungulates, and they are sometimes major predators, causing an ungulate population to decline, as discussed in Section 1.3.2.6a, 1.3.2.6c. Bear populations have increased dramatically in many states over last two decades and the impacts of bear population growth are now being investigated in the proposed study (e.g., LeBlond et al. 2016).

53. EA did not consider habitat loss and fragmentation as factors diminishing mule deer herds sufficiently.

This was discussed in Section 1.3.2.6c of the EA. WS-Colorado recognizes that habitat loss and fragmentation diminish mule deer herds. Work by Leland et al. 2016 analyzed impacts of habitat fragmentation which resulted in increased bear predation on caribou. The deer being studied on Piceance are not suffering habitat loss. Deer near Salida may

not be suffering habitat loss. However, deer in the towns of Salida and Buena Vista are doing very well. Deer in natural habitat are declining from something, it appears to be predation in preliminary studies by CPW (Section 1.3.2.6d "Mule deer survival and effects of cougar predation on a central Colorado population", Appendix B). Causes of mule deer declines were discussed in 1.3.2.6d.

54. Colorado mountain lion harvest quotas are unsustainable.

This was addressed in the EA in Section 4.1.1.1j. The state of Colorado has authority to manage mountain lion populations. Colorado keeps harvest at less than 11% which keeps the lion population at carrying capacity, which is considered conservative. There are exceptions where CPW intentionally causes higher harvest for other management goals, and these are discussed in section 4.1.1.1j under Indirect Impacts. The EA has determined that the level of take will have minimal to no impact on the mountain lion population in Colorado.

55. Hounds running bears and mountain lions will kill cubs and it is not fair.

WS-Colorado is taking a number of measures to ensure that cubs are not killed. Forst, WS-Colorado activities are timed so that bear cubs will be about a four months old or a year and a few months old, they will be mature enough to climb trees to escape hounds during the May and June time period. Dogs are trained not kill the bear cubs, but rather to chase and bay the bears and lions. The mountain lion cubs will not be as old but they too will climb trees and shrubs also to escape hounds during the February-March management actions by WS-Colorado. There is a small risk to the hounds being injured by black bears and mountain lions. Our employees understand this risk and try to keep hounds away from treed or cornered bears and lions.

Illegal hunting is governed by fair chase ethics, but wildlife damage management is not. Wildlife damage management is professional management of conflicts caused by wildlife that are to be resolved as efficiently, effectively and humanely as possible. WS-Colorado follows standards for humaneness and professionalism pursuant to WS Directive 2.445.

56. Comments not within the scope of the analysis of the EA.

a. Cattle cause global warming
b. BLM should stop killing wild horses

CHAPTER 6. LIST OF PREPARERS, PERSONS CONSULTED, AND LITERATURE CITED

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6.3 LITERATURE CITED

Ables, E. D. 1969. Activity studies of red foxes in southern Wisconsin. J. Wildl. Manage. 33:145-153.

Aldridge, C. L., D. J. Saher, T. M. Childers, K. E. Stahlnecker and Z. H. Bowen. 2012. Crucial nesting habitat for Gunnison Sage Grouse: a spatially explicit hierarchiacal approach. J. of Wildl. Manage. 76:391-406.

Allen, S. H., J. O. Hastings, and S. C. Kohn. 1987. Composition and stability of coyote families and territories in North Dakota. Prairie Nat. 19:107-114.

Allen, S. H., and A. B. Sargeant. 1993. Dispersal patterns of red foxes relative to population density. J. Wildl. Manage. 57:526-533.

Alt, G. L. 1981. Reproductive Biology of Black Bears of Northeastern Pennsylvania. Trans. Northeast Section Wildl. Soc. 38:88-89.

Althoff, D. P. 1978. Social and spatial relationships of coyote families and neighboring coyotes. M.S. Thesis, Univ. Nebraska, Lincoln. 80 pp.

American Bird Conservation. 1997. A catastrophe for birds. Bird Conserv. Summer Nesting Edition p. 10-11.

American Veterinary Medical Association (AVMA). 1987. Panel Report on the Colloquium on Recognition and Alleviation of Animal Pain and Distress. J. Amer. Veterinary Med. Assoc. 191:1186-1189.

_____AVMA. 2001. 2000 report of the American Veterinary Medical Association panel on euthanasia. J. Amer. Vet. Med. Assoc. 218:669-696.

_____AVMA. 2013. AVMA guidelines for the euthanasia of animals. AVMA. Shaumburg, IL. 98 pp plus appendices.

Ames, D. R., and L. A. Arehart. 1972. Physiological response of lambs to auditory stimuli. J. Animal Science. 34:994-998.

Andelt, W.F. 1985. Behavioral ecology of coyotes in south Texas. Wildl. Monogr. 94. 45 pp.

Andelt, W. F. and P. S. Gipson. 1979. Home range, activity, and daily movements of coyotes. J. Wildl. Manage. 43:944-951.

Andelt, W.F. 1992. Effectiveness of livestock guarding dogs for reducing predation on domestic sheep. Wildl. Soc. Bull. 20:55-62.

Andersen, D. E., O. J. Rongstad and W. R. Mytton. 1989. Response of nesting red-tailed hawks to helicopter overflights. Condor 91:296-299.

Andrews, R. D., G. L. Storm, R. L. Phillips, and R. A. Bishop. 1973. Survival and movement of transplanted and adopted red fox pups. J. Wildl. Manage. 37:69-72.

_____ APHIS. 2004. Wildlife Services' Mission. USDA- APHIS website @ http://www.aphis.usda.gov/ws/mission.html. *Last visited 04/14/05*.

Arhart, D. K. 1972. Some factors that influence the response of starlings to aversive visual stimuli. M.S. Thesis. Oregon State Univ., Corvallis.

Arrington, O. N. and A. E. Edwards. 1951. Predator control as a factor in antelope management. Trans. N. Am. Wildl. Conf. 16:179-193.

Arritt, S. 1997. Little grouse on the prairie: reversing the decline of lesser prairie-chickens. New Mex. Partners Conserving Endang. Species. Cons. Serv. Div., New Mex. Game and Fish. Dept.

Ashman, D., G. C. Christensen, M.L. Hess, G. K. Tsukamoto and M.S. Wickersham. 1983. The mountain lion in Nevada. Nev. Div. Wildl., Reno. 75 pp.

Association of Fish and Wildlife Agencies. 2006. Best Management Practices for Trapping in the United States. Washington, DC. 13 pp.

Autenrieth, R. E. 1981. Sage grouse management in Idaho. Idaho Dept. Fish and Game. Proj. No. ID W-125-R and ID W-160-R. 249 pp.

Baker, R. O. and R. M. Timm. 1998. Management of conflicts between urban coyotes and humans in southern California. Proc. Vertebrate Pest Conf. 18:299-312.

Ballard, W. B., D. Lutz, T. W. Keegan, L. H. Carpenter, and J. C. deVos, Jr. 2001. Deer-predator relationships: a review of recent North American studies with emphasis on mule and black-tailed deer. Wildl. Soc. Bull. 29(1):99-115.

Balser, D. S., D. H. Dill, and H. K. Nelson. 1968. Effect of predator reduction on waterfowl nesting success. J. Wildl. Manage. 32:669-682.

Bandy, L. W. 1965. The colonization of artificial nesting structures by wild mallards and black ducks. Thesis, Ohio St. Univ., Columbus.

Bartmann, R. M., G. C. White. And L. H. Carpenter. 1992. Compensatory mortality in a Colorado mule deer population. Wildlife Mono. 121:1-39.

Bartush, W. S. 1978. Mortality of white-tailed deer fawns in the Wichita Mountains, Comanche County, Oklahoma, Part II. M.S. Thesis. Okla. St. Univ., Stillwater. 161 pp.

Batterson, W. M., and W. B. Morse. 1948. Oregon sage-grouse. Ore. Fauna Ser. No. 1, Ore. State Game Comm., Portland.

Beale, D.M., and A.D. Smith. 1973. Mortality of pronghorn antelope fawns in western Utah. J. Wildl. Manage. 37:343-352.

Beck, J. L. and D. L. Mitchell. 2000. Influence of livestock grazing on sage grouse habitat. Wildl. Soc. Bull. 28:993-1002.

Beier, P. 1991. Cougar attacks on humans in the United States and Canada. Wildl. Soc. Bull. 19:403-412.

Bekoff, M. and M. C. Wells. 1982. Behavioral ecology of coyotes: social organization, rearing patterns, space use, and resource defense. Z. Tierpsychol. 60:281-305.

Bekoff, M. and M. C. Wells. 1986. Social ecology and behavior of coyotes. Adv. Study Behav. 16:251-338.

Bergerud, A. T. 1988. Increasing the numbers of grouse. Pp. 686-731 *in* A. T. Bergerud and M. W. Gratson, Eds. Adaptive strategies and population ecology of northern grouse. Univ. Minn. Press, Minneapolis.

Bergman, E. J., P. F. Doherty, G. C. White and D. J. Freddy. 2015. Habitat and herbivore density: response of mule deer to habitat management. J. Wildlife Management 79:60-68.

Bergman, E. J., C. J. Bishop, D. J. Freddy, G. C. White and P. F. Doherty. 2014. Habitat management influences overwinter survival of mule deer fawns in Colorado. J. of Wildlife Management 78:448-455.

Bergman, E. J., P. F. Doherty, C. J. Bishop, L. L. Wolfe and B. A. Banulis. 2014a. Herbivore body condition response in altered environments: mule deer and habitat management. PLoS ONE 9(9): e106374. Doi:10.1371/journal.pone.0106374

Bergstrom, B. J., L. C. Arias, A. D. Davidson, A. W. Ferguson, L. A. Randa, and S. R. Sheffield. 2013. License to kill: reforming federal wildlife control to restore biodiversity and ecosystem function. Conservation Letters http://onlinelibrary.wiley.com/doi/10.1111/conl.12045/abstract.

Berryman, J. H. 1991. Animal damage management: responsibilities of various agencies and the need for coordination and support. Proc. East. Wildl. Damage Control Conf. 5:12-14.

Bishop, C. J., G. C. White, D. J. Freddy, B. E. Watkins, and T. R. Stephenson. 2009. Effect of enhanced nutrition on mule deer population rate of change. Wildlife Monographs 172: 1-28.

BISON-M (Biota Information System of New Mexico). Species List/Species Accounts. Version 01/2004 @ http://fwie.fw.vt.edu/states/nm.htm. *Last visited 4/17/05.*

Bjorge, R. R., J. R. Gunson, and W. M. Samuel. 1981. Population characteristics and movements of striped skunks (*Mephitis mephitis*) in central Alberta. Can Field. Nat. 95:149-155.

Bleich, V. C., and T. J. Taylor. 1998. Survivorship and cause specific mortality in f1ve populations of mule deer. Great Basin Naturalist 58:265-272.

Blejwas, K. M., B. N. Sacks, M. M. Jaeger, and D. R. McCullough. 2002. The effectiveness of selective removal of breeding coyotes in reducing sheep predation. Journal of Wildlife Management 66(2):451-462.

Blunden, J., and D. S. Arndt, Eds. 2013. State of the climate in 2012. Bulletin of the American Meteorological. Society 94:S1-S238.

Boddicker, M. L. 1980. Managing Rocky Mountain Furbearers. Colorado Trapper's Assoc. Training Manual, 181 pp.

Bomford, M. 1990. Ineffectiveness of a sonic device for deterring starlings. Wildl. Soc. Bull. 18:151-156.

Borg, E. 1979. Physiological aspects of the effects of sound on man and animals. Acta Otolaryngol, Suppl. 360:8–85.

Braun, C. E., T. Britt, and R. O. Wallestad. 1977. Guidelines for maintenance of sage grouse habitats. Wildl. Soc. Bull. 5:99-106.

Bromley, C and E. M. Gese. 2001a. Surgical sterilization as a method of reducing coyote predation on domestic sheep. J. Wildl. Manage. 65:510-519.

Bromley, C. and E. M. Gese. 2001b. Effects of sterilization on territory fidelity and maintenance, pair bonds, and survival rates of free-ranging coyotes. Can. J. Zool. 79:386-392.

Bulger, A. 2016. Safe Passage. Colorado Outdoors. September/October. Denver, CO

Bunnell, K. D., and J. T. Flinders. 1999. Restoration of sage-grouse in Strawberry Valley, Utah 1998-99 report. Unpubl. Rept. to Utah Reclamation Mitigation and Conservation Commission. Brigham Young Univ., Provo.

Burkepile, N. A., K. P. Reese, and J. W. Connelly. 2001. Mortality patterns of sage-grouse chicks in southeast Idaho. Abstract Pres. 2001 Ann. Mtg. Idaho Chapt. Wildl. Soc., Boise.

Burns, R. J. 1983. Coyote predation aversion with lithium chloride: management implications and comments. Wildl. Soc. Bull. 11:128-133.

Burns, R. J. and G. E. Connolly. 1980. Lithium chloride aversion did not influence prey killing in coyotes. Proc. Vertebr. Pest Conf. 9:200-204.

Burns, R. J. and G. E. Connolly. 1985. A comment on "Coyote control and taste aversion". Appetite 6:276-281.

Buskirk, S. W., L. F. Ruggiero, and C. J. Krebs. 1999. Habitat fragmentation and interspecific competition: implications for lynx conservation. Chapt. 4 *In* L.F. Ruggiero, K.B Aubry, S.W. Buskirk, *et al*., tech. Eds. The Scientific Basis for Lynx Conservation in the Contiguous United States. Gen. Tech. Rpt. RMRS-GTR-30. Ogden, UT: USDA, USFS, Rocky Mtn. Res. Sta.

Caine, S., A. Kadlec, D. L. Allen, R.A. Cooley, M. C. Hornocker, A. S. Leopold, and F. H. Wagner. 1972. Predator control-1971: a report to the Council on Environmental Quality and the Department of the Interior by the Advisory Committee on Predator Control. CEQ and USDI, Wash., DC. 207pp.

California Department of Fish and Game. 1991. Final Environmental Document--Bear Hunting. Sections 265, 365, 366, 367, 367.5. Title 14 Calif. Code of Regs. Calif. Fish and Game, April 25, 1991. 13pp.

California Department of Fish and Wildlife. 2016. Verified mountain lion attacks on humans in California (1986 through 2014). www.wildlife.ca.gov/conservaion/mammals/mountain-lion/attacks. Retrieved 8/24/16

Camenzind, F. J. 1978. Behavioral ecology of coyotes on the National Elk Refuge, Jackson, Wyoming. Pp 267-294 *in* M. Bekoff, ed. Coyotes: Biology, behavior and management. Academic Press, New York.

Caughley, G. 1976. Wildlife management and the dynamics of ungulate populations. Pages 183-246 in T. W. Coaker, ed. Applied biology. Vol. 1 Academic Press, New York, NY

CensusScope. 2001. Colorado population growth. http://www.Censusscope.org/us/s8/chart_popl.html. Data retrieved December 5, 2016.

Centers for Disease Control. 1990. Morbidity and mortality weekly report. Compendium of Rabies Control. 39, No. RR-4: 6.

Chessness, A. A., M. M. Nelson, and W. H. Longley. 1968. The effect of predator removal on pheasant reproductive success. J. Wildl. Manage. 32:683-697.

Clark, F. W. 1972. Influence of jackrabbit density on coyote population change. J. Wildl. Manage. 36:343-356.

Coates, P. S. and D. J. Delehanty. 2010. Nest predation of greater sage grouse in relation to microhabitat factors in predators. J. of Wildl. Manage. 74:240-248.

Coates, P. S., and D. J. Delehanty. 2001. Progr. Rpt: Columbian sharp-tailed grouse reintroduction in northeastern Nevada. NEV. Div. Wildl. and Univ Nev., Reno.

Coates, P. S., B. E. Brussee, K. B. Howe, K. B. Gustafson, M. L. Casazza and D. J. Delehanty. 2016. Landscape characteristics and livestock presence influence common ravens: relevance to greater sage grouse conservation. Ecosphere. http://onlinelibrary.wiley.com/doi/10.1002/ecs2.1203/full

Colorado Parks and Wildlife (CPW). 2004. Living with wildlife. CPW Last updated December 2004. @ http://wildlife.state.co.us/Education/LivingWithWildlife. *Last visited 4/28/05.*

_____. 2016. River Otter. http://cpw.state.co.us/Documents/LandWater/WetlandsProgram/PrioritySpecies/Factsheet-and-Habitat-Scorecard_RiverOtter.pdf#search=river%20otterReport to the Legislature. Denver, CO. 3pp.

_____. 2015. Human-Bear Conflicts. Report to the Legislature. Denver, CO. 28pp.

_____. 2014a. Colorado west slope mule deer strategy. *http://cpw.state.co.us/Documents/MuleDeer/MuleDeerStrategy.pdf*. *Last visited 2/11/2015*.

_____. 2014b. Big game harvest survey statistics @ http://cpw.state.co.us/thingstodo/Pages/Statistics.aspx. *Last visited 11/06/14*.

_____. 2014c. Mountain lion harvest survey statistics @ http://cpw.state.co.us/thingstodo/Pages/LionStatistics.aspx. *Last visited 11/06/14*.

_____. 2014d. Small game harvest survey statistics @ http://cpw.state.co.us/thingstodo/Pages/SmallGameStatistics.aspx. *Last visited 11/06/14*.

_____. 2014e. Colorado West Slope Mule Deer Strategy. @ http://cpw.state.co.us/learn/Pages/CO-WestSlopeMuleDeerStrategySummit/aspx. Retrieved August 3, 2016.

_____. 2005. Guidelines for response to gray wolf reports in Colorado. CPW, January. 19 pp.

Colorado Wolf Management Working Group. 2004. Recommendations for managing wolves that migrate into Colorado. Report to CPW. December 28, 2004. 67 pp.

Connelly, J. W., and C. E. Braun. 1997. Long-term changes in sage-grouse *Centrocercus urophasianus* populations in western North America. Wildl. Biol. 3:229-234.

_____. M. A. Schroeder, A. R. Sands, and C. E. Braun. 2000. Guidelines to manage sage-grouse populations and their habitats. Wildl. Soc. Bull. 28:967-985.

_____. 1992. Coyote damage to livestock and other resources. Pp. 161-169 *in* A.H. Boer, ed. Ecology and Management of the Eastern Coyote. Univ. of New Brunswick, Fredericton, N.B., Canada.

_____. 1995. The effects of control on coyote populations: another look. Pages 23-29 *in* D. Rollings, C. Richardson, T. Blanenship, K. Canon, and S. Henke, editors. Coyotes in the Southwest: A compendium of our knowledge. Texas Parks and Wildlife Department, Austin, TX, USA.

_____. and W. M. Longhurst. 1975. The effects of control on coyote populations. Div. of Agric. Sci., Univ. of Calif. Davis. Bull. 1872. 37 pp.

_____. and B. W. O'Gara. 1987. Aerial hunting takes sheep-killing coyotes in Western Montana. Proc. Great Plains Wildl. Damage Control Workshop. 8:184-188.

Conover, M. R., J. G. Francik, and D. E. Miller. 1977. An experimental evaluation of aversive conditioning for controlling coyote predation. J. Wildl. Manage. 41:775-779.

_____. 1982. Evaluation of behavioral techniques to reduce wildlife damage. Proc Wildl.-Livestock Relation Sym. 10:332-344.

Cook, J. A. 1986. Occasional Papers the Museum of Southwestern Biology No.4 June 30, 1986. The Mammals of the Animas Mountains and Adjacent Areas, Hidalgo County, New Mexico. Univ. New Mex. 45 pp

Coolahan, C . 1990. The use of dogs and calls to take coyotes around dens and resting areas. Proc. Vertebr. Pest Conf. 14:260-262.

Cooley, H. S., H. S. Robinson, R. B. Wielgus and C. S. Lambert. 2008. Cougar prey selection in a white-tailed deer and mule deer community. J. of Wildl. Manage. 72:99-106

Cowardin, L. M., D. S. Gilmer, and C. W. Shaiffer. 1985. Mallard recruitment in the agricultural environment of North Dakota. Wildl. Monogr. 92.

Creed, R. F. S. 1960. Gonad changes in the wild red fox (*Vulpes vulpes crucigera*). J. Phys. (London) 151:19-20.

Crowe, D. M. 1975. A model for exploited bobcat populations in Wyoming. J. Wildl. Manage. 39:408-415.

Cunningham, S.C., L.A. Haynes, C. Gustavson, and D.D. Haywood. 1995. Evaluation of the interaction between mountain lions and cattle in the Aravaipa-Klondike area of southeast Arizona. Ariz. Game & Fish Dep. Tech. Rep. 17, Phoenix. 64 pp.

Dacko, A. 2004. What is the campaign for illegal poisoning of animals? Britain Department for Environment, Food and Rural Affairs 4 pp. @ http://homepage.ntlworld.com/anthony.dacko. *Last visited 4/17/05.*

Danner, D. A. 1976. Coyote home range, social organization, and scent post visitation. M.S. Thesis, University of Arizona, Tucson. 86 pp.

_____ and N. S. Smith. 1980. Coyote home range, movements, and relative abundance near cattle feedyard. J. Wildl. Manage. 44:484-487.

Darimont, C. T., C. H. Fox, H. M. Bryan and T. E. Reimchen. 2015. The unique ecology of human predators. Science 349:858-860.

Davis, A. J., M. L. Phillips and P. F. Doherty, Jr. 2015. Survival of Gunnison sage grouse *Centrocercus minimus* in Colorado, USA. J. of Avian Biology 45:186-192

Davis, D. E. 1974. Comments on rabies control. J. Wild. Dis. 10:77-82.

Decker, D. J., and G. R. Goff. 1987. Valuing wildlife: economic and social perspectives. Westview Press. Boulder, Colo. 424pp.

DeLiberto, T. J., E. M. Gese, F. F. Knowlton, J. R. Mason, M. R. Conover, L. Miller, R. H. Schmidt, and M. K. Holland. 1998. Fertility control in coyotes: is it a potential management tool? Proc. Vertebr. Pest Conf. 18:144-149.

DeLorenzo, D.G., and V.W. Howard, Jr. 1977. Evaluation of sheep losses on a range lambing operation in southeastern New Mexico. N. Mex. State Univ. Agri. Exp. Sta. Res. Rep. 341.

Denny, R. N. 1976. Regulations and mule deer harvest. Pages 85-90 in G. W. Workman and J. B. Low, Eds. Mule deer decline in the West: a symposium. Utah State Univ. And Utah Ag. Experiment Station. Logan.

Dinkins J. B., K. T. Smith, and J. L. Beck,. 2016. Microhabitat conditions in Wyoming's sage-grouse Core Areas: Effects on nest site selection and success. PLoS ONE. 11(3):e0150798.

Dolbeer, R. A., P. P. Woronecki, and R. L. Bruggers. 1986. Reflecting tapes repel blackbirds from millet, sunflowers, and sweet corn. Wildl. Soc. Bull. 14:418-425.

Dumke, R. T., and C. M. Pils. 1973. Mortality of radio-tagged pheasants on the Waterloo wildlife area. Wisc. Dept. Nat. Res. Techn. Bull. 72. 52 pp.

Eacker, D. R., M. Hebblewhite, K. M. Proffitt, B. S. Jimenez, M. S. Mitchell and H. S. Robinson. 2015. Annual elk calf survival in a multiple carnivore system. J. of Wildlife Management, DOI: 10.1002/jwmg.21133

Eccleston, C. H. 1995. NEPA: Determining when an analysis contains sufficient detail to provide adequate coverage for a proposed action. Federal Facilities Environmental Journal, Summer.

Eagle, T. C., and J. S. Whitman. 1999. Mink. Pp. 614-624. *In* M. Novak, J. Baker, M. Obbard, B. Mallock, eds. Wild Furbearer Management and Conservation in North America. Rev. Ed. Minist. Nat. Res., Ont., Ca. 1150 pp.

Edwards, L. L. 1975. Home range of coyotes in southern Idaho. M.S. Thesis, Idaho State Univ., Moscow. 36 pp.

Elbroch, L. M., P. E. Lendrum, M. L. Allen, H. U. Wittmer. 2015. Nowhere to hide: Pumas, black bears and competition refuges. Behavioral ecology 26:247-254.

EPA. 2009. Letter to W. Keefover-Ring, Carnivore Protection Program from Debra Edwards, Office of Pesticide Programs. Petition to the EPA for suspension and cancellation of M-44 sodium cyanide capsules and sodium fluoroacetate (Compound 1080) Livestock Protection Collars. January 16, 2009. Washington, DC. 53 pp.

EPA (United States Environmental Protection Agency). 2000. How to evaluate alternative cleanup technologies for underground storage tank sites: A guide for corrective action plan reviewers. @http://www.epa.gov/cgi-bin/claritgw. *Last visited 4/27/05.*

Evans, W. 1983. The cougar in New Mexico: Biology, status, depredation of livestock, and management recommendations. Rpt. to NM House of Rep., NMDGF. 40 pp. (*Abstract only*).

Everett, D. D., D. W. Speake, and W. K. Maddox. 1980. Natality and neonatality of a north Alabama wild turkey population. Proc. National Wild Turkey Symp. 4:117-126.

Fagerstone, K. A. 1999. Black-footed ferret, long-tailed weasel, short-tailed weasel, and least weasel. Pp.548-573. *In* M. Novak, J. Baker, M. Obbard, B. Mallock, Eds. Wild Furbearer Management and Conservation in North America. Rev. ed. Minist. Nat. Res., Ont., Ca. 1150 pp.

Fagerstone, K. A., L. A. Miller, K. S. Bynum, J. D. Eisemann, and C. Yoder. 2006. When, where and for what wildlife species will contraception be a useful management approach? Proc. 22nd Vertebr. Pest Conf. (R. M. Timm and J. M. O'Brien, Eds.). Published at Univ. of Calif., Davis. Pp. 45-54.

Federal Wildlife Officer, The. 2000. Macon, GA, investigations. Fed. Wildl. Officers Assoc. Fall Newsletter 13(4):1.

Ferris, D. H. and R. D. Andrews. 1967. Parameters of a natural focus of *Leptospira pomona* in skunks and opossums. Bull. Wildl. Dis. Assoc. 3:2-10.

Finley, D. J. 1999. Distribution of the swift fox (*Vulpes velox*) on the eastern Plains of Colorado. M.A. Thesis, Univ. N. Colo., Greeley.

_____, G. C. White, and J. P. Fitzgerald. 2005. Estimation of swift fox population size and occupancy rates in eastern Colorado. J. Wildl. Manage. *In press.*

Fitzgerald, P., C. A. Meany, and D. M. Armstrong. 1994. Mammals of Colorado. Denver Museum Nat. Hist., Denver, CO. 467 pp.

Fitzhugh, E. L. and W. P. Gorenzel. 1986. Biological status of mountain lions in California. Pages 336-346 *in* Proceedings Twelfth Vertebrate Pest Conference. T. P. Salmon, ed. Univ. of California. Davis, CA.

Forrester, T. D. and H. U. Wittmer. 2013. A review of the population dynamics of mule deer and black-tailed deer *Odocoileus hemionus* in North America. Mammal Review 43:292-308.

Fraser, D., J. F. Gardner, G. B. Kolenosky, and S. M. Strathearn. 1982. Estimation of Harvest Rate of Black Bears from Age and Sex Data. Wildl. Soc. Bull. 10:53-57.

Frenzel, R. W., and R. G. Anthony. 1989. Relationship of diets and environmental contaminants in wintering bald eagles. J. Wildl. Manage. 53:792-802.

Fritzell, E. K. and K. J. Haroldson. 1982. Urocyon cineroargenteus. Mammalian Species 189:1-8.

Fritzell, E. K. 1987. Gray fox and island fox. In Novak, M; Baker, J. A.; Obbard, M. E.; Malloch, B., eds. Wild furbearer management and conservation in North America. North Bay, ON. Ontario Trappers Assoc. 408-420.

Fuller, W.A. 1969. Changes in numbers of three species of small rodent near Great Slave Lake N.W.T. Canada, 1964-1967 and their significance for general population theory. Ann. Zool. Fennici. 6:113-144

Gantz, G. 1990. Seasonal movement pattern of coyotes in the Bear River Mountains of Utah and Idaho. Thesis, Utah St. Univ., Logan.

Garrettson, P. R., and F. C. Rowher. 2001. Effects of mammalian predator removal on production of upland-nesting ducks in North Dakota. J. Wildl. Manage. 65:398-405.

Gazda, R., and J. Connelly. 1993. Ducks and predators: more ducks with fewer tree? Idaho Wildl. 13:8-10.

Gehrt, S. D., and W. R. Clark. 2003. Raccoons, coyotes, and reflections on the mesopredator release hypothesis. Wildl. Soc. Bull. 31:836-842.

George, J.L., R. Kahn, M.W. Miller, and B. Watkins. 2009. Colorado bighorn sheep management plan 2009-20019. Special Report Number 81. Colorado Parks and Wildlife. February 2009.

Gese, E. M., O. J. Rongstad, and W. R. Mytton. 1988. Home range and habitat use of coyotes in southeastern Colorado. J. Wildl. Manage. 52:640-646.

_____ and S. Grothe. 1995. "Analysis of coyote predation on deer and elk during winter in Yellowstone National Park, Wyoming." Am. Midl. Nat. 133[1]:36-43.

_____., R. L. Ruff, and R. L. Crabtree. 1996. Social and nutritional factors influencing the dispersal of resident coyotes. Animal Behaviour 52:1025-1043.

Gese, E. 2005. Demographics and spatial response of coyotes to changes in food and exploitation. Proceedings of the Wildl. Damage Conf. 11:271-285.

Gilbert, S. L., K. J. Sivy, C. B. Pozzanghera, A. DuBour, K. Overduijn, M. M. Smith, J. Zhou, J. M. Little and L. R. Prugh. 2016. Socioeconomic benefits of large carnivore recolonization through reduced wildlife-vehicle collisions. J. for the Society of Conservation Biology

Graber, D. M. 1981. Ecology and management of black bears in Yosemite National Park. Ph.D. Thesis, University of California, Berkeley, California.

Graves, G. E., and W. F. Andelt. 1987. Prevention and control of woodpecker damage. Service in Action, Colo. St. Univ. Coop. Ex. Serv. Publ. no 6.516. Ft. Collins, Colo. 2 pp.

Greenwood, R. J. 1986. Influence of striped skunk removal on upland duck nest success in North Dakota. Wildl. Soc. Bull. 14:6-11.

Gregg, M. A. 1991. Use and selection of nesting habitat by sage-grouse in Oregon. Thesis, Oregon State University, Corvallis, USA.

Gregg, M. A. and J. A. Crawford. 2007. Survival of greater sage grouse chicks and broods in the northern Great Basin. J. of Wildl. Manage. 73:904-913.

Gunnison Sage-grouse Rangewide Steering Committee. 2005. Gunnison sage-grouse rangewide conservation plan. Colorado Parks and Wildlife, Denver, Colorado, USA. http://wildlife.state.co.us/species_cons/Gunnison_sage_grouse/

Guthrey, F. S. 1996. Upland gamebirds. Pages 59-69 *in* P. R. Krausman, editor. Rangeland wildlife. The Society for Range Management, Denver, CO.

Hamlin, K. L., S. J. Riley, D. Pariah, A. R. Dood, and R. J. Mackie. 1984. Relationships among mule deer fawn mortality, coyotes, and alternate prey species during summer. J. Wildl Manage. 48:489-499.

Harris, S. 1977. Distribution, habitat utilization and age structure of a suburban fox (*Vulpes vulpes*) population. Mammal Rev. 7:25-39.

Harris, S. 1979. Age-related fertility and productivity in red fox, *Vulpes vulpes*, in suburban London. Journal of Zoology 187:195-199.

Harris, S. and J. Rayner. 1986. Urban fox (*Vulpes vulpes*) population estimates and habitat requirements in several British cities. J. Anim. Ecol. 55:575-591.

Harrison, S., and D. Hebert. 1989. Selective predation by cougar within the Junction Wildlife Management Area. Symp. N. Wild Sheep and Goat Council 6:292-306.

Hatter, I. W. and D. W. Janz. 1994. Apparent demographic changes in black-tailed deer associated with wolf control on northern Vancouver Island. Canadian J. of Zoology 72:878-884.

Hayes, C. L., E. S. Rubin, M. C. Jorgensen, R. A. Botta, and W. M. Boyce. 2000. Mountain lion predation of bighorn sheep in the Peninsular Ranges, California. J. Wildl. Manage. 64:954-959.

Hayes, D. J. 1993. Lead shot hazards to raptors from aerial hunting. USDA, APHIS, ADC. Billings, MT. Unpubl. Rpt. 14 pp.

Hemker, T. P., F. G. Lindzey, and B. B. Ackerman. 1984. Population characteristics and movement patterns of cougars in southern Utah. J. Wildl. Manage. 48:1275-1284.

Henke, S.E. 1992. Effect of coyote removal on the faunal community ecology of a short-grass prairie. Ph.D. Thesis. Tex. Tech Univ., Lubbock. 229 pp.

Henke, S. E. 1995. Effects of coyote control on their prey: A review. In (Proceedings) Coyotes in the Southwest: A Compendium of our Knowledge. December 1995. Tex. Agric. Ext. Serv., Tex. A&M Univ. San Angelo, TX. Pp. 35-40.

Henne, D. R. 1975. Domestic sheep mortality on a western Montana ranch. Pp. 133-149 *in* R. L. Phillips and C. Jonkel Ed. Proc. 1975 Predator Sym. Montana For. Conserve. Exp. Sta., School For., Univ. Mont. Missoula.

Hess, J. E. and J. L. Beck. 2012. Disturbance factors influencing greater sage grouse lek abandonment in north-central Wyoming. J. of Wildl. Manage. 76:1625-1634.

Hill, E. P., P. W. Sumner, and J. B. Wooding. 1987. Human influences on range expansion of coyotes in the southeast. Wildl. Soc. Bull. 15:521-524.

Hoffman, C. O. and J. L. Gottschang. 1977. Numbers, distribution, and movements of a raccoon population in a suburban residential community. J. Mammal. 58:623-636

Hopcraft, J. G. C., H. Olff and A. R. E. Sinclair. 2010. Herbivores, resources and risks: alternating regulation along primary environmental gradients in savannas. Trends in Ecology and Evolution 25:119-128

Horn, S. W. 1983. An evaluation of predatory suppression in coyotes using lithium chloride-induced illness. J. Wildl. Manage. 47:999-1009.

Hornocker, M.G. 1970. An analysis of mountain lion predation upon mule deer and elk in the Idaho primitive area. Wildl. Monogr. 21. 39 pp.

Houseknecht, C. R. 1971. Movements, activity patterns and denning habits of striped skunks (*Mephitis mephitis*) and exposure potential for disease. Ph.D. Thesis, Univ. Minnesota, Minneapolis. 46 pp.

Hovick, T. J., R. D. Elmore, D. K. Dahlgren, S. D. Fuhlendorf and D. M. Engle. 2014. Evidence of negative effects of anthropogenic structures on wildlife: a review of grouse survival and behaviour. J. of Applied Ecology 51:1680-1689.

Howard, V. W., Jr. and T. W. Booth. 1981. Domestic sheep mortality in southeastern Colorado. Agric. Exp. Stn., Colorado State Univ., Las Cruces. Bull 683.

Howard, V. W., Jr. and R. E. Shaw. 1978. Preliminary assessment of predator damage to the sheep industry in southeastern Colorado. Agric. Exp. Stn., Colorado State Univ., Las Cruces, Res. Rpt. 356.

Howell, R. G. 1982. The urban coyote problem in Los Angeles County. Proc. Vertebr. Pest Conf. 10:21-23.

Hurley, M. A., J. W. Unsworth, P. Zager, M. Hebblewhite, E. O. Garton, D. M. Montgomery, J. R. Skalski and C. L. Maycock. 2011. Demographic response of mule deer to experimental reduction of coyotes and mountain lions in southeastern Idaho. Wildlife Mono. Vol. 178. 33pp.

Innman, K. H., M. R. Vaughn, 2002. Hunter effort and success rates hunting bears with hounds in Virginia. Ursus 13:223-230.

International Association of Fish and Wildlife Agencies. 2004. The potential costs of losing hunting and trapping as wildlife management tools. Animal Use Committee, IAFWA, Wash., DC. 46 pp.

Ivan, J., M. Rice, T. Shenk, D. Theobald, and E. Odell. 2011. Predictive map of Canada lynx habitat use in Colorado. Unpublished report, Colorado Parks and Wildlife, Fort Collins, Colorado, USA. http://cpw.state.co.us/Documents/Research/Mammals/Publications/CPWPredictiveLynxMapReport.pdf pp.1-17.

Jahnke, L. J., C. Phillips, S. H. Anderson, and L. L. McDonald. 1987. A methodology for identifying sources of indirect costs of predation control: A study of Wyoming sheep producers. Vertebr. Pest. Cont. Manage. Mat. 5, ASTM STP 974. pp 159-169.

Johnson, E. L. 1984. Applications to use sodium fluoroacetate (Compound 1080) to control predators; final decision. Fed. Reg. 49(27):4830-4836.

Johnson, D. H., A. B. Sargeant, and R. J. Greenwood. 1988. Importance of individual species of predators on nesting success of ducks in the Canadian Prairie Pothole region. Canadian Journal of Zoology 67:291-297.

Johnson, G. D. and M. D. Strickland. 1992. Mountain lion compendium and an evaluation of mountain lion management in Wyoming. Western EcoSystems Tech., Inc., 1406 S. Greeley Hwy., Cheyenne, WY 82007. 41 pp.

Jones, H. W., Jr. 1939. Winter studies of skunks in Pennsylvania. J. Mammal. 20: 254-256.

Jones, P. V., Jr. 1949. Antelope management. Coyote predation on antelope fawns: main factor in limiting increase of pronghorns in the upper and lower plains areas in Texas. Texas Game and Fish. 7:4-5, 18-20.

Jonker, S. A., J. F. Organ, R. M. Muth, R. R. Zwick, and W. F. Siemer. 2009. Stakeholder norms toward beaver management in Massachusetts. Journal of Wildlife Management 73:1158-1165.

Kahn, R. 2001. Chapter 3 - Draft regulation discussion - Furbearer seasons. CPW, 4/23/01. Presented to Colo. Wildl. Comm. @http://wildlife.state.co.us/wildlifecommission/2001/may2001/premtg/ch3part3.pdf. *Last visited 4/27/05*.

Kaufmann, J. H. 1999. Ringtail and White-nosed Coati. Pp. 500-508. *In* M. Novak, J. Baker, M. Obbard, B. Mallock, Eds. Wild Furbearer Management and Conservation in North America. Rev. ed. Minist. Nat. Res., Ont., Ca. 1150 pp.

Keech, M. A., M. S. Lindberg, R. D. Boertje, P. Valkenburg, B. D. Taras, T. A. Boudreau, and K. B. Beckmen. 2011. Effects of predator treatments, individual traits, and environment on moose survival in Alaska. Journal of Wildlife Management 75:1361-1380.

Keister, G. P., and M. J. Willis. 1986. Habitat selection and success of sage-grouse hens while nesting and brooding. Progress report. Pitman Robinson Proj. W-87-R-2, Ore. Dept. Fish and Wildl. Portland.

Keith, L. B. 1961. A study of waterfowl ecology on small impoundments in southeastern Alberta. Wildl. Monogr. 6.

Keith, L. B. 1974. Some features of population dynamics in mammals. Int. Cong. Game Biol. 11:17-59.

Knowlton, F. F. 1964. Aspects of coyote predation in south Texas with special reference to white-tailed deer. Ph.D. Thesis, Purdue Univ. Lafayette. 147 pp.

Knowlton, F. F. 1972. Preliminary interpretation of coyote population mechanics with some management implications. J. Wildl. Manage. 36:369-382.

Knowlton, F. F. and L. C. Stoddart. 1983. Coyote population mechanics: another look. Proc. NW Section Wildl. Soc., March 1978. Publ. Forest, Wildl. and Range Exp. Sta., Univ. Idaho, Moscow. 14:93-111.

Knowlton, F. F. and L. C. Stoddart. 1992. Some observations from two coyote-prey studies. Pp 101-121 *in* A. H. Boer, ed., Ecology and Management of the Eastern Coyote. Univ. of New Brunswick, Fredericton, New Brunswick, Canada.

Knowlton, F.F., E.M. Gese and M.M. Jaeger. 1999. "Coyote depredation control: an interface between biology and management." J. Range Manage. 52:398-412.

Koehler, G. 1987. The Bobcat. *In* Silvestro, R. L. Ed. Audubon Wildlife Report, The National Audubon Society, New York, N.Y. pp.399-409.

Kohn, B. E. 1982. Status and Management of Black Bears in Wisconsin. Wisconsin Department of Natural Resources Technical Bulletin, Vol. 129.

Kolenosky, G. B., and S. M. Strathearn. 1999. Black Bear. Pp. 442-454. *In* M. Novak, J. Baker, M. Obbard, B. Mallock, Eds. Wild Furbearer Management and Conservation in North America. Rev. ed. Minist. Nat. Res., Ont., Ca. 1150 pp.

Krausman, P. R., B. D. Leopold, R. F. Seegmiller, and S. G. Torres. 1989. Relationships of bighorn sheep and habitat in Western Arizona. Wildl. Monogr. 102.

Kurzejeski, E. W., L. D. Vangilder, and J. B. Lewis. 1987. Survival of wild turkey hens in north Missouri. Journal of Wildlife Management 51:188-193.

Kushlan, J.A. 1979. Effects of helicopter censuses on wading bird colonies. J. Wildl. Manage. 43:756-760.

Laliberte, A. S. and W. J. Ripple. 2004. Range contractions of North American carnivores and ungulates. Bioscience 54:123-138.

Lambert, C. M. S., R. B. Wielgus, H. S. Robinson, D. D. Katnik, H. S. Cruickshank, R. Clarke, and J. Almack. 2006. Cougar Population Dynamics and Viability in the Pacific Northwest. Journal of Wildlife Management 70:246-254.

Latham, A. D. M., M. C. Latham, K. H. Knopff, M. Hebblewhite and S. Boutin. 2013. Wolves, white-tailed deer, and beaver: implications of seasonal prey switching for woodland caribou declines. Ecography 36:1276-1290.

Latham, R. M. 1960. Bounties Are Bunk. Nat. Wildl. Federation, Wash., D.C. 10 pp.

Layne, J. N. and W. H. McKeon. 1956. Some aspects of red fox and gray fox reproduction in New York. N. Y. Fish and Game J. 3:44-74.

Leblond, M., C. Dussault. J. P. Quellet, and M. H. St. Laurent. 2016. Caribou avoiding wolves face increased predation by bears – caught between Scylla and Charybdis. Journal of Applied Ecology. DOI: 10.1111/1365-2664.12658

LeCount, A. 1982. Population characteristics of Arizona black bears. J. Wildl. Manage. 46:861-868.

Leopold, A. S. 1933. Game Management. Charles Scribner & Sons, NY, NY. 481 pp.

Lindzey, F. G., W. D. Van Sickle, S. P. Laing, and C. S. Mecham. 1992. Cougar population response to manipulation in southern Utah. Wildlife Society Bulletin 20:224-227.

Logan, K. A. and L. L. Sweanor. 2001. Desert puma: evolutionary ecology and conservation of an enduring carnivore. Inland Press, Washington, D. C.

Logan, K. A., L. L. Sweanor, T. K. Ruth, and M. G. Hornocker. 1996. Cougars of the San Andres Mountains, Colorado. Final Report. Federal Aid Wildl. Restor. Project W-128-R. New Mexico Dep. Game and Fish, Santa Fe. 280 pp.

Lynch, G. M. 1972. Effect of strychnine control on nest predators of dabbling ducks. J. Wildl. Manage. 36:436-440.

MacDonald, D. W. and M. T. Newdick. 1982. The distribution and ecology of foxes. *Vulpes vulpes* (L.) in urban areas. *In* R. Bornkamm, J. A. Lee, and M. R. D. Seaward Eds. Urban Ecology. Blackwell Sci. Publ., Oxford, UK. Pp.123-135.

Manfredo, M. J., C. L. Pierce, D. Fulton, J. Pate, and B. R. Gill. 1999. Public acceptance of wildlife trapping in Colorado. Wildlife Society Bulletin 27:499-508.

Manzer, D. L. and S. J. Hannon. 2005. Relating grouse nest success and corvid density to habitat: a multi-scale approach. J. of Wildl. Manage. 69:110-123.

Mattson, D., K. Logan and L. Sweanor. 2011. Factors governing risk of cougar attacks on humans. Human-Wildlife Interactions. 5:135-158.

McBride, R. T. 1976. The status and ecology of the mountain lion *Felis concolor stanleyana* of the Texas-Mexico border. M.S. Thesis, Sul Ross St. Univ,. Alpine, Texas.

Messick, J. P. 1999. Badger. Pp. 586-597. *In* M. Novak, J. Baker, M. Obbard, B. Mallock, Eds. Wild Furbearer Management and Conservation in North America. Rev. ed. Minist. Nat. Res., Ont., Ca. 1150 pp.

Messier, F. and C. Barrette. 1982. The social system of the coyote *(Canis latrans*) in a forested habitat. Can. J. Zool. 60:1743-1753.

Messmer, T. A., M. W. Brunson, D. Reiter, and D. G. Hewitt. 1999. United States public attitudes regarding predators and their management to enhance avian recruitment. Wildl. Soc. Bull. 27:75-85.

Miller, S. D. 1990. Population management of bears in North America. Int. Conf. Bear Res. Manage. 8:357-373.

Mitchell, B. R., M. M. Jaeger, and R. H. Barrett. 2004. Coyote depredation management: Current methods and research needs. Wildl. Soc. Bull. 32:1209-1218.

Monteith, K. L., V. C. Bleich, T. R. Stephenson, B. M. Pierce, M. M. Connor, J. G. Kie and R. T. Bower. 2014. Life history characteristics of mule deer: effects of nutrition in a variable environment. Wildlife Mono. Vol 186. 56pp.

Mooring, M. S., T. A. Fitzpatrick, and T. T. Nishihira. 2004. Vigilance, predation risk, and the Allee effect in desert bighorn sheep. J. Wildl. Manage. 68(3):519-532.

Moreno, D. 2016. Black bear damage in Colorado. Unpublished report. USDA-APHIS-Wildlife Services, Grand Junction, CO. 13 pp.

Mott, D. F. 1985. Dispersing blackbird-starling roosts with helium-filled balloons. Proc. East. Wildl. Damage Cont. Conf. 2:156-162.

Mule Deer Working Group. 2012. Relationships among mule deer and their predators, Fact Sheet #1. www.muledeerworkinggroup.com

Munoz, J. R. 1977. Cause of Sheep Mortality at the Cook Ranch, Florence, Montana. 1975-1976. M.S. Thesis. University of Montana, Missoula. 55 pp.

Murphy, J. 2016. Colorado is the second fastest growing state in the U. S. Denver Post. July 7, 2016. Updated September 6, 2016.

Mysterud, I. 1977. Bear management and sheep husbandry in Norway, with discussion of predatory behavior significant foe evaluation of livestock losses. International Conf. Bear Res. 4:233-241.

Nass, R. D. 1977. Mortality associated with range sheep operations in Idaho. J. Range Manage. 30: 253-258

Nass, R. D. 1980. Efficacy of predator damage control programs. Proc. Vertebrate Pest Conf. 9:205-208.

National Agricultural Statistics Service (NASS). 1991. Sheep and goat predation loss. USDA, NASS, Wash., DC. 12 pp.

_____. 1992. Cattle and calves death loss. USDA, NASS, Wash., DC. 23 pp.

_____. 1995. Sheep and goat predator loss. USDA, NASS, Wash., DC. 16 pp.

_____. 1996. Cattle predator loss. USDA, NASS, Wash., DC. 23 pp.

_____. 1998. Colorado sheep and lamb losses - 1997. Colo. NASS, Lakewood. 4 pp.

_____. 2000. Sheep and goat predator loss. USDA, NASS, Wash., DC. 10 pp.

_____. 2001. Cattle predator loss. USDA, NASS, Wash., DC. 13 pp.

_____. 2003. Colorado sheep and lamb losses. USDA, NASS, CO, Lakewood. 4 pp.

_____. 2004. 2003 Colorado Agricultural Statistics. USDA, NASS, CO, Lakewood. @ http://www.nass.usda.gov/co/. *Last visited 4/17/05*

_____. 2014. 2012 Census of Agriculture: Colorado State and County Data. USDA, NASS. May 2014 515pp plus appendices.

National Business Center. 2004. Aviation Safety Review Fiscal Year 04. U.S. Dept. Interior, Nat. Bus. Ctr., Aviation Mgt. Directorate, Aviation Safety Div., Boise, ID Aircraft. 46 pp.

National Transportation Safety Board. 2003. Annual review of aircraft data, U.S. general aviation for calendar year 1999. Wash., DC. 56 pp.

_____. 2014. Review of US Civil Aviation Accidents, Calendar Year 2011. Annual Review NTSB/ARA-14/01. Washington, DC. 45 pp.

Neff, D. J., R. H. Smith, and N. G. Woolsey. 1985. Pronghorn antelope mortality study. Arizona Game and Fish Department, Res. Branch Final Rpt. Fed. Aid Wildl. Restor. Proj. W-78-R. 22 pp.

Neff, D. J., and N. G. Woolsey. 1979. Effect of predation by coyotes on antelope fawn survival on Anderson Mesa. Arizona Game and Fish Dept. Spec. Rept. No. 8. Phoenix. 36pp.

Neff, D. J., and N. G. Woolsey. 1980. Coyote predation on neonatal fawns on Anderson Mesa, Arizona. Proc. Biennial Pronghorn Antelope Workshop. 9:80-97.

New Mexico Game and Fish Department. 2010. Management strategy for cougar control to protect desert bighorn sheep. March 26, 2010. www.wildlife.state.nm.us/download/conservation/species/mammals/bighorn-sheep/management-plans/Cougar %20Control%20to%20Protect%20Desert%20Bighorn%20Sheep.pdf. Last accessed 12-29-2014.

Nohrenberg, G. A. 1999. The effects of limited predator removal on ring-necked pheasant populations in southern Idaho. Thesis, Univ. Idaho, Moscow.

Nunley, G. L. 1977. The effects of coyote control operations on nontarget species in Colorado. Great Plains Wildl. Damage Workshop 3:88-110.

O'Farrell, T.P. 1999. Kit Fox. Pp. 422-431. *In* M. Novak, J. Baker, M. Obbard, B. Mallock, Eds. Wild Furbearer Management and Conservation in North America. Rev. ed. Minist. Nat. Res., Ont., Ca. 1150 pp.

O'Gara, B. W., K. C. Brawley, J. R. Munoz, and D. R. Henne. 1983. Predation on domestic sheep on a western Montana ranch. Wildl. Soc. Bull. 11:253-264.

Oregon Department of Fish and Wildlife. 1993. Oregon Department of Fish and Wildlife Cougar Management Plan 1993-1998. Oregon Department of Fish and Wildlife, Portland, USA.

Oyler-McCance, S. J., J. St. John, S. E. Taylor, A. D. Apa and T. W. Quinn. 2005. Population genetics of Gunnison Sage-grouse: implications for management. J. Wildl. Manage. 69:630-637.

Ozoga, J. J. and E. M. Harger. 1966. Winter activities and feeding habits of northern Michigan coyotes. J. Wildl. Manage. 30:809-818.

Parks, M. and T. Messmer. 2016. Participant perceptions of range rider programs operating to mitigate wolf-livestock conflicts in the western United States. Wildl. Soc. Bull. 40:514-524.

Pattee, O. H., S. N. Wiemeyer, B.M. Mulhern, L. Sileo, and J. W. Carpenter. 1981. Experimental lead-shot poisoning in bald eagles. J. Wildl. Manage. 45:806-810.

Pearce, R., J. McLain, D. Henderson, T. Harris, and T. Tetz. 1999. Impacts of federal land livestock reductions on Nevada's economy. Rangeland Mag. 5 pp.

Pederson, J. 1988. Poster of Black Bear. Public Affairs, New Mex. Dept. Game and Fish. Santa Fe.

Peebles, K. A., R. B. Wielgus, B. T. Maletzke, and M. E. Swanson. 2013. Effects of Remedial Sport Hunting on Cougar Complaints and Livestock Depredations. Plos One 8.

Peek, J. M. 1980. Natural regulation of ungulates (what constitutes a real wilderness?) Wildl. Soc. Bull. 8:217-227.

Peek, J. M., B. Dennis, and T. Hershey. 2002. Predicting population trends of mule deer. J. of Wildl. Manage. 66:729-736.

Pfeifer, W. K., and M. W. Goos. 1982. Guard dogs and gas exploders as coyote depredation control tools in North Dakota. Proc. Vertebr. Pest Conf. 10:55-61.

Phillips, R. L. 1996. Evaluation of 3 types of snares for capturing coyotes. Wildl. Soc. Bull. 24:107-110.

Phillips, R. L., and K. S. Gruver. 1996. Selectivity and effectiveness of the Paw-I-Trip pan tension device on 3 types of traps. Wild. Soc. Bull. 24:119-122.

Phillips, R. L., and L. D. Mech. 1970. Homing behavior of a red fox. J. Mamm. 51:621.

Pils, C. M. and M. A. Martin. 1978. Population dynamics, predator-prey relationships and management of the red fox in Wisconsin. Wisc. Dept. Nat. Res., Techn. Bull. 105.

Pimlott, D. H. 1970. Predation and productivity of game populations in North America. Trans. Int. Congr. Game Biol. 9:63-73.

Pitt, W. C., F. F. Knowlton, and P. W. Box. 2001. A new approach to understanding canid populations using an individual-based computer model: preliminary results. End. Spp. Update 18:103-106.

Pojar, T. M. and D. C. Bowden. 2004. Neonatal mule deer fawn survival in west-central Colorado. J. of Wildl. Manage. 68:550-560.

Poole, K. G., and G. Mowat. 2001. Alberta furbearer harvest data analysis. Alberta Sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 31. Edmonton, AB. 51pp.

Porter, S. 2004. Corporation fined for poisoning bald eagle in KY. Wildl. Law News Q. 2:14.

Presnall, C. C., and A. Wood. 1953. Coyote predation on sage-grouse. J. Mamm. 34:127.

Pyrah, D. 1984. Social distribution and population estimates of coyotes in north-central Montana. J. Wildl. Manage. 48:679-690.

Ripple, W. J. and R. L. Beschta. 2006. Linking a cougar decline, trophic cascade and catastrophic regime shift in Zion National Park. Biological Conservation 133:397-408.

Ripple, W. J. and R. L. Beschta. 2012. Trophic cascades in Yellowstone: The first 15 years after wolf reintroduction. Biological Conservation 145:205-2013.

Riter, W. E. 1941. Predator control and wildlife management. Trans. N. Am. Wildl. Conf. 6:294-299.

Rivest, P., and J. M. Bergerson. 1981. Density, food habits, and economic importance of raccoons (*Procyon lotor*) in Quebec agrosystems. Can. J. Zool. 59:1755-1762.

Robel, R. J., A. D. Dayton, F. R. Henderson, R. L. Meduna, and C. W. Spaeth. 1981. Relationships between husbandry methods and sheep losses to canine predators. J. Wildl. Manage. 45:894-911.

Robinette, W.L., J. S. Gashwiler, and O. W. Morris. 1961. Notes on cougar productivity and life history. J. Mammal. 42:204-217.

Robinson, H. S., R. B. Wielgus and J. C. Gwilliam. 2002. Cougar predation and population growth on sympatric mule deer and white-tailed deer. Canadian Journal of Zoology 80:556-568.

Robinson, W. B. 1961. Population changes of carnivores in some coyote-controlled areas. J. Mamm. 42:510-515.

Rogers, L. L. 1976. Effect of mast and berry crop failures on survival, growth, and reproductive success of black bear. Transactions of the North American Wildlife and Natural Resources Conference, Vol. 41. pp. 431-438.

Rohwer, F. C., P. R. Garrettson, and B. J. Mense. 1997. Can predator trapping improve waterfowl recruitment in the Prairie Pothole region? Proc. Eastern Wildl. Damage Manage. Conf. 7:12-22.

Rolley, R. E. 1985. Dynamics of a harvested bobcat population in Oklahoma. J. Wildl. Manage.49:283-292.

Rolley, R. E. 1999. Bobcat. Pp. 670-681. *In* M. Novak, J. Baker, M. Obbard, B. Mallock, Eds. Wild Furbearer Management and Conservation in North America. Rev. ed. Minist. Nat. Res., Ont., Ca. 1150 pp.

Rosatte, R. C. 1999. Striped, spotted, hooded and hog-nosed skunks. Pp. 599-613. *In* M. Novak, J. Baker, M. Obbard, B. Mallock, Eds. Wild Furbearer Management and Conservation in North America. Rev. ed. Minist. Nat. Res., Ont., Ca. 1150 pp.

Rosatte, R. C. and J. R. Gunson. 1984. Dispersal and home range of striped skunks, *Mephitis mephitis*, in an area of population reduction in southern Alberta. Can. Field Nat. 98:315-319.

Rosatte, R.C., M.J. Power, and C.D. MacInnes. 1992. Density, Dispersion, Movements and Habitat of Skunks (*Mephitis mephitis*) and Raccoons (*Procyon Lotor*) in Metropolitan Toronto. Pp 932-944 in Wildlife 2001: Populations. D.R. McCullough and R.H. Barrett, Eds. Elsevier Science Publishers Ltd. England.

Ross, P. I., M. G. Jalkotzky, and M. Festa-Bianchet. 1997. Cougar predation on bighorn sheep in southwestern Alberta during winter. Can. J. Zool. 74:771-775.

Rossbach, R. 1975. Further experiences with the electroacoustic method of driving starlings from their sleeping areas. Emberiza 2:176-179.

Rowlands, I. W., and A. S. Parkes. 1935. The reproductive processes of certain mammals VIII. Reproduction in foxes (*Vulpes spp*.). Proc. Zool. Soc. London: 823-841.

Rowley, G. J. and D. Rowley. 1987. Decoying coyotes with dogs. Proc. Great Plains Wildl. Damage Cont. Work. 8:179-181.

Roy, L. D. and M. J. Dorrance. 1985. Coyote movements, habitat use, and vulnerability in central Alberta. J. Wildl. Manage. 49:307-313.

Ruediger, B, J. Claar, S. Gniadek, B. Holt, L. Lewis, S. Mighton, B. Naney, G. Patton, T. Rinaldi, J. Trick, A. Vandehey, F. Wahl, N. Warren, D. Wenger, and A. Williamson. 2000. Canada lynx conservation assessment and strategy. USDA, Forest Service Northern Region, USDI, Fish and Wildlife Service, BLM, and National Park Service, Missoula, Montana, Aug. 2000.

Ruth, T. K., M. A. Haroldson, K. M. Murphy, P. C. Buotte, M. G. Hornocker, and H. B. Quigley. 2011. Cougar survival and source-sink structure on Greater Yellowstone's northern range. J. Wildl. Manage. 6:1381-1398.

Sacks, B., and J. Neale. 2002. Foraging strategy of a generalist predator toward special prey: Coyote predation on sheep. Ecol. Appl. 12:299-306.

Sanderson, G. C. 1999. Raccoon. Pp 486-499. *In* M. Novak, J. Baker, M. Obbard, B. Mallock, Eds. Wild Furbearer Management and Conservation in North America. Rev. ed. Minist. Nat. Res., Ont., Ca. 1150 pp.

Sargeant, A. B. 1978. Red fox prey demands and implications to prairie duck production. J. Wildl. Manage. 42:520-527.

Sargeant, A. B., S. H. Allen, and R. T. Eberhardt. 1984. Red fox predation on breeding ducks in midcontinent North America. Wildl. Monogr. 89.

Sauer, J. R., J. E. Hines, and J. Fallon. 2004. The North American Breeding Bird Survey, Results and Analysis 1966-2003. Version 2004.1. USGS, Patuxent Wildl. Res. Cen., Laurel, MD.

Schaefer, R. J., S. G. Torres, and V. C. Bleich. 2000. Survivorship and cause-specific mortality in sympatric populations of mountain sheep and mule deer. Cal. Fish and Game 86:127-135.

Schmidt, R. H. 1989. Vertebrate pest control and animal welfare. Pp.63-68 *in* Vert. Pest Control and Manag. Materials. 6th Vol., ASTM STP 1055, K. A. Fagerstone and R. D. Curnow, Eds., Amer. Soc. Material and Testing, Philadelphia.

Schmidt, R.H. and M.W. Brunson. 1995. Assessing Public Attitudes toward Animal Damage Control Management Policies: Initial Findings. Utah State University. Logan, UT.

Schmidt, R. H., and R. J. Johnson. 1984. Bird dispersal recordings: an overview. ASTM STP 817. 4:43-65.

Schroeder, M. A., and R. K. Baydack. 2001. Predation and the management of prairie grouse. Wildl. Soc. Bull. 29:24-32.

Scott-Brown, J.M., S. Herrerod, and J. A. Reynolds. 1999. Swift fox. Pp. 432-441. *In* M. Novak, J. Baker, M. Obbard, B. Mallock, Eds. Wild Furbearer Management and Conservation in North America. Rev. ed. Minist. Nat. Res., Ont., Ca. 1150 pp.

Seidensticker, J. C., IV, M.G. Hornocker, W. V. Wiles, and J. P. Messick. 1973. Mountain lion social organization in the Idaho Primitive Area. Wildlife Monogr. 35. 60 pp.

Seidensticker, J. C., M. A. O'Connell, and A. J. Johnsingh. 1999. Virginia opossum. Pp. 246-263. *In* M. Novak, J. Baker, M. Obbard, B. Mallock, Eds. Wild Furbearer Management and Conservation in North America. Rev. ed. Minist. Nat. Res., Ont., Ca. 1150 pp.

Shaw, H. G. 1977. Impact of mountain lion on mule deer and cattle in northwestern Arizona. *In* Phillips, R. L. and C. Jonkel. Proc. Sym. Montana For. Conserv. Exp. Stn. Missoula, pp. 17-32.

Shaw, H. G. 1981. Comparison of mountain lion predation on cattle on two study areas in Arizona. pp. 306 - 318. Proc. Wild.- Livestock Relationships Symposium. Coeur d'Alene, ID. April 20-22, 1981.

Shaw, H. G. 1987. A mountain lion field guide. Federal Aid in Wildlife Restoration Project W-87-R, 3rd, Special Report Number 9. Arizona Game and Fish Dept., Phoenix.

Sheldon, W. G. 1950. Denning habits and home range of red foxes in New York State. J. Wildl. Manage. 14:33-42.

Shenk, T. 2004. Lynx Update, Colorado's Lynx. CPW @ http://wildlife.state.co.us /T&E/lynx.asp. 5pp.

Shenk, T. 2005. General locations of lynx (*Lynx canadensis*) reintroduced to southwestern Colorado from February 4, 1999 through February 1, 2005. Report for CPW, April 2005. 13 pp.

Shirota, Y. M., M. Sanada, and S. Masake. 1983. Eyespotted balloons are a device to scare gray starlings. Appl. Ent. Zool. 18:545-549.

Shivik, J. A., and D. J. Martin. 2001. Aversive and disruptive stimulus applications for managing predation. Proc. Wildl. Damage Manage. Conf. 9:111-119.

Sinclair, A. R. E. and C. J. Krebs. 2002. Complex numerical responses to top-down and bottom-up processes in vertebrate populations. Philosophical Transactions of the Royal Society of London. Series B. Biological Sciences 357:1221-1231.

Slate, D. A., R. Owens, G. Connolly, and G. Simmons. 1992. Decision making for wildlife damage management. Trans. N. A. Wildl. Nat. Res. Conf 57:51-62.

Smith, R. H., D. J. Neff, and N. G. Woolsey. 1986. Pronghorn response to coyote control - A benefit:cost analysis. Wildl. Soc. Bull. 14:226-231.

Sonenshine, D. E. and E. L. Winslow. 1972. Contrasts in distribution of raccoons in two Virginia localities. J. Wildl. Manage. 36:838-847.

Speake, D. W. 1985. Wild turkey population ecology on the Appalachian Plateau region of northeastern Alabama. Fed. Aid Proj. W-44-6, Final Rpt., Ala. Game and Fish Div., Montgomery.

Speake, D. W., R. Metzler, and J. McGlincy. 1985. Mortality of wild turkey poults in northern Alabama. J. Wildl. Manage. 49:472-474.

Stauber, E., N. Finch, P.A. Talcott, and J.M. Gay. 2010. Lead Poisoning of Bald (*Haliaeetus leucocephalus*) and Golden (*Aquila chrysaetos*) Eagles in the US Inland Pacific Northwest Region—An 18-year Retrospective Study: 1991–2008. Journal of Avian Medicine and Surgery 24:279-287.

Sterner, R. T., and S. A. Shumake. 1978. Bait-induced prey aversion in predators: some methodological issues. Behav. Bio. 22:565-566.

Stoddart, L. C. 1984. Relationships between prey base fluctuations and coyote depredation on sheep on the Idaho National Engineering Laboratory (INEL), 1979-1982. Unpublished Research Work Unit Report. Denver Wildl. Res. Cent. 16 pp.

Storm, G. L. 1972. Daytime retreats and movements of skunks on farmlands in Illinois. J. Wildl. Manage. 36:31-45.

Storm, G. L., R. D. Andrews, R. L. Phillips, R. A. Bishop, D. B. Siniff, and J. R. Tester. 1976. Morphology, reproduction, dispersal, and mortality of midwestern red fox populations. Wildlife Monog. 49.

Storm, G. L., and M. W. Tzilkowski. 1982. Furbearer population dynamics: a local and regional management perspective. Pp. 69-90 *in* G. C. Anderson, ed. Midwest Furbearer Management. Proc. Sym. 43rd Midwest Fish and Wildl. Conf., Wichita, KS.

Strickland, M. A., and C. W. Douglas. 1999. Marten. Pp. 530-546. *In* M. Novak, J. Baker, M. Obbard, B. Mallock, Eds. Wild Furbearer Management and Conservation in North America. Rev. ed. Minist. Nat. Res., Ont., Ca. 1150 pp.

Sweanor, L. L. and K. A. Logan. 2009. Cougar-human interactions. In M. G. Hornocker and S. Negri, editors. Cougar ecology and Conservation. Univ. of Chicago. Chicago and London.

Sweanor, L. L., K. A. Logan, J. W. Bauer, B. Millsap and W. M. Boyce. 2008. Puma and human spatial and temporal use of a popular California State Park. J. Wild.. Manage. 72:1076-1084.

Tabel, H., A. H. Corner, W. A. Webster, and C. A. Casey. 1974. History and epizootiology of rabies in Canada. Canadian Veterinary J. 15:271-281.

Taylor, R. L., B. L. Walker, D. E. Naugle, and L. S. Mills. 2012. Managing multiple vital rates to maximize greater sage grouse population growth. J. of Wildl. Manage. 76:336-347.

Texas Department of Agriculture. 2003. Preventing pesticide misuse in controlling animal pests. Agriculture Department, Austin, TX @http://www.agr.state.tx.us/pesticide/. *Last visited 4/17/05.*

Theberge, J. B. and D. A. Gauthier. 1985. Models of wolf-ungulate relationships: when is wolf control justified? Wildl. Soc. Bull. 13:449-458.

Thomas, G. E. 1989. Nesting ecology and survival of hen and poult eastern wild turkeys in southern New Hampshire. Thesis, Univ. New Hamp., Durham.

Thompson, B.C., D. F. Miller, T. A. Doumitt, and T. R. Jacobson. 1992. Ecologically based management evaluation for sustainable harvest and use of New Mexico furbearer resources. Report by NM Coop. Fish and Wildl. Res. Unit, USFWS, to NM Dept. of Game and Fish. NM Fed. Aid Proj. W-129-R, Job 1. 131pp.

Tigner, J. R. and G. E. Larson. 1977. Sheep losses on selected ranches in southern Wyoming. J. Range Manage. 30:244-252.

Till, J. A. 1992. Behavioral effects of removal of coyote pups from dens. Proc. Vertebr. Pest Conf. 15:396-399.

Till, J. A., and F. F. Knowlton. 1983. Efficacy of denning in alleviating coyote depredations upon domestic sheep. J. Wildl. Manage. 47:1018-1025.

Tobin, M. E., P. P. Woronecki, R. A. Dolbeer, and R. L. Bruggers. 1988. Reflecting tape fails to protect ripening blueberries from bird damage. Wildl. Soc. Bull. 16:300-303.

Todd, A. W. and L. B. Keith. 1976. Responses of coyotes to winter reductions in agricultural carrion. Alberta Recreation, Parks Wildl., Wildl. Tech. Bull. 5. 32 pp.

Trainer, C. E., J. C. Lemos, T. P. Kister, W. C. Lightfoot, and D. E. Toweill. 1981. Mortality of mule deer fawns in southeastern Oregon. 1968-1979. Oregon Dept. Fish Wildl. Res. Dev. Sect. Wildl. Res. Rpt. 10: 113 pp.

Trautman, C. G., L. Fredrickson, and A. V. Carter. 1974. Relationships of red foxes and other predators to populations of ring- necked pheasants and other prey, South Dakota. Trans. N. Amer. Wildl. Nat. Res. Conf. 39:241-252.

Treves, A., K. A. Martin, A. P. Wydeven, and J. E. Wiedenheoft. 2011. Forecasting environmental hazards and the application of risk maps to predator attacks on livestock. Bioscience 61:451-458.

Tullar, B. F. Jr., L. T. Berchielli, Jr., and E. P. Saggese. 1976. Some implications of communal denning and pup adoption among red foxes in New York. NY Fish and Game J. 23:93-95.

Turkowski, F. J., A. R. Armistead and S. B. Linhart. 1984. Selectivity and effectiveness of pan tension devices for coyote foothold traps. J. Wildl. Manage. 48:700-708.

Twichell, A. R. and H. H. Dill. 1949. One hundred raccoons from one hundred and two acres. J. Mamm. 30:130-133.

Udy, J. R. 1953. Effects of predator control on antelope populations. Utah Dept. Fish and Game. Salt Lake City, UT. Publ. No. 5, 48 pp.

Unsworth. J. W., D. F. Pac, G. C. White, and R. M. Bartmann. 1999. Mule deer survival in Colorado, Idaho, and Montana. J. Wildl. Manage. 63:315-326.

U.S. Fish and Wildlife Service (USFWS). 1978. Predator damage in the West: a study of coyote management alternatives. BLM-USFWS, Wash., D.C. 168 pp.

_____. 1979. Mammalian predator damage management for livestock protection in the Western United States. Final Environ. Impact Statement. BLM-USFWS, Wash., D.C. 789 pp.

_____. 1989. Progress report: control to enhance production of greater sandhill cranes at Malheur National Wildlife Refuge. BLM-USFWS-Malheur Nat. Wildl. Refuge. 16 pp.

_____. 1990. Progress report: control to enhance production of greater sandhill cranes at Malheur National Wildlife Refuge. BLM-USFWS-Malheur Nat. Wildl. Refuge. 17 pp.

_____. 1991. Progress report: control to enhance production of greater sandhill cranes at Malheur National Wildlife Refuge. BLM-USFWS-Malheur Nat. Wildl. Refuge. 17 pp.

_____. 1992. ESA Consultation and Biological Opinion on ADC Program. Received 28 July 1992 from Richard Smith, Acting Director, U.S. Fish and Wildlife Service. 69 pp.

_____. 1994. Final report: control to enhance production of greater sandhill cranes at Malheur National Wildlife Refuge. BLM-USFWS-Malheur Nat. Wildl. Refuge. 7 pp.

_____. 1996b. National Survey of Fishing, Hunting, and Wildlife-Associated Recreation - Colorado. U.S. Dept of Interior, USFWS; U.S. Department of Commerce, Economics and Statistics Administration, BUREAU OF THE CENSUS; FHW/96-CO; Issued March 1998.

_____. 1998a. Biological Opinion on Mexican gray wolf. Letter to USDA-APHIS-WS from USFWS. May 27. 16 pp. + App.

_____. 1998b. Final Environmental Assessment of Predator Damage Management to Enhance Nest Success and Survival of Attwater's Prairie-chicken. USFWS Region 2, Albuquerque, NM. 22 pp.

_____. 2000. Determination of Threatened Status for the Contiguous U.S. Distinct Population Segment of the Canada Lynx and Related Rule; Final Rule. Fed. Reg. 65(58), March 24, 2000, p. 16052-16086

_____. 2001. Local assistance sought in review of California condor experiment. USFWS Southwest Region, Albuquerque, NM. 2 pp.

_____. 2003. Service agents issue citations. USFWS News Release Nov. 4, 2003. @(http://news.fws.gov). 2pp.

_____. 2005. Biological Opinion on Canada lynx. Letter to USDA-APHIS-WS from USFWS. Aug 23.

_____. 2007. National Bald Eagle Management Guidelines. Wash., D.C. May 2007. 25 pp.

_____. 2009. Biological Opinion on Canada lynx. Letter to USDA-APHIS-WS from USFWS. December 7, 2009.

_____. 2012. Authorized Activities Involving Unintentional Eagle Disturbance. Midwest Region Division of Migratory Birds, Wash. D.C., April 2012, 2 pp.

_____. 2016. Bald and Golden Eagles: Population demographics and estimation of sustainable take in the United States, 2016 update. Division of Migratory Bird Management, Washington D.C., USA.

U.S. Forest Service (USFS). 1998. Final Environmental Impact Statement and Revised Land and Resource Management Plan-Routt National Forest, U.S. Dept. of Agriculture -USFS, 300+ pp. + App A-l.

U.S. General Accounting Office. 1990. Wildlife Management: Effects of Animal Damage Control Program on Predators. U.S. GAO Report to the Hon. Alan Cranston, U.S. Senate. GAO/RCED-90-149. 31 pp.

Urban, D. 1970. Raccoon populations, movement patterns, and predation on a managed waterfowl marsh. J. Wildl. Manage. 34:372-382.

Verts, B. J. 1967. The biology of the striped skunk. Univ. Illinois Press, Urbana. 218 pp.

Voigt, D. R. 1999. Red fox. Pp. 378-392. *In* M. Novak, J. Baker, M. Obbard, B. Mallock, Eds. Wild Furbearer Management and Conservation in North America. Rev. ed. Minist. Nat. Res., Ont., Ca. 1150 pp.

Voigt, D. R. and Berg 1999. Coyote. Pp. 344-357. *In* M. Novak, J. Baker, M. Obbard, B. Mallock, Eds. Wild Furbearer Management and Conservation in North America. Rev. ed. Minist. Nat. Res., Ont., Ca. 1150 pp.

Voigt, D. R., and B. D. Earle. 1983. Avoidance of coyotes by red fox families. Journal of Wildlife Management 47:852-857.

Voigt, D. R., and D. W. MacDonald. 1984. Variation in the spatial and social behavior of the red fox, *Vulpes vulpes*. Acta Zoologica Fennica. 171:261-265.

Vucetich, J. A., D. W. Smith and D. R. Stahler. 2005. Influence of harvest, climate and wolf predation on Yellowstone elk, 1961–2004. Oikos 111:259–270.

Wade, D. A. and J. E. Bowns. 1982. Procedures for evaluating predation on livestock and wildlife. Texas Agri. Ext. Serv. & TX Agric. Exp. Sta., Texas A&M Univ./USDI-USFWS Pub. B-1429. 42 pp.

Wagner, F.H. 1988. Predator control and the sheep industry. Iowa State Univ. Press. Ames, IA. 230 pp.

Wagner, F. H. and L. C. Stoddart. 1972. Influence of coyote predation on black-tailed jackrabbit populations in Utah. J. Wildl. Manage. 36:329-342.

Wagner, K. K. 1997. Preventive predation management: an evaluation using winter aerial coyote hunting in Utah and Idaho. Ph.D. Thesis. Utah St. Univ., Logan, UT.

Wagner, K. K. and M. R. Conover. 1999. Effect of preventive coyote hunting on sheep losses to coyote predation. J. Wildl. Manage. 63: 606-612.

Wakeling, B. F. 1991. Population and nesting characteristics of Merriam's turkey along the Mongolon Rim, Arizona. Arizona Game and Fish Dept. Techn. Rpt No. 7, Phoenix.

Walker, B. L, A. D. Apa, and K. Eichhoff. 2016. Mapping and prioritizing seasonal habitats for Greater Sage Grouse in northwestern Colorado. J. of Wildl. Manage. 80:63-77.

Western Association of Fish and Wildlife Agencies. 2016. Relationship among mule deer and their predators. Retrieved July 2016. 2 pp.

White, G. C., and R. M. Bartmann. 1998. Effect of density reduction on overwinter survival of free-ranging mule deer fawns. Journal of Wildlife Management 62:214-225.

White and Garrott. 2005. Northern Yellowstone elk after wolf restoration. Wildlife Society Bulletin 33: 942–955

Wielgus, R. B. and K. A. Peebles. 2014. Effects of wolf mortality on livestock depredations. PloS One 9(12)e113505.

Wildlife Services (WS). 1997a. Predator damage management in the Albuquerque ADC District in northern New Mexico. Environmental Assessment, Finding of No Significant Impact, and Record of Decision. 1/31/97. USDA-APHIS-WS, 8441 Washington NE, Albuquerque, NM 87113-1001. 108. pp.

_____. 1997b. Predator damage management in Western Colorado. Environmental Assessment, Finding of No Significant Impact, and Record of Decision. 10/30/97. USDA-APHIS-WS, 12345 West Alameda Parkway, Suite 204, Lakewood, Colorado 80228. 96 pp.

_____. 1999a. Predator damage management in Eastern Colorado. Environmental Assessment, Finding of No Significant Impact, and Record of Decision. 11/1/99. USDA-APHIS-WS, 12345 West Alameda Parkway, Suite 204, Lakewood, Colorado 80228. 98 pp.

_____. 2001. Predator damage management in Western Colorado. Monitoring Report (FY 1998 and 1999), Finding of No Significant Impact, and Record of Decision. 3/14/01. USDA-APHIS-WS, 12345 West Alameda Pkwy., Suite 204, Lakewood, CO 80228. 12 pp.

_____. 2005a. Biological Assessment of potential impacts on lynx by the USDA, APHIS Colorado Wildlife Damage Management Program. USDA-APHIS-WS. Submitted January 2005. 45 pp.

_____. 2005b. Finding of No Significant Impact, and Record of Decision for predator damage management in Colorado. 12/16/05. USDA-APHIS-WS, 12345 West Alameda Parkway, Suite 204, Lakewood, Colorado 80228. 26 pp plus appendices.

_____. 2005c. Predator damage management in Colorado. Environmental Assessment, Finding of No Significant Impact, and Record of Decision. October 2005. USDA-APHIS-WS, 12345 West Alameda Parkway, Suite 204, Lakewood, Colorado 80228. 163 pp.

_____. 2009. Biological Assessment of potential impacts on lynx by the USDA, APHIS Colorado Wildlife Damage Management Program. USDA-APHIS-WS. Submitted June 11, 2009. 6 pp.

_____. 2013. Final environmental assessment, finding of no significant impact, and decision for bird damage management in Colorado. January 2013. USDA-APHIS-WS, 12345 West Alameda Parkway, Suite 204, Lakewood, Colorado 80228. 186 pp plus appendices.

_____. 2016. Biological assessment for predator damage management in Colorado. July 29, 2016. USDA-APHIS-WS, 12345 West Alameda Parkway, Suite 204, Lakewood, Colorado 80228. 44 pp plus appendices.

Wildlife Society, The. 1990. Conservation Policies of the Wildlife Society. The Wildl. Soc., Wash., D.C. 20 pp.

Williams, L. E., D. H. Austin, and T. E. Peoples. 1980. Turkey nesting success in a Florida study area. Proc. National Wild Turkey Symp. 4:102-107.

Willis, M. J., G. P. Keister, D. A. Immell, D. M. Jones, R. M. Powell, and K. R. Durbin. 1993. Sage-grouse in Oregon. Wildl. Res. Rept. No. 15. Ore. Dept. Fish and Wildl., Portland.

Windberg, L. A. and F. F. Knowlton. 1988. Management implications of coyote spacing patterns in southern Texas. J. Wildl. Manage. 52:632-640.

Yeager, L. E. and R. G. Rennels. 1943. Fur yield and autumn foods of the raccoon in Illinois River bottom lands. J. Wildl. Manage. 7:45-60.

APPENDIX A: Addressing Neonate Mule Deer Survival in the Piceance Basin

PROGRAM NARRATIVE STUDY PLAN
FOR MAMMALS RESEARCH
FY 2016-17

State of:	Colorado	:	Parks and Wildlife
Cost Center:	3430	:	Mammals Research
Work Package:		:	
Task No.		:	
		:	
Federal Aid Project No.			

Addressing Neonate Mule Deer Survival in the Piceance Basin

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Cooperators

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STUDY PLAN APPROVAL

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PROGRAM NARRATIVE STUDY PLAN
FOR MAMMALS RESEARCH
FY 2016-17 – FY 2018-19

Addressing Neonate Mule Deer Survival in the Piceance Basin

A Study Plan Proposal Submitted by:
Chuck Anderson, Mammals Research Leader, Colorado Parks and Wildlife

A. NEED

The Piceance Basin in northwest Colorado (GMU 22) represents winter range supporting the largest migratory mule deer (*Odocoileus hemionus*) population in Colorado. This area has been the focus of research and monitoring efforts since the late 1940's and likely represents one of the best documented mule deer populations in North America. Research efforts conducted during the 1980s (Bartmann *et al*. 1992) documented a high density deer population (mean winter density = 63/km^2) that appeared to be at or near carrying capacity. During the early 1990s, this population declined to about 1/3 of the previous winter range density (mean winter density = 23/km^2; White and Bartmann 1998), likely due to exceeding the forage capacity on winter range.

Thirteen years later (January 2008), another research effort was initiated to address mule deer/energy development interactions in the Piceance Basin (Anderson 2015; Federal Aid Project No. W-185-R), where similar data are being collected to provide comparisons to mule deer demographic data from the 1980s and early 1990s. In comparing data between the 2 time periods (1982-1990 before the decline, and 2008-present from unmanipulated control areas): (1) December fawn weights have increased (averaging 3.7 kg heavier), (2) over-winter fawn survival (Dec – June) has more than doubled (averaging 0.737 versus 0.351), and (3) winter starvation has become rare (<3% of collared fawns), which was common during the 1980s (averaging 33% annually), which suggests mule deer in the Piceance Basin are no longer limited by habitat conditions. Further evidence that this population is no longer limited by forage conditions is evident in the animal-indicated Nutritional Carrying Capacity (NCC; Monteith *et al*. 2014) from doe body condition measurements providing annual lamda estimates ranging from 1.01 – 1.04 (values >1.0 suggest the population is below NCC), except during 2011 when lamda was slightly below 1.0.

While current research (Anderson 2015; Federal Aid Project No. W-185-R) indicates habitat no longer appears to be the limiting factor, annual winter fawn recruitment has declined from ~73 fawns/100 does to ~49 fawns/100 does, and the average mule deer densities since 2008 (mean late winter density = 19.1/km^2) are comparable to the relatively low levels observed during 1994 and 1995 (mean mid-winter density = 23.5/km^2; White and Bartmann 1998). Because over-winter fawn survival is high, but early winter fawn recruitment appears low, there is need to discern why fewer fawns may be arriving on winter range in the Piceance Basin. Data collected during the ongoing research largely rules out issues surrounding low fecundity, as measured pregnancy and twining rates have been consistently high, averaging 95% since 2009 and 1.75 in utero fawns/doe. Thus, evidence suggests that wildlife biologists need information to better understand early fawn survival, from birth until December.

Newborn fawn survival has been addressed in the Piceance Basin the past 4 years (in partial collaboration with Colorado State University). Thus far, neonate survival has been relatively low, (~40%) with a large portion of mortality attributed to predation (at least 49% of collared fawns) and low frequency of malnutrition (<4%). This suggests predation may be limiting neonatal (i.e., 0–6 months old, June – December) survival and recruitment to winter range if predation is additive to other types of mortality (e.g., disease, starvation). Monteith *et al*. (2014) reported high predation rates of mule deer neonates in California (>60% bear predation) and document that predation rather than nutrition was limiting the population.

Past research evaluating success of predator reduction to enhance ungulate populations has provided mixed results. Hurley *et al*. (2010) addressed coyote (*Canis latrans*) and cougar (*Puma concolor*) reduction to enhance mule deer populations in Idaho. They reported that coyote predation of mule deer was related to lagomorph abundance and coyote control exhibited no influence on early winter fawn recruitment. However, cougar reduction resulted in increased survival and winter fawn recruitment, but was largely ineffective when environmental factors (drought, severe winters) limited mule deer populations. Keech *et al*. (2011) addressed wolf (*C. lupus*) and bear (*Ursus* spp.) predation on moose (*Alces alces*) in Alaska and noted that predator reduction enhanced moose populations when environmental factors were non-limiting (i.e., during summer, fall). Predator reduction may benefit prey populations when they are not limited by habitat/environmental conditions, when predation is identified as a limiting factor, and when predator reduction is focused in scale to effectively reduce predation rates and timed to address critical periods in prey survival (Mule Deer Working Group 2012).

To address the reason for declining winter fawn recruitment in the Piceance Basin and identify potential management options, we propose to continue monitoring newborn fawn survival for another 3 years, while simultaneously implementing short-term and focused predator control in a treatment area and comparing fawn survival to an unmanipulated control area (Figure 1). This information will provide evidence to determine if predation is additive or compensatory to other types of mortality (e.g., disease, starvation). If neonate predation appears additive to other forms of mortality, focused predator reduction during mule deer parturition may be useful to enhance neonate survival and recruitment in mule deer populations experiencing decline and not limited by environmental conditions. If, on the other hand, neonate predation appears compensatory, predator management should be disregarded as a management option to enhance neonate survival and recruitment. Conditions in the Piceance Basin are comparable to other western Colorado mule deer populations where high winter fawn survival and low starvation frequency has been documented and this information will likely be applicable to declining or below objective deer herds in the western third of the state exhibiting factors inconsistent with climate or habitat limitations (e.g., low starvation frequency, good forage conditions).

B. OBJECTIVES

To assess neonate mule deer survival and recruitment in the Piceance Basin in response to predator control of black bears (*U. americanus*) and cougars, this project will evaluate focused predator removal efforts just prior to and during the spring birthing period on a summer range treatment area for the next 3 years and comparing neonate survival rates to an unmanipulated control area. Comparisons to 4 years of pretreatment survival rates in the treatment and 3 years in the control area (Peterson 2016) will also be available to address the additive or compensatory nature of predation on neonate mule deer survival.

C. EXPECTED RESULTS OR BENEFITS

1) Address additive or compensatory nature of predation relative to neonate mule deer survival and recruitment.
2) Evaluate the utility of spring predator management in enhancing mule deer fawn survival and recruitment.

D. APPROACH

Doe Captures and Demographic Data

Ongoing research to address mule deer/energy development interactions (Anderson 2015; Federal Aid Project No. W-185-R) will support adult female capture efforts early March 2017 to attach GPS radio-collars (G-2110D, Advanced Telemetry Systems, Isanti, MN, USA) and provide dam specific data for pregnancy status, fetal counts, and adult female body condition. Specific capture and handling

procedures are addressed in Anderson and Freddy (2008) and Anderson (2015). Pregnant females on winter range will be equipped with vaginal implant transmitters (VITs; MOD M3930, Advanced Telemetry Systems, Isanti, MN, USA) to facilitate spring neonate capture and collaring efforts following birth on the predator reduction summer range (Fig. 1).

Neonate captures and monitoring

Daily fixed-wing aircraft flights will be used to monitor VITs and identify birth sites and timing on the predator treatment summer range. Once expelled VITs are detected, field crews will be directed to birth site locations to locate and capture newborn fawns. Neonate searches will typically last up to 30–45 minutes and will not exceed 1 hour. Due to past logistical complications during neonate captures on the control summer range (being more widely dispersed with private and remote land access complications), we plan to focus neonate capture efforts in a few high density areas targeting collared and uncollared adult females during parturition without the aid of VITs. Each neonate will be handled with sterile nitrile latex gloves to minimize the transfer of human scent, blindfolded, and placed in a cloth bag to measure body mass. Hind foot length, chest girth, age (days), and sex will also be recorded. Each neonate will be fitted with an expandable radio-collar (M4210, ATS, Isanti, MN, USA) with a 4 hour mortality sensor and designed to drop off after 8-10 months; radio-collars will be modified for drop-off by splicing the collar and inserting 2 lengths of rubber surgical tubing. Handling time will be ≤ 5 minutes and neonates will be placed in the precise location where they were located to minimize abandonment.

Neonate collar signals will be monitored daily from fixed wing aircraft while monitoring doe VITs and collar signals. After all VITs are expelled and/or accounted for, monitoring of neonate collar signals will continue daily from the ground and from fixed wing aircraft weekly. Daily monitoring will afford us the ability to detect mortalities and assess fetal survival within 24 hours. Monitoring of neonate signals will continue until a mortality signal is detected. Once detected, neonates and/or collars will be located from the ground or air and if any part of a carcass is present a thorough field necropsy will be conducted to determine cause-specific mortality.

Addressing Differences in Survival

Preliminary results will be reported annually using age-specific Kaplin-Meier survival estimation. Final analyses will be conducted using multi-state survival estimation methods (Lebreton *et al*. 2009) in Program MARK (White and Burnham 1999). Each neonate mortality will be assigned one of three states including predation, starvation, and other assuming a reduction in predation concurrent with an increase in survival. Sibling dependency and overdispersion in survival estimates will be addressed by conducting data-bootstrap analyses in Program MARK (Bishop *et al*. 2008).

Sample Size

A total of 55-60 pregnant females will receive VITs during March captures from the winter range study areas (Fig. 1). Because past fetal counts have averaged 1.75 (C. Anderson, unpublished data) and assuming a small number of VIT failures and that some adult females will be inaccessible on summer range, we conservatively estimate a minimum of 60 neonate captures on the predator treatment summer range (Fig. 1). A minimum of 40 neonates will be targeted from the control study area. Bishop *et al*. (2009) reported statistical power (1-β) of 0.81 to detect a 15% difference in neonate survival assuming survival of control fawns = 0.40, which is consistent with previous neonate survival rates in the Piceance Basin. Thus, sample sizes from the previous 4 years (n = 55 – 85) and proposed sample sizes for the next 3 years should be sufficient to conservatively detect a 15% increase/difference in fawn survival following predator control assuming this mortality is additive.

Predator Reduction

Following guidelines from the Mule Deer Working Group (2012) to address the likely factor limiting fawn survival/recruitment (predation), applying focused predator reduction to sufficiently reduce predation rates (>15%), and identifying the critical survival period when habitat is non-limiting, we will

focus predator control efforts on a relatively small summer range parturition area (1,277 km^2, Figure 1) during a 2 month period (May 1 – June 30) just prior to and during mule deer parturition. Because this area consists primarily of private lands limiting hunter access and spring hunting seasons are currently unavailable, USDA Wildlife Services (WS) will be contracted to address spring predator reduction efforts. A large portion of summer range in the predator treatment study area is owned by energy companies, most of which have been collaborators with the current mule deer/energy development research since 2008 (Anderson 2015). Ron Velarde (Northwest Regional Manager, CPW) will take the lead in arranging agreements between agencies and energy companies to conduct predator control efforts.

Because black bear predation has been most prevalent the past 4 years (averaging 14% of collared neonates), predator control efforts will focus on this species. Cougar (*Puma concolor*) predation has also been notable (averaging 8%) and therefore will be a secondary species for control efforts. Predation from other predatory species (coyotes, bobcats, golden eagles) has been relatively minor (averaging ≤5% per species) and therefore these species will not be targeted during predator control efforts; coyote (Hurley *et al*. 2010) and bobcat predation of mule deer may be more compensatory than cougar and black bear predation. Although average predation rates of 23% have been documented from black bears and cougars combined, a large portion of unknown predation (11%) and unknown mortality (9%) of neonates documented the past 4 years is likely also related to these predators. To illicit a significant effect on predation rates to adequately address the additive or compensatory influence on neonate survival, predation should be reduced by 20%. The level of predator removal required to achieve this reduction in overall predation is currently speculative given that we are not aware of previous research to addressed individual cougar and black bear predation rates for mule deer neonates. However, we propose that focal removal (targeting areas of past predation activity) of 5-10 cougars and 10-20 black bears annually will provide the desired predation rate reduction. Our approach will need to be flexible to insure we achieve the desired predation rate reduction of ≥20%. While the objective is to reduce cougar and black bear densities in this focal area, overall densities at the much larger Data Analysis Unit (DAU) scale (representing population level biological units) should be minimally influenced; the predator treatment summer range area (Fig. 1) represents 6% mountain lion DAU L-7 and 16% of black bear DAU B-1.

Cougar and black bear removal methods employed by WS will consist of cage traps, culvert traps, foot snares, and trailing hounds for capture and a firearm will be used for euthanasia. Although probability of capturing non-target species is low, the non-lethal capture methods employed will provide for immediate release during daily trapping efforts. NEPA requirements for this project are currently under review in an Environmental Assessment prepared by USDA Wildlife Services. All bears and cougars killed by WS personnel will be reported to CPW within 5 working days of the taking. Reporting shall consist of a CPW Bear and Lion Form completed by WS personnel and forwarded to CPW personnel. Required sample collections from each carcass will include meat and blood samples for stable isotope diet analysis and a first premolar for aging. WS personnel will make every effort to salvage all black bear and cougar hides and meat for CPW disposal or distribution. If the carcass is not salvageable, the entire carcass, including hide, head, feet, skull and gall bladder will be destroyed in the field immediately upon taking possession of the animal. WS personnel will destroy all bear gall bladders in the field. Whenever feasible, the carcass of bears and cougars will be properly cared for and transported to CPW, meat will be donated to needy families, and other parts will be destroyed or used for educational purposes. Family groups (females with young) will not be euthanized and will be translocated and released at least 50 km from the capture site.

E. Location

This research will occur on summer ranges for mule deer that occupy the Piceance Basin winter range in northwest Colorado (portions of Game Management Units 22, 31 and 32 in Moffat and Garfield counties; Fig. 1). Detailed study area and habitat descriptions are provided by Anderson (2015).

F. Schedule of Work

Activity	Date
Adult female captures on winter range (from ongoing research)	March 2017–2019
Black bear and cougar removal	May 1–June 30, 2017–2019
Neonate capture and collaring efforts	Late May–June 2017–2019
Neonate survival monitoring	Late May–mid Dec. 2017–2019
Data analyses and manuscript preparation	Dec. 2019–2020

G. Estimated Costs

FY 2016-17 (field work beginning May 2017)

Description	Unit cost	Sub total
Temporary personal services	14 technicians for 6 weeks	$ 59,555
Contract personal services	WS predator control	$ 50,000
Operating		
VITs	60 X $250	$ 15,000
Neonate collars	40 X $234	$ 9,360
Fixed-wing flights	48 hours X $314	$ 15,072
Rental trucks	3 X $3,300	$ 9,900
Rental truck tires	8 X $250	$ 2,000
Temp truck fuel	2 X $1,500	$ 3,000
Misc. equipment		$ 5,000
Total		$168,887

FY 2017-18 – FY 2018-19

Description	Unit cost	Sub total
Temporary personal services	14 technicians for 6 weeks	$ 59,555
Contract personal services	APHIS predator control	$ 50,000
Operating		
VITs	60 X $250	$ 15,000
Fixed-wing flights	48 hours X $314	$ 15,072
Rental trucks	3 X $3,300	$ 9,900

Rental truck tires	8 X $250	$ 2,000
Temp truck fuel	2 X $1,500	$ 3,000
Misc. equipment		$ 5,000
Total		$159,527

H. Related Federal Projects

This project will primarily occur on energy development company and BLM properties, including a small amount of private lands. The study does not involve formal collaboration with any federal agencies, other than contracting predator control efforts with WS, nor does the work duplicate any ongoing federal projects.

I. Literature Cited

Anderson, C. R. Jr. 2015. Population performance of Piceance Basin mule deer in response to natural gas resource extraction and mitigation efforts to address human activity and habitat degradation. Federal Aid Project No. W-185-R Annual Report, Colorado Parks and Wildlife, Fort Collins, USA.

Anderson, C. R., and D. J. Freddy. 2008. Population performance of Piceance Basin mule deer in response to natural gas resource extraction and mitigation efforts to address human activity and habitat degradation. Wildlife Research Reports Mammal Section, Colorado Division of Wildlife, Fort Collins, USA.

Bartmann, R. M., G. C. White, and L. H. Carpenter. 1992. Compensatory mortality in a Colorado mule deer population. Wildlife Monographs No. 121.

Bishop, C. J., G. C. White, and P. M. Lukacs. 2008. Evaluating dependence among mule deer siblings in fetal and neonatal survival analyses. Journal of Wildlife Management 72:1085-1093.

Bishop, C. J., G. C. White, D. J. Freddy, B. E. Watkins, and T. R. Stephenson. 2009. Effect of enhanced nutrition on mule deer population rate of change. Wildlife Monographs No. 172.

Hurley, M. A., J. W Unsworth, P. Zager, M. Hebblewhite, E. O. Garton, D. M. Montgomery, J. R. Skalski, and C. L. Maycock. 2010. Demographic response of mule deer to experimental reduction of coyotes and mountain lions in southeastern Idaho. Wildlife Monographs No. 178.

Keech, M. A., M. S. Lindberg, R. D. Boertje, P. Valkenburg, B. D. Taras, T. A. Boudreau, and K. B. Beckmen. 2011. Effects of predator treatments, individual traits, and environment on moose surivial in Alaska. Journal of Wildlife Management 75:1361-1380.

Lebreton, J. D., J. D. Nichols, R. J. Barker, R. Pradel, and J. A. Spendelow. 2009. Modeling individual animal histories with multistate capture-recapture models. Pages 87-173 *in* H. Caswell, editor. Advances in Ecological Research, Vol 41.

Monteith, K. L., V. C. Bleich, T. R. Stephenson, B. M. Pierce, M. M. Conner, J. G. Kie, and R. T. Bowyer. 2014. Life-history characteristics of mule deer: effects of nutrition in a variable environment. Wildlife Monographs 186:1-56.

Mule Deer Working Group. 2012. Relationships among mule deer and their predators, Fact Sheet #1. www.muledeerworkinggroup.com

Peterson, M. E. 2016. Reproductive success, habitat selection, and neonatal mule deer mortality in a natural gas development area. Dissertation, Colorado State University, Fort Collins, USA.

United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. 2005. Environmental Assessment of predator damage management in Colorado. USDA, APHIS, Grand Junction, CO USA.

White, G. C., and R. M. Bartmann. 1998. Effect of density reduction on overwinter survival of free-ranging mule deer fawns. Journal of Wildlife Management 62:214-225.

White, G. C., and K. P. Burnham. 1999. Program mark: Survival estimation from populations of marked animals. Bird Study 46:120-139.

J. Tables and Figures

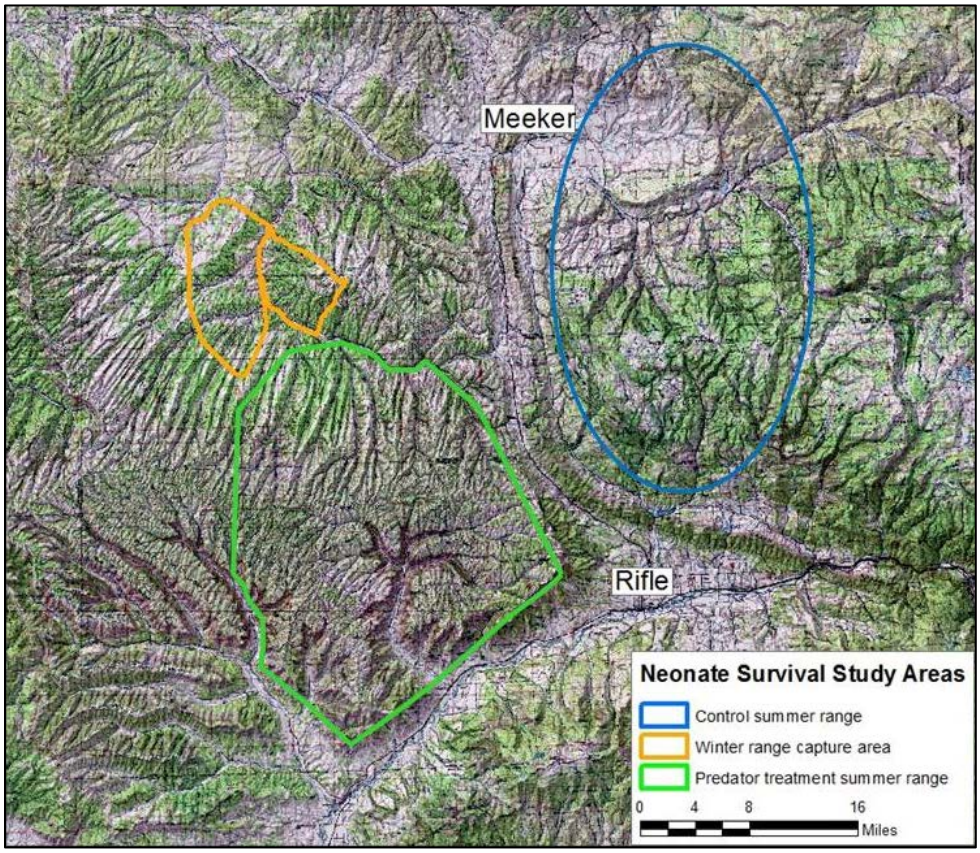

Figure 1. Mule deer winter and summer ranges, Piceance Basin, northwest Colorado. Pregnant adult females on winter range (orange boundary) will receive vaginal implant transmitters to facilitate neonate capture and collaring efforts in the predator treatment area (green boundary). Noenates in the control area (blue boundary) will be opportunistically captured to provide survival rate comparisons between summer ranges with and without focused predator reduction.

K. Appendices

Compliance

NEPA
NEPA requirements for this project are currently under review in an Environmental Assessment prepared by USDA Wildlife Services.

Endangered Species Act
The project work in this proposal does not include any ground disturbing activities and therefore will not disturb any sensitive plant species in the area. Trapping activities could influence medium to large mammal species. Sensitive mammal species in Colorado that could be influenced by trapping efforts include Canada lynx (*Lynx Canadensis*), wolverine (*Gulo gulo*), and gray wolf (*Canis lupus*). Potential occurrence of these species in the predator treatment study area is extremely low given that the area represents low quality lynx habitat and that no records of these species have been documented in this area in recent history. In the unlikely event that one of these species is caught during trapping efforts, the trapping methods employed are non-lethal and captured animals will be immediately released during daily trapping efforts.

Other Landscape-Oriented Federal Acts
This project will have no negative impact on the landscape, therefore it will not violate provisions of Federal Legislation governing floodplains, wetlands, historical sites, and prime and unique farmlands.

Americans With Disabilities Act
When hiring personnel as part of this project, qualified individuals will not be discriminated against based on disability. No structures or access points will be constructed as part of this research, and thus accessibility is not applicable.

Animal Welfare Act
Neonate captures in the predator treatment area have been addressed through an extension of CPW ACUC protocols 01-2012 below. Additional neonate capture and handling protocols for the control area and WS trapping and euthanasia protocols will be addressed through an addendum submitted to the CPW ACUC committee prior to project initiation.

COLORADO PARKS AND WILDLIFE ANIMAL CARE AND USE COMMITTEE (CPWACUC)
ADDENDUM TO ONGOING, APPROVED WILDLIFE RESEARCH PROJECTS

Note: This form may not be used for new wildlife research projects.

1. CPW ACUC File # 01-2012
2. Principal Investigator(s): Chuck Anderson Phone: 970-472-4335

3. Title of project: Effects of natural gas development disturbance on neonatal mule deer survival

4. Fiscal year of this project's initiation: 2012

5. List names of all new personnel associated with this project:

6. Are sample sizes or numbers of animals to be used the same as originally described with no substantive changes (i.e., 10% of original proposal)? If sample sizes or animal numbers are substantially greater or less than described in original study plan, provide a justification for this change.

   Maximum sample size will be reduced from 120 to 80 neonate captures annually due to reduction from 4 to 2 study areas. The 2 study areas removed proved to be too logistically difficult to maintain adequate sample sizes. This project will continue through 2018.

7. Is the animal component of the project the same as originally described with no substantive changes (e.g., anesthesia, analgesia, capture methods, euthanasia, species, surgical procedures, etc.)?

   Yes __X____ No _____. *If No, describe changes:*

8. Will the foregoing changes result in greater levels of pain, suffering, stress, discomfort, deprivation, etc., experienced by experimental animals than those originally described and approved?
   Yes ____ No__X_

   If answered yes, attach detailed justification and indicate here the date of search, source of literature search, date range searched, and key words an combination of key words searched to document the lack of alternative methods:

9. Will additional pain and suffering be controlled? Yes _____ No _____ N/A __X__
   If answered no, attach a detailed justification.

   If answered yes, attach a detailed description of how pain and suffering will be controlled.

10. If required, was the attending veterinarian consulted when planning these changes?
    Yes ____ No____

11. Does the proposed project now include planned euthanasia of animals? Yes ____ No____

Date: 5/25/2015 Signed: [signature]
Principal Investigator

Date: 5/ Signed: _____
ACUC Attending Veterinarian

Date: 5/25/15 Signed: [signature]

APPENDIX B: MULE DEER POPULATION RESPONSE TO COUGAR POPULATION MANIPULATION

PROGRAM NARRATIVE STUDY PLAN ADDENDUM
FOR MAMMALS RESEARCH
FY 20115-16

State of:	Colorado	:	Parks and Wildlife
Cost Center:	3430	:	Mammals Research
Work Package:		:	
Task No.		:	
		:	
Federal Aid Project No.			

Mule Deer Population Response to Cougar Population Manipulation

Principal Investigator
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Cooperators
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STUDY PLAN:

STUDY PLAN APPROVAL

Prepared by:	Mat Alldredge	Date:	August 22, 2016
Submitted by:	Mat Alldredge	Date:	
Reviewed by:		Date:	
		Date:	
		Date:	
Biometrician:		Date:	

Mule Deer Population Response to Cougar Population Manipulation

A. NEED

The recently adopted Colorado mule deer strategy identifies predation as one of the potential factors limiting Colorado mule deer populations. Since the adoption of the mule deer strategy by the Parks and Wildlife Commission, members of the Leadership Team developed a plan for the implementation of the strategy. As part of the implementation strategy, staff examined existing predator and deer research and monitoring data to identify areas where predation may be most limiting to mule deer, which in turn could be used to inform predator harvest/management decisions. In June 2015, CPW personnel from the SE Region, Terrestrial, and Research branches met to explore the concept for a project that examines how deer demographic parameters may change following cougar suppression.

Deer data analysis unit (DAU) D-16 is comprised of game management units (GMUs) 49, 57, 58 and 581 which are located on the north side of the Arkansas River between the towns of Leadville and Canon City (Figure 1). Beginning in 1999, D-16 was added as one of 5 intensive deer monitoring DAUs in the state. Under the intensive monitoring protocol, we typically monitor 80-90 radio collared adult does to determine annual survival rates and 60 radio collared fawns annually to determine over winter fawn survival rates. Since 1999, we have radio collared 1,086 adult does and 898 fawns in D-16 to examine annual adult survival and winter fawn mortality.

From 1999-2014 , averaging across all years, the leading known cause of both doe (6.4%) and fawn (7.5%) mortality has been cougar predation (Figure 3, 4 and Table 1, 2). Cougar predation has ranged from 0 to 60% (avg. 28%) of the total mortality for does and 0 to 64% (avg. 32%) of the total mortality for fawns (Calculated from table 1,2). Currently, the mule deer population in D-16 is (11,247) below the long-term population objective of 16,000-20,000 deer. Based on survival data from 1999-2014, deer population growth in D-16 might partially be limited by cougar predation on fawns and adult does (Figure 3 and 4).

Predation on mule deer is often identified as one of the potential reasons that populations are below the long-term objectives (Colorado West Slope Mule Deer Strategy http://cpw.state.co.us/Documents/MuleDeer/MuleDeerStrategy.pdf, Ballard *et al*. 2001). In D-16, the adult survival data and relatively high predation rates from 2008-2012 (Table 1) suggests that cougar predation could be contributing to this lower than objective mule deer population.

Overwinter fawn survival has shown similar patterns to annual doe survival ranging between 59.2% and 86.2% (Table 2). Since 2013, overwinter fawn survival has been near 80% (Table 2). However, early winter fawn:doe ratios in D-16 have averaged 54.7 fawns per 100 does (range 38.5 to 68.0) since 1995 (CPW, unpublished data). Assuming fetal rates for adult (≥ 2 years old) mule deer of 1.8 (Bishop *et al*. 2008), it would appear neonate survival is a bigger issue for population growth and recruitment than other demographic rates, unless doe survival drops below 80%. Using the above fetal rate (1.8), early winter fawn:doe ratio (54.7), and overwinter survival of 80%, survival to age one for mule deer would be 24.3%.

The success of a project to control predators to increase a population of mule deer is dependent upon the deer population in relation to the habitat carrying capacity (Ballard *et al*. 2001). If the population is at, or surpassed the habitat carrying capacity, it is likely that increases in survival rates caused by predator control will be compensated by other factors of mortality, such as malnutrition (Bartman *et al*. 1992). Conversely, if the population is below the habitat carrying capacity, reduction in mortality caused by predation could provide an additive response to increase survival rates of a mule deer population (Bleich and Taylor 1998; Hurley *et al*. 2004).

Examination of the malnutrition rates of fawns in D-16 can give some indication about whether a given population is at or exceeds carrying capacity. Since 1999, the highest rate of malnutrition was observed in 2004, when 5 of 57 (9%) fawns died from malnutrition causes (Table 2). Bartman *et al*. (1992) observed significantly higher rates of malnutrition in a NW Colorado mule deer herd, in which they documented reductions in predation rates being compensated by higher rates of malnutrition. The relatively low rates of malnutrition (1.6%) observed since 1999 suggests that the current population is below carrying capacity and limiting factors, such as predation, may be restricting mule deer population growth in D-16.

In order to assess the effect of management manipulations it is necessary to do this in an experimental framework with a control and treatment study area, otherwise the magnitude of the effect will be unknown as other limiting factors fluctuate. D-34 (GMUs 69, 691, 84, 86, and 861) is an adjacent mule deer DAU to the south of D-16, which has a similar mule deer population size (10,468) and habitat. Surveys (winter flights) also suggest that demographic rates are similar in terms of population ratios (45.2 fawns per 100 does based on 5 year average). Using D-16 and D-34 in a crossover design will allow for the manipulation of a potential limiting factor for mule deer population growth or survival and examining similarities in the response as the control and treatment is switched between the areas.

A research project will be conducted, beginning in the winter of 2016/2017, to examine the mule deer population response to cougar suppression. The study will be conducted in D-16 and the adjacent DAU, D-34. A crossover design will be used to examine the effects of cougar suppression in three stages. In stage one (years 1-3), cougar populations in D-16 will be suppressed (50% of population potential), while cougar populations in D-34 will be allowed to increase towards habitat potential with light harvest(10% harvest). Stage 2 (years 4-6) represents a recovery stage where both populations will be allowed to increase towards habitat potential (10% harvest). The final stage (years 7-9) represents the crossover where D-34 cougar populations will be suppressed (50% of population potential), while D-16 will continue to be allowed to increase towards habitat potential with light harvest (10% harvest).

The impact of cougar hunting on cougar populations, especially high levels designed to suppress populations, can be varied and is not well understood. Anderson and Lindzey (2005) demonstrated that a Wyoming cougar population could be significantly suppressed through 2 years of heavy harvest. Harvest rates of approximately 15% of the population have generally been shown as the tipping point between maintaining stable populations and decreasing populations. However, the percent adult female harvest is the crucial factor in population change.

The direct effect of harvest on population size is fairly clear but more subtle impacts on other demographic parameters is less clear, primarily due to a lack of information on these parameters. Cougars are inherently difficult to study because of their reclusive nature, small population sizes and large movement patterns. Technological advances, such as GPS collars, are only now allowing for the detailed study of cougars to understand these more subtle impacts. Past research has been limited by small sample sizes and case studies of a few events observed during the course of monitoring studies.

Harvest structure can be a useful tool for monitoring and managing cougar populations (Anderson and Lindzey 2005). Because the sex and age classes of cougars exhibit different behaviors and movement patterns (Barnhurst 1986) they also tend to differ in their vulnerability to harvest. The management experiment being conducted provides a unique opportunity to more completely develop our understanding of the relationship between harvest structure and cougar population structure. Understanding this relationship as populations are manipulated throughout the management experiment will provide critical information for management in the future as decisions are made about suppressing, stable or increasing cougar populations.

In addition to furthering CPW's understanding of harvest structure, this management experiment will provide us a significant amount of information on population level responses to various harvest strategies within a crossover design. Several studies have examined the impacts of harvest on cougar populations (Anderson and Lindzey 2005, Cooley *et al*. 2009, Ruth *et al*. 2011, Wielgus *et al*. 2013, Maletzke *et al*. 2014, Logan 2015), however no study that we are aware of has examined the impact of hunting at these two ranges in harvest level within a controlled crossover design. Such detail should allow for detailed data during decreasing and increasing phases of the population across the two study areas.

Density-dependent population regulation has a rich history and provides much of the basis for sustainable hunting and game management (Caughley 1977, Caughley and Sinclair 1994, Strickland *et al*. 1994). Compensatory mortality would predict that harvest mortality would be offset by density-dependent responses in reproduction, cub survival, and female population growth if harvest is primarily males because of reduced competition for resources. However, Wielgus *et al*. (2013) suggest that harvest of male cougars is not compensatory but is additive or possibly even depensatory.

One aspect of this study will be to closely examine cause specific mortality and develop a thorough understanding of levels of mortality in relation to population size and hunting pressure. Previous studies have suggested that male survival is lower in hunted populations (Lambert el al. 2006, Robinson *et al*. 2008, Ruth *et al*. 2011) but that female survival is lower in non-hunted populations (Logan and Sweanor 2001). Part of this is due to hunter selectivity on males but under situations of heavy harvest selectivity may decrease (Anderson and Lindzey 2005). The progression of the management experiment will directly allow us to measure cause specific survival during declining and increasing phases of a cougar population and under heavy and light harvest scenarios. This will allow a clear examination of non-hunting mortality rates, such as disease, intra-specific strife, or other natural mortality.

Similarly, cause specific survival of kittens throughout the stages of the project will provide essential information for management as this directly relates to population growth and recovery. Past research has suggested that increased harvest has actually led to decreased kitten survival because of infanticide (Cooley *et al*. 2009, Ruth *et al*. 2011). Increased infanticide has been suggested to relate to high male harvest as this leads to an increase in subadult males in the population and territorial instability (Logan and Sweanor 2010, Ruth *et al*. 2011). However, recent cougar research in Colorado have shown higher infanticide rates during a 5 year non-hunting period than the subsequent 5 year hunting phase of the study (Logan 2015).

Other aspects of cougar population growth are reproductive rates and immigration/emigration rates. Theory behind density-dependent relationships would suggest that reproductive rates would increase during scenarios of increased harvest. Increased male immigration has been documented as a result of increased harvest levels (Cooley *et al*. 2009, Wielgus *et al*. 2013). Almost all males disperse, regardless of cougar density, with typical dispersal distances of 85 to 100 km (Sweanor *et al*. 2000). However, 50 to 80% of females remain in their natal range, establishing overlapping home-ranges with other breeding females (Sweanor *et al*. 2000). In a recent cougar study in the Front-Range of Colorado, a significant portion of subadult males did not disperse (Alldredge, unpublished data). It is unclear how various levels of harvest will impact immigration/emigration rates and the potential impact that this could have on reproductive rates. Wielgus *et al*. (2013) suggest that increased immigration actually decreased female reproductive success.

There is also the perception that high immigration rates of subadult males will lead to increases in human conflict and livestock depredation. Some studies have indicated that harvest and subsequent increases in subadult males have correlated with human-cougar conflict (Peebles *et al*. 2013, Maletzke *et al*. 2014). However, Kertson *et al*. (2013), suggest that demographic class did not relate to human-cougar

interaction. This management experiment will provide direct information on human-cougar interactions with respect to changes in cougar populations, age structure, and immigration rates.

Cougar hunting has also been linked to changes in movement patterns, home-range size and diet composition. Keehner *et al*. (2015) suggested that female cougars will switch primary prey in an attempt to avoid conflict with male cougars in a hunted population. Increased hunting pressure was also suggested to increase home-range size and overlap in Washington (Maletzke *et al*. 2014) suggesting increased intraspecific conflict. Avoidance behaviors, increased space use and changes in movement patterns could all impact energetic demands of cougars, which could then alter foraging behavior.

Estimating cougar population size or density is also very useful for management purposes but has proven to be difficult and expensive to do. Historically mark-recapture techniques have been used, which require the physical capture and handling of animals and is therefore expensive. More recently developments have been made for noninvasive genetic sampling of cougars to get population estimates using scat detection dogs or hair snags. Alldredge (unpublished data) has been developing the hair snag approach and it is showing promising results. In a hunting situation, especially when reporting is mandatory, harvest data can be used to supplement these data in statistical population reconstruction models (Fieberg *et al*. 2010, Skalski *et al*. 2012, Gast *et al*. 2013). Through this management experiment both hair snag and harvest data will be available to test these procedures and develop techniques to obtain better population densities statewide. GPS collared cougars will provide baseline data for assessing potential bias in estimates.

B. OBJECTIVES

The primary objectives of this study are to examine the effects of cougar predation on mule deer demographic parameters in order to develop a better understanding of how cougar management strategies can impact deer management. These objectives are to evaluate the effects of cougar population size on mule deer demographic parameters and to evaluate the effectiveness of sport hunting to achieve high rates of cougar harvest. As part of this we will need to determine cougar density estimates both pre and post suppression periods.

In addition to the primary objectives we also intend to develop a better understanding of cougar harvest structure and population responses to varied levels of harvest. Age/sex structure of the harvest will be examined relative to cougar density and harvest levels in order to inform future management of the relationship between cougar population demographics and harvest. Harvest information will also be used to estimate population density through statistical population reconstruction. Cougar demographic rates (cause specific mortality, reproduction, immigration/emigration) will be estimated relative to population density and harvest level. In addition to this movement patterns, nuisance behavior and diet composition will be monitored in relation to density and harvest pressure.

C. EXPECTED RESULTS OR BENEFITS

Predator control is often raised as a management option to attain management goals for prey populations. Past research has not produced definitive results, especially at large scales. This study is designed to directly assess management strategies is a predator-prey system and the feasibility of such strategies. The primary results and benefits are:

1. Determining our ability to manipulate cougar populations through harvest.
2. Examining the effects on mule deer population demographics relative to changes in cougar density.

Cougar hunting is an ever increasingly contentious issue among our stakeholders. Unfortunately information on the subject is depauperate, conflicting, or based on small sample size. This study is designed to address some of the specific concerns raised about hunting and provide managers with tools to evaluate the success of future management strategies.

1.) Harvest information that can be utilized for future management of cougars.
    a. Evaluation of harvest structure relative to cougar population density and harvest levels during decreasing and increasing phases.
    b. Examination of population recovery after heavy harvest.
2.) Demographic information on cougar populations relative to cougar density and harvest regime.
    a. Density-dependence of cougar harvest.
    b. Cause specific mortality of adults and subadults.
    c. Cause specific mortality of kittens, including infanticide rates.
    d. Reproductive rates.
    e. Immigration/emigration rates.
    f. Movement patterns.
    g. Diet composition.
    h. Nuisance behavior.
3.) Further refinement of population estimation techniques.
    a. Statistical population reconstruction based on hair snag and harvest data.

D. APPROACH

Cougar Suppression

Both D-16 and D-34 have cougar hunt codes that are inclusive of all the GMUs within the DAU. Beginning in 2017, we will initiate suppression in D-16 for a 3 year period to suppress lion populations in the GMUs included in D-16. To suppress cougars we would increase lion harvest to a level which will have a significant impact on the density of cougars in the DAU (harvest rate of approximately 50% of the potential population). In years 1-6, D-34 would serve as the unsupressed cougar population for this experiment, where harvest quotas would be set to 3 lions per 1,000 km^2. It is expected that this rate of removal will reflect a reduction in the historic quota in D-34 and would result in an increasing cougar population. In years 4-9 harvest quotas would be decreased in D-16 to 3 cougars per 1,000 km^2 in order to allow the population to recover to a high level by year 7. In years 7-9, we would suppress lion populations in D-34 similarly too years 1-3 in D-16. If suppression levels are not reached by hunter harvest other approaches will be considered to reduce population densities. Other approaches may include using USDA Wildlife Services (using hounds, cage traps, and snares to capture cougars) or contracting with cougar hunters using hounds to increase removal efforts in the area to reach necessary removal levels. If these other approaches are utilized all meat and hides will be donated. Over the course of the study, we will examine the effects of cougar population density on mule deer demographic parameters using the crossover in cougar harvest in D-16 and D-34.

Deer DAU	Total Area km^2	Lion Habitat km^2	Potential Population	Suppressed Quota	Unsuppressed Quota
D16	6,138	4,096	123	61	12
D34	6,536	4,913	147	73	15

Cougar Monitoring

Recently, CPWs Mammals Research Section developed a sampling methodology and protocol for estimating cougar densities non-invasively through the collection of hair samples at hair snags (Yeager 2016, Alldredge unpublished data). Hair samples are genetically analyzed and the DNA profile of each cougar is used to develop a mark-recapture population estimate. We will use this methodology to estimate cougar abundance for both D-16 and D-34 throughout the study. Sampling will be conducted in year 3, 6 and 8 to capture the high and low population sizes. Monitoring in D-34 will occur in years 2, 7 and 9 to match up with the changes in harvest to capture the high and low population sizes as well. We can use this information to examine changes in cougar populations and also changes in sex and age class structure of the population both pre and post-harvest treatment. High lion harvest rates will be required to successfully reduce the population and it will be important to know if standard harvest management is successful in achieving this objective. An added benefit of monitoring the lion population under a suppression management objective would be evaluation of this approach for statewide lion management application.

A typical grid cell size used for population surveys is one that is equal to a quarter of the average home-range size for the species of interest (Otis *et al*. 1978, White *et al*. 1982, Williams *et al*. 2002). The average home-range size for female cougars on the Front-Range is about 100 km^2 (Alldredge, unpublished data), so we will use a 5 km by 5 km grid cell size as our primary grid (Figure 5). A 1 km by 1 km grid will be overlaid within the primary grid and one of these smaller cells will be randomly selected within each primary grid. Within each selected cell, specific sites will be selected based on likely areas to attract a cougar, property access, and field logistics. Given the size of the area every other primary grid cell will be sampled in a checker board pattern (67 cells), and additional cells will be incorporated if logistically feasible.

There will be 3 main sampling periods during the study, each 4 weeks in duration. During sampling, sites will have a call, a camera (if possible), a scent, a visual lure and 1 to 2 hair snaring devices. All sites will be checked at approximately weekly intervals for signs of visitation and hair, and batteries will be checked in cameras and calls.

All sites will be similar in design, containing the same elements. The primary attractant will be a predator call (fawn or rabbit distress) programmed to play a 5 to 10 second distress call 30 second intervals. These calls are also equipped with light sensors rendering them inactive during daylight hours. These calls also have a motion sensor so they play quieter when an animal is detected and a motion device is activated within the cubby to provide a moving visual stimulus. We will cable the calls <1 m up from the base of a tree. We will then build a perimeter around the tree with thick brush leaving obvious entry ways to the call and bait. We will configure lines of barbed wire (vertical or horizontal) within the entrance. Terrain and vegetation features will determine the height of the wire and consequently whether we desire a cougar to step over, under, or through 2 strands. A sticky roller will also be used as a secondary hair snag at each site. Additional hair snag devices may be tested where a target animal has to reach for bait over a hair snag. At each site, we will position an infrared motion-sensor camera (Reconyx® PC85 Rapidfire® or PC800 Hyperfire®) set to rapidly take 5 photos when triggered.

To minimize the possibility of sample contamination (multiple animals leaving hair) and degradation, we will check the sites for activity every week. We will consider hair on a single barb as one sample and denote quantity with a score of 1 – 3 (1 equals < 5 hairs, 2 equals 6 – 15 hairs, and 3 equals > 15 hairs). We will remove hair using sterile tweezers and re-sterilize the barb by passing a flame under it (Kendall *et al*. 2008, Settlage *et al*. 2008). We will place the hair in a small paper envelope. Paper envelopes will then be put in a plastic bag with a desiccant and stored at room temperature (Taberlet and Luikart 1999).

If hair is on the sticky rollers the entire roller will be collected, wrapped in wax paper and placed in a plastic bag.

We will tally detections as one per night per cougar based on photographic confirmation. Dependent kittens will not be counted. Though we expect all animals visiting the sites to be detected by camera, hair samples may also provide proof of cougar presence as well as identifying unmarked animals.

Hair samples will be processed at the USGS Fort Collins Science Center, FORT Molecular Ecology Lab. Taberlet *et al*. (1996) suggested that to achieve a correct genotype at a 99% confidence level, 8 U template DNA is needed (1 U is equivalent to the DNA content of 1 diploid cell). Therefore when possible, we will extract DNA from 10 hairs (Goossens *et al*. 1998, Boersen *et al*. 2003) using Qiagen DNeasy® Tissue Kits (Qiagen Inc., Valencia, CA). Samples will be genotyped using 9 – 12 microsatellite primers shown to have high variability in cougars (Ernest *et al*. 2000, Sinclair *et al*. 2001, Anderson *et al*. 2004). We will amplify the DNA by polymerase chain reaction (PCR) using a M13-tailed forward primer as described by Boutin-Ganache *et al*. (2001). Each locus will be analyzed via GeneMapper®.

Teeth from harvested cougars are also routinely collected in order to obtain the age structure of the harvested population. DNA will be extracted from teeth collected in D-16 and D-34 and genotyped following a similar procedure. This information may be incorporated into population estimates, although, if hunters are selective this may bias estimates. Potentially, within gender, the bias will not exist.

Capture-recapture models (Williams *et al*. 2002) will be used to estimate population size or density. A robust design framework (Kendall 1999) will be used initially to assess temporary emigration. Given the sampling design we will also be able to use spatially explicit capture-recapture models if multiple detections are made at multiple locations (Borchers and Efford 2008, Royle *et al*. 2009) or models that incorporate auxiliary telemetry data (Ivan *et al*. 2013) that provide information on the effective area sampled. Estimates will be compared across years for consistency.

Given the collaring effort that will be made during the study it will also be possible to use mark-recapture techniques to estimate populations, which would allow for an assessment of the genetic technique. Harvest data will also provide the opportunity to combine data sets and use statistical population reconstruction (Fieberg *et al*. 2010, Skalski *et al*. 2012, Gast *et al*. 2013). Combining these approaches should provide more robust estimates of cougar density. The development of these reconstruction models should also allow for better estimation of cougar densities across the state.

Monitoring Mule Deer Population Demographics

Since 1999, we have been monitoring a sample size of approximately 80 adult does in D-16 to examine annual deer survival. We have also collared 60 fawns annually to examine over-winter fawn mortality. For this project, we will maintain a similar sample size in D-16. In addition, we will capture (see appendix I for approved capture and handling guidelines) and monitor a sample size of 80 adult does and 60 fawns annually in D-34 to examine cause-specific adult doe annual survival and over-winter fawn survival. In both D-16 and D-34 we will conduct aerial surveys in the month of December annually to examine post-hunt fawn:doe:buck ratios. These values will be used to examine any potential changes in population performance as a result of this management experiment. Expectations are that doe survival in the heavily harvested area will maintain at or near 90%, while doe survival in the lightly harvested area will be lower, if predation is an additive factor.

December fawn:doe ratios and cause specific mortality are likely to be more sensitive parameters to examine in relation to differences in cougar harvest. It would appear that fawn mortality from birth up to

December is significant, as discussed above, and, if this is in part due to cougar predation on neonatal fawns, a difference should appear in December fawn:doe ratios between the two study areas.

We will also use a competing risks model (Heisey and Patterson 2006) to examine cause specific mortality rates. This will allow us to directly estimate mortality due to cougar predation and compare between years and study areas to determine if cougar harvest levels are influencing this mortality vector. Cougar population estimates may also be used in these models as covariates to examine the effect size of the cougar population on potential deer mortality.

Additional Considerations for Mule Deer Monitoring

As discussed previously, December fawn:doe ratios suggest a considerable amount of mortality occurring in neonates and much lower levels of mortality for over-winter fawn survival. Addressing cause specific neonatal mortality within the current study design may greatly improve our understanding of factors driving this population and why it is currently under objective. This will involve capturing adult does and fitting them with VITs, and subsequently capturing neonates following parturition and fitting them with expandable fawn collars to examine mortality sources from birth to age 1.

Capture and Handling of Cougars for Monitoring

In order to have sufficient power to detect changes in demographic parameters we need a large sample size. For example, current deer monitoring in Colorado use samples sizes of at least 50 does to detect changes in annual survival. In comparison, for D-16 and D-34 during the heavy harvest phase of the study we expect cougar population size to be 61 and 74 individuals, respectively. Because cougars exist at very low densities the majority of the population will have to be monitored during the heavy harvest phases of the study and a similar sample size will be maintained throughout.

Estimating infanticide rates relative to harvest levels is one of the key objectives of the study and likely the most difficult. Past studies have recorded a few cases of infanticide but generally not sufficient to calculate rates or compare differences. Because of this we will attempt to maintain a minimum of 20 collared adult females in each study area. Assuming birth intervals of 18 months, sample size of litters at risk will still be low over the course of the study. Kittens will be collared in all litters detected. Collaring adult and subadult males will also be important as these animals represent the mortality vector and it will be important to determine if infanticide is related to the age of the male. Such intensive collaring efforts should be sufficient to address the other objectives of the study, such as movement patterns and immigration/emigration rates.

Capture efforts for marking cougars will be conducted year-round, with the primary effort occurring between November and April. Capture with dogs and cage traps will be the primary methods for capturing adult and subadult cougars for radio collaring, but foot-hold snares and free-range darting may also be used if dogs or cage traps are not feasible. Capture of young kittens for fitting with expandable radio collars will be done by hand. Capture efforts for this part of the study are for marking individuals and collecting biological data, and not related to cougar suppression. A detailed description of CPW approved capture methods and handling procedures is provided (Appendix I).

Cougars will be ear-tagged in each ear with uniquely identifiable numbers marked with the withdrawal date, and a genetic sample collected using a 6 mm biopsy punch from each ear. A blood sample (approximately 6 ml) will be collected and archived for future use. All cougars will also be PIT tagged for individual identification by injecting a PIT tag in the back of the neck between the ears. Sex, approximate age from tooth wear, weight and morphometric measurements will be recorded. Vital signs will also be monitored during handling of cougars.

Adults, subadult females (over 1 year old) and subadult males (over 2 years old), will be fitted with satellite GPS collars equipped with proximity sensors. Subadult males estimated to be less than 2 years old will be fitted with expandable GPS collars equipped with proximity sensors because their neck size is still increasing at this age.

Den sites will be identified from clustering of GPS locations of the female. Once identified dens will be investigated to determine the number of kittens in each litter. Kittens will be collared using expandable VHF collars equipped with proximity sensors following procedures outlined in CPW approved capture and handling procedures (Appendix I). The proximity sensors found on all marked animals will allow for an assessment of interactions among individuals, especially in relation to the kittens. Proximity sensors on kitten collars will allow for an assessment of how much time the mother is with the kittens and will immediately send an alert when an unrelated individual comes in close contact with the kittens.

Harvest Structure of Cougars

It is mandatory in Colorado to check all harvested cougars. Age and sex structure of the harvest will be obtained through this mandatory check process. The relationship of the age and sex structure of the harvest will then be examined relative to cougar density, harvest regime and time since implementation of the harvest regime. A model will then be developed based on the harvest structure to predict current population characteristics. This will work in conjunction with the population reconstruction model.

Genetic samples will also be collected from all harvested cougars in the study area and surrounding DAUs by extracting DNA from the tooth collected for aging. These samples will be genotyped and analyzed for genetic relatedness within the study areas. We will also use genotype information to examine immigration/emigration at a larger extent. The specifics of this are not yet known but may actually require examining viral DNA to understand dispersal and source areas.

Demographic Rates of Cougars

We will use Bayesian statistical inference to estimate the cumulative incidence or cause-specific mortality function for adults, subadults and kittens (Heisey and Patterson 2006, Heisey 2009). Population density and harvest regime will be used as covariates in the model to determine if these factors have significant effects on cause specific mortality rates. Other factors that will be included are study area, time of year, landscape features, and human density. Density-dependence will be assessed with regard to levels of hunter harvest.

GPS data will be used to assess immigration/emigration rates between the two adjacent study areas. GPS data will also be used to evaluate dispersal patterns and distances. This will also be evaluated with respect to cougar density and harvest pressure. Genetic assessment of subadult males over a broader geographic area will be used to investigate the general dispersal patterns over a larger area that is more representative of typical dispersal distances.

Movement models will be used to assess landscape level factors that are driving the movement patterns of cougars on the landscape (Hanks *et al*. 2015). These movement patterns will be compared among harvest strategies and population densities to determine impacts of social structure and hunting pressure. Movement models will also include comparisons of individual cougars to determine if avoidance or spatial segregation occurs as population structures change in response to harvest. Female movement patterns will also be examined relative to live stage to determine the effects that kittens have on movement patterns and energetic demands.

E. Location

This work will be conducted in deer Data Analysis Units (DAU) D-16 and D-34 (Figures 1 and 2), located in the foothills and mountainous regions of south-east Colorado. D-16 consists of the Buffalo Peaks game management units (GMU) 49, 57, and 58, and one of the Cripple Creek/Pikes Peak GMU 581. Elevations in D16 range from 5,250 feet to 14,200 feet characterized by valley bottoms and canyons rising up to steep mountains. Vegetation ranges from grass/shrub communities and pinon/juniper and lower elevations and includes aspen, pine, and spruce/fir as elevations increase up to alpine communities. Public land in these units ranges from 35% to 80% of the area. Total area of D-16 is 6,138 km^2 with approximately 4,096 km^2 considered potential cougar habitat, with a potential population of 123 cougars.

D-34 consists of the Wet Mountains/Sangre De Cristo GMUs 69, 691, 84, 86, and 861. Elevations range from 5,168 feet to 14,064 feet characterized by prairie, foothill, rocky canyons at lower elevations and rising up to steep mountainous terrain. Vegetation ranges from short grass prairie, pinon/juniper, shrub communities at low elevations and includes aspen, pine and spruce/fir as elevations increase to alpine communities at higher elevations. Public land ranges between 30% to 70% of the area in these units. Total area of D-34 is 6,536 km^2 with approximately 4,913 km^2 considered potential cougar habitat, with a potential population of 147 cougars.

H. Related Federal Projects

Our research will be conducted on federal (i.e., BLM, USFS), state and private lands. The study does not duplicate any ongoing federal projects.

I. LITERATURE CITED

Alldredge, M.W. 2015. Cougar and black bear demographics and cougar-human interactions in Colorado. Federal Aid Project No. W-204-R Annual Report, Colorado Parks and Wildlife, Fort Collins, USA.

Anderson, C. R., F. G. Lindzey, and D. B. McDonald. 2004. Genetic structure of cougar populations across the Wyoming Basin: Metapopulation or megapopulation. Journal of Mammalogy **85**:1207-1214.

Anderson, C. R., and F. G. Lindzey. 2005. Experimental evaluation of population trend and harvest composition in a Wyoming cougar population. Wildlife Society Bulletin 33:179–188.

Ballard, W. B., D. Lutz, T. W. Keegan, L. H. Carpenter, and J. C. deVos. Jr., 2001. Deer-predator relationships: a review of recent North American studies with emphasis on mule and black-tailed deer. Wildlife Society Bulletin 29:99–115.

Barnhurst, D. 1986. Vulnerability of cougars to hunting. Thesis, Utah State University, Logan, USA.

Bartmann, R.M., G. C. White, and L. H. Carpenter. 1992. Compensatory mortality in a Colorado mule deer population. Wildlife Monographs 121.

Bleich, V. C., and T. J. Taylor. 1998. Survivorship and causespecific mortality in f1ve populations of mule deer. Great Basin Naturalist 58:265-272.

Boersen, M. R., J. D. Clark, and T. L. King. 2003. Estimating black bear population density and genetic diversity at Tensas River, Louisiana using microsatellite DNA markers. Wildlife Society Bulletin **31**:197-207.

Borchers, D.L., and M.G. Efford. 2008. Spatially explicit maximum likelihood methods for capture-

recapture studies. Biometrics 64:377-385.

Boutin-Ganache, I., M. Raposo, M. Raymond, and C. F. Deschepper. 2001. M13-tailed primers improve the readability and usability of microsatellite analyses performed with two different allele-sizing methods. Biotechniques **31**:24-+.

Caughley, G. 1977. Analysis of vertebrate population. John Wiley, New York, New York, USA.

Caughley, G. and J. Sinclair. 1994. Wildlife ecology and management. Blackwell Science, Malden Massachusetts, USA.

Cooley, H.S., R.B. Wielgus, G.M. Koehler, H.S. Robinson, and B.T. Maletzke. 2009. Does hunting regulate cougar populations? A test of the compensatory mortality hypothesis. Ecology 90:2913-2921.

Dreher, B. and J. Vayhinger. 2005. Cougar data analysis unit L-11 management plan. Colorado Division of Wildlife. 13 pages.

Ernest, H. B., M. C. T. Penedo, B. P. May, M. Syvanen, and W. M. Boyce. 2000. Molecular tracking of cougars in the Yosemite Valey region in California: genetic analysis using microsatellites and faecal DNA. Molecular Ecology 9:433-441.

Fieberg, J.R., K.W. Shertzer, P.B. Conn, K.V. Noyce, and D.L. Garshelis. 2010. Integrated population modeling of black bears in Minnesota: implications for monitoring and management. PLoS ONE 5(8):e12114.doi:10.1371/journal.pone.0012114.

Gast, C., J.R. Skalski, and D.E. Beyer. 2013. Evaluation of fixed- and random-effects models and multistage estimation procedures in statistical population reconstruction. Journal of Wildlife Management 77:1258-1270.

Goossens, B., L. P. Waits, and P. Taberlet. 1998. Plucked hair samples as a source of DNA: reliability of dinucleotide microsatellite genotyping. Molecular Ecology **7**:1237-1241.

Hanks, E.M., M.B. Hooten, and M.W. Alldredge. (2015) Continuous-time discrete-space models for animal movement. Annals of Applied Statistics 9:145-165

Heisey, D. M. 2009. Wildlife survival analysis applications using WinBUGS. http://www.nwhc.usgs.gov/staff/dennis_heisey.jsp. Accessed 11/18/2011.

Heisey, D. M., and B. R. Patterson. 2006. A review of methods to estimate cause-specific mortality in presence of competing risks. Journal of Wildlife Management 70:1544–1555.

Hurley, M. A., Unsworth, J. W., Zager, P., Hebblewhite, M., Garton, E. O., Montgomery, D. M. Montgomery, J. R. Skalski, and C. L. Maycock. 2011. Demographic response of mule deer to experimental reduction of coyotes and cougars in southeastern Idaho. Wildlife Monographs, 178(1), 1-33.

Ivan, J.S., G.C. White, and T.M. Shenk. 2013. Using auxiliary telemetry information to estimate animal density from capture-recapture data. Ecology 94:809-816.

Keehner, J.R., R.B. Wielgus, B.T. Maletzke, M.E. Swanson. 2015. Effects of male targeted harvest regime on sexual segregation in cougar. Biological Conservation 192 42-47.

Kendall, K. C., J. B. Stetz, D. A. Roon, L. P. Waits, J. B. Boulanger, and D. Paetkau. 2008. Grizzly bear density in glacier National Park, Montana. Journal of Wildlife Management **72**:1693-1705.

Kertson, B.N., R.D. Spencer, and C.E. Grue. 2013. Demographic influences on cougar residential use and interactions with people in western Washington. Journal of Mammology 94:269-281.

Lambert, C.M.S., R.B. Wielgus, H.S. Robinson, D.D. Katnik, H.S. Cruickshank, R. Clarke, and J. Almack. 2006. Cougar population dynamics and viability in the Pacific Northwest. Journal of Wildlife Management 70:246-254.

Logan, K.A. and L.L. Sweanor. 2001. Desert puma: evolutionary ecology and conservation of an enduring carnivore. Island Press, Washington, D.C.

Logan, K.A. and L.L. Sweanor. 2010. Behavior and social organization of a solitary carnivore. Pages 105-117 *in* M.G. Hornocker and S. Negri, editors. Cougar: ecology and conservation. University of Chicago Press, Chicago, Illinois, USA.

Logan, K. 2015. Mountain lion population responses to sport-hunting on the Uncompahgre Plateau, Colorado. Federal Aid Project No. W-204-R Annual Report, Colorado Parks and Wildlife, Fort Collins, USA.

Maletzke, B.T., R. Wielgus, G.M. Koehler, M. Swanson, H. Cooley, and J.R. Alldredge. 2014. Effects of hunting on cougar spatial organization. Ecology and Evolution 4:2178-2185.

Otis, D.L., K.P. Burnham, G.C. White, and D.R. Anderson. 1978. Statistical inference from capture data
on closed animal populations. Wildlife Monographs 62:1-135.

Peebles, K.A., R.B. Wielgus, B.T. Maletzke, and M.E. Swanson. 2013. Effects of remedial sport hunting on cougar complaints and livestock depredations. PLoS ONE 8:1-8.

Robinson, H.S., R.B. Wielgus, H.S. Cooley, and S.W. Cooley. 2008. Sink populations in carnivore management: cougar demography and immigration in a hunted population. Ecological Applications 18:1028-1037.

Royle, J.A., J.D. Nichols, K.U. Karanth, and A.M. Gopalaswamy. 2009. A hierarchical model for estimating density in camera-trap studies. Journal of Applied Ecology 46:118-127.

Ruth, T.K., M.A. Haroldson, K.M. Murphy, P.C. Buotte, M.G. Hornocker, and H.B. Quigley. 2011. Cougar survival and source-sink structure on Greater Yellowstone's northern range. Journal of Wildlife Management 75:1381-1398.

Settlage, K. E., F. T. Van Manen, J. D. Clark, and T. L. King. 2008. Challenges of DNA-based mark–recapture studies of American black bears. Journal of Wildlife Management **72**:1035-1042.

Sinclair, E. A., E. L. Swenson, M. L. Wolfe, D. C. Choate, B. Bates, and K. A. Crandall. 2001. Gene flow estimates in Utah's cougars imply management beyond Utah. Animal Conservation **4**:257-264.

Skalski, J.R., J.J. Millspaugh, and M.V. Clawson. 2012. Comparison of statistical population reconstruction using full and pooled adult age-class data. PLoS ONE 7(3):e33910.doi:10.1371/journal.pone.0033910.

Strickland, M.D., H.J. Harju, K.R. McCaggery, H.W. Miller, L.M. Smith, and R.J. Stoll. 1994. Harvest management. Pages 445-473 *in* T.A. Bookhout, editor. Research and management techniques for wildlife and habitats. The Wildlife Society, Bethesda, Maryland, USA.

Sweanor, L.L., K.A. Logan, and M.G. Hornocker. 2000. Cougar dispersal patterns, metapopulation dynamics and conservation. Conservation Biology 13:798-808.

Taberlet, P., S. Griffin, B. Goossens, S. Questiau, V. Manceau, N. Escaravage, L. P. Waits, and J. Bouvet. 1996. Reliable genotyping of samples with very low DNA quantities using PCR. Nucleic Acids Research **24**:3189-3194.

Taberlet, P. and G. Luikart. 1999. Non-invasive genetic sampling and individual identification. Biological Journal of the Linnean Society **68**:41-55.

Vitt, A. 2005. Cougar management guidelines for lion DAU L-16. Colorado Division of Wildlife. 13 pages.

White, G.C., D.R. Anderson, K.P. Burnham, and D.L. Otis. 1982. Capture-recapture removal methods for sampling closed populations. Los Alamos National Laboratory Publication LA-8787-NERP. Los Alamos, NM.

Wielgus, R.B., D.E. Morrison, H.S. Cooley, and B. T. Maletzke. 2013. Effects of male trophy hunting on female carnivore population growth and persistence. Biological Conservation 167:69-75.

Williams, B.K., J.D. Nichols and M.J. Conroy. (2002) Analysis and Management of Animal Populations. Academic Press. San Diego, CA.

J. Tables and Figures

Table 1: Doe mortality in D16, 1999-2014

Year	N	Mort N	Survived	Coyote	Mtn Lion	Other/Ukn Pred	Road Kill	Other	Malnutrition	Harvest	UKN	Survival
1999	49	6	43	0	0	1	0	0	0	0	5	87.8%
2000	47	7	40	0	0	0	0	2	0	0	5	85.1%
2001	40	12	28	0	3	5	1	2	1	0	0	70.0%
2002	43	13	30	0	1	0	2	1	1	0	8	69.8%
2003	47	14	33	0	1	0	3	0	1	0	9	70.2%
2004	62	11	51	0	3	0	1	0	0	0	7	82.3%
2005	61	4	57	0	1	0	0	0	0	0	3	93.4%
2006	69	10	59	0	6	1	0	0	0	0	3	85.5%
2007	80	13	67	3	3	1	0	0	3	0	3	83.8%
2008	80	20	60	3	9	0	0	0	3	0	5	75.0%
2009	83	24	59	3	6	1	6	0	1	0	7	71.1%
2010	83	20	63	1	9	1	1	0	1	0	7	75.9%
2011	92	20	72	3	6	0	4	0	0	0	7	78.3%
2012	90	24	66	3	14	0	3	0	0	1	3	73.3%
2013	81	11	70	2	5	0	0	0	1	0	3	86.4%
2014	79	9	70	1	2	0	1	1	0	1	3	88.6%
Total	1086	218	868	19	69	10	22	6	12	2	78	
%	100%	20.1%	79.9%	1.7%	6.4%	0.9%	2.0%	0.6%	1.1%	0.2%	7.2%	

Table 2: Fawn mortality in D16, 1999-2014

Year	N	Mort N	Survived	Coyote	Mtn Lion	Ukn Pred	Road Kill	Other	Malnutrition	Harvest	UKN	Survival
1999	53	18	35	0	0	0	2	0	0	0	16	66.0%
2000	49	20	29	0	5	2	0	0	1	0	12	59.2%
2001	46	11	35	1	7	2	1	0	0	0	0	76.1%
2002	43	8	35	1	1	0	2	0	0	0	4	81.4%
2003	60	9	51	0	2	0	1	2	0	0	4	85.0%
2004	57	10	47	1	2	0	1	0	5	0	1	82.5%
2005	57	9	48	2	3	0	0	1	1	0	2	84.2%
2006	57	10	46	1	4	1	0	0	1	0	3	80.7%
2007	58	8	50	1	2	0	0	1	3	0	1	86.2%
2008	60	19	41	3	5	1	0	0	0	0	10	68.3%
2009	58	22	36	5	8	0	1	0	0	0	8	62.1%
2010	63	12	51	2	7	0	0	0	0	0	3	81.0%
2011	61	16	45	4	6	0	1	0	0	0	5	73.8%
2012	57	19	38	8	6	0	0	0	0	0	5	66.7%
2013	58	12	46	2	5	0	0	0	2	0	3	79.3%
2014	61	13	48	3	4	0	1	0	1	0	4	78.7%
Total	898	216	681	34	67	6	10	4	14	0	81	
%	100%	24.1%	75.8%	3.8%	7.5%	0.7%	1.1%	0.4%	1.6%	0.0%	9.0%	

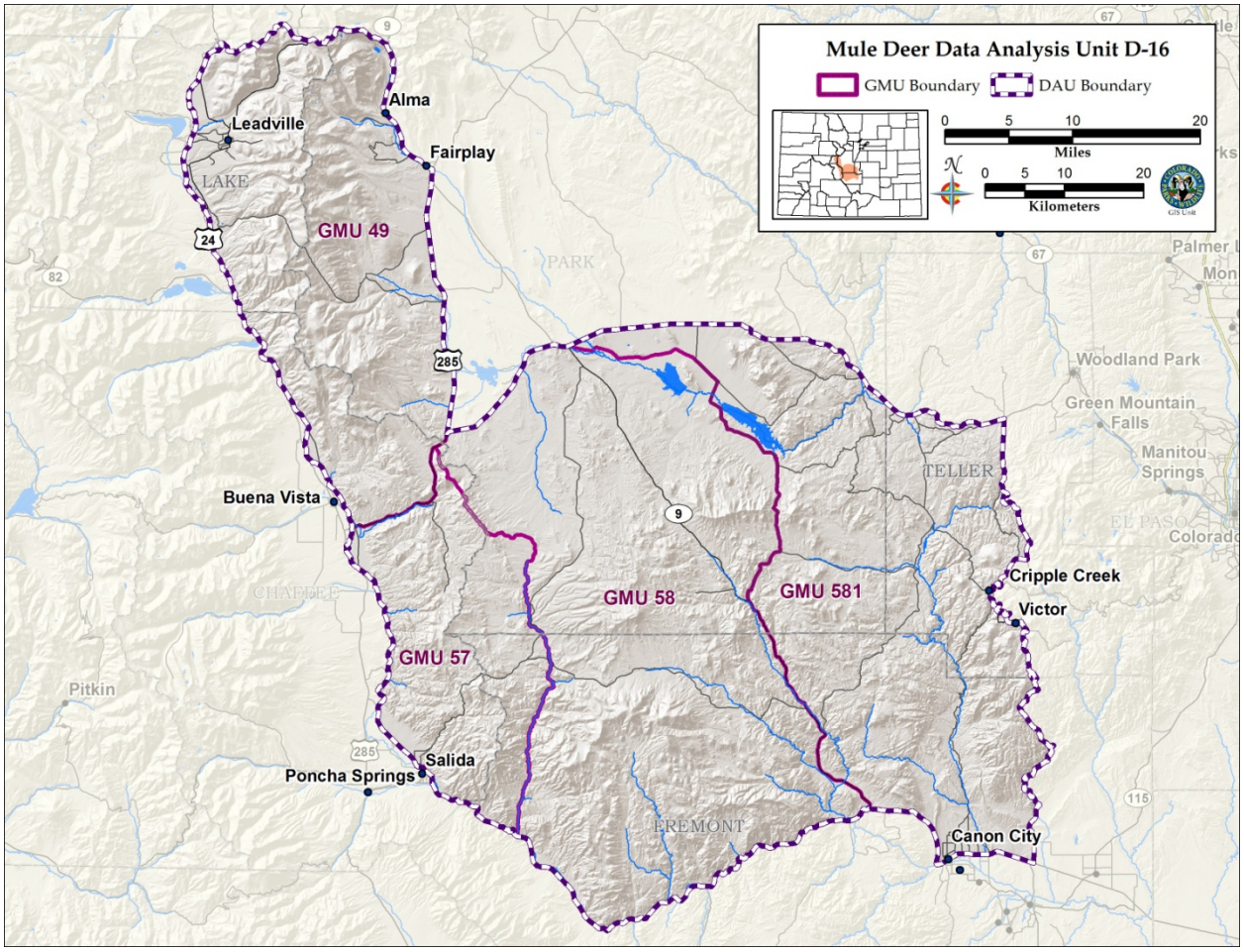

Figure 1. Deer DAU D-16, which includes game management units 49, 57, 58 and 581 in central Colorado

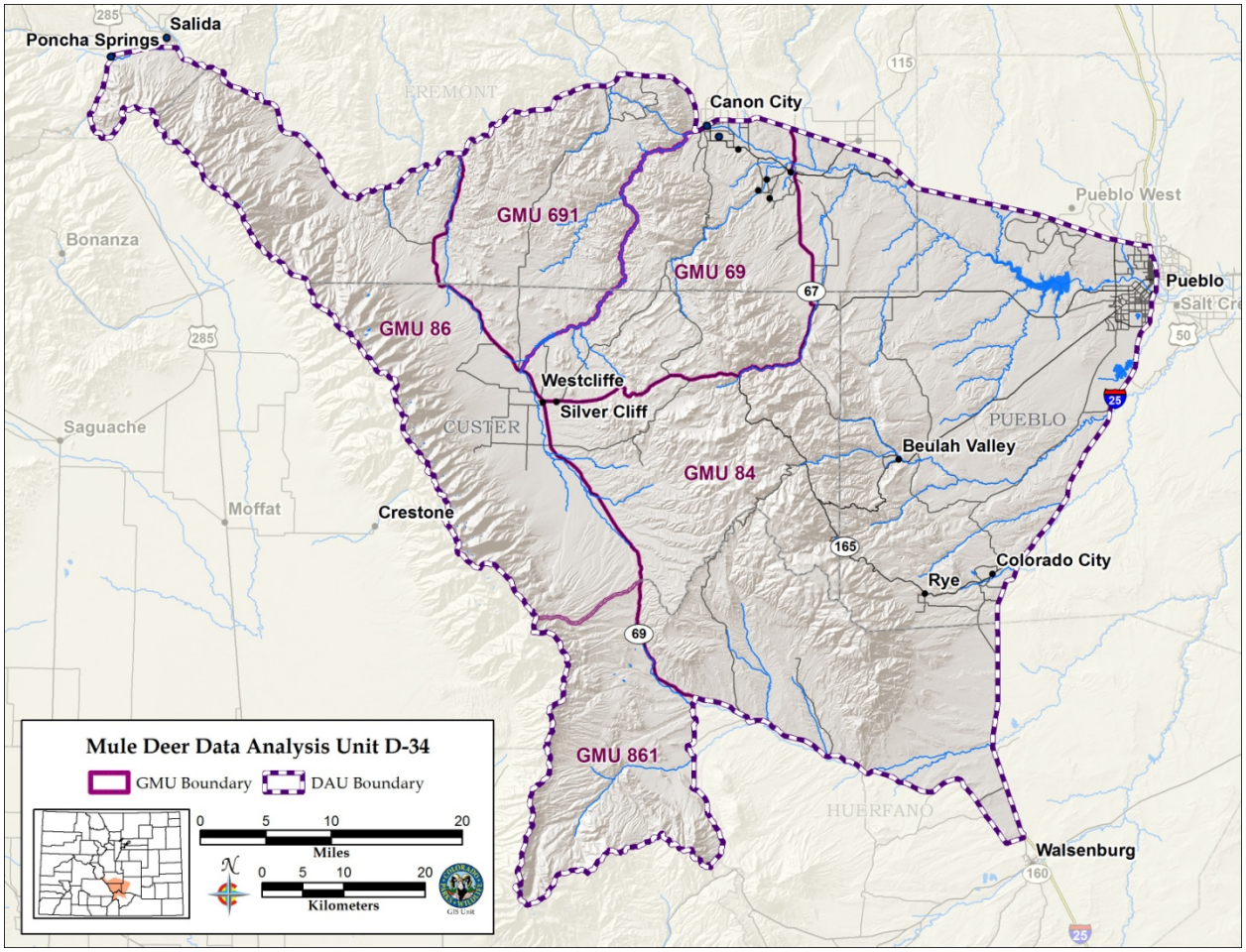

Figure 2. Deer DAU D-34, which includes game management units 69, 84, 86, 691, and 861 in central Colorado

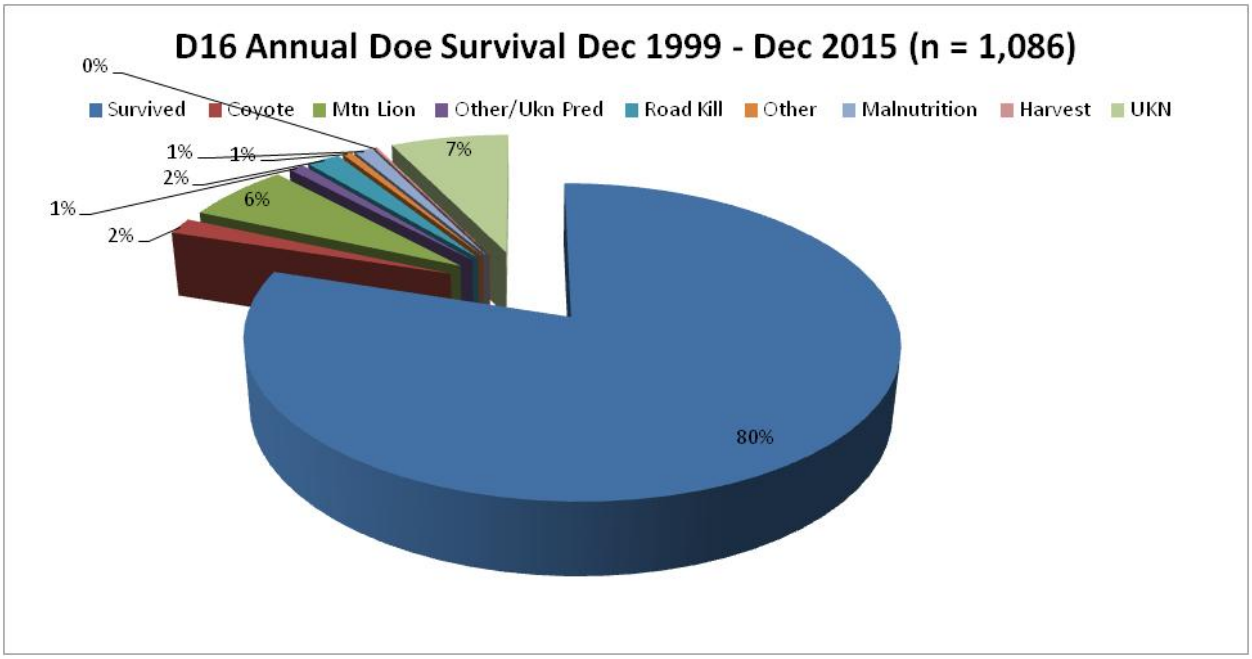

Figure 3. Annual doe survival and cause specific mortality for mule deer in D-16 from 1999-2015

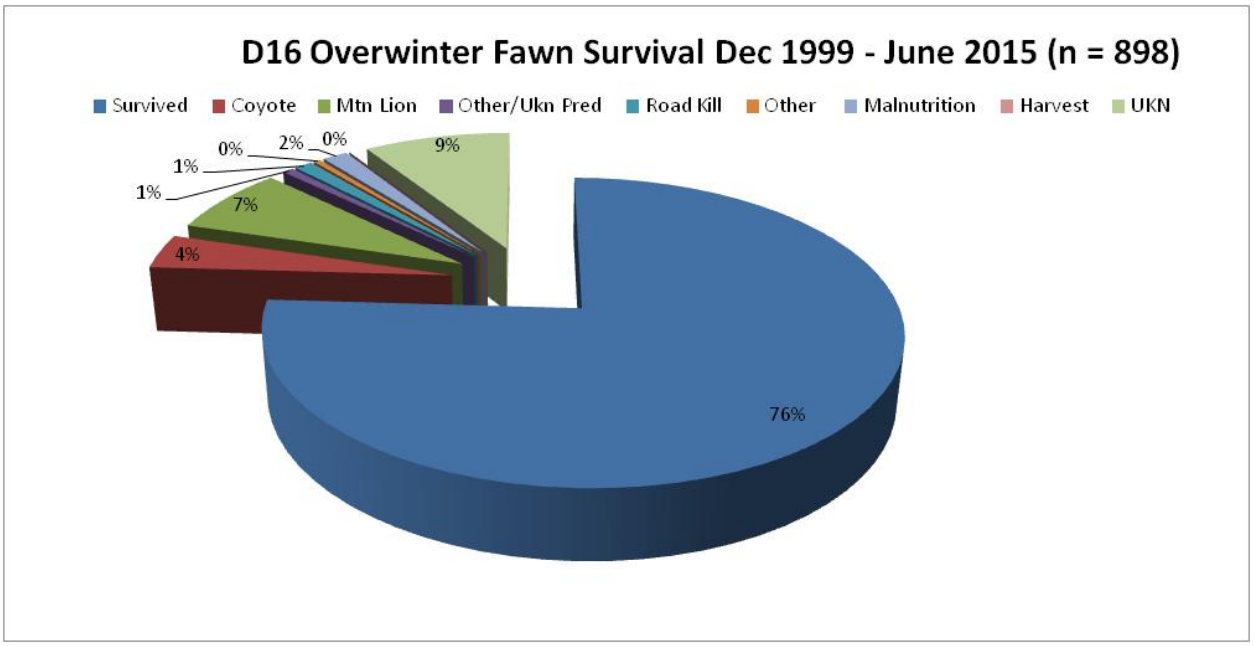

Figure 4. Overwinter fawn survival and cause specific mortality for mule deer in D-16 from 1999-2015.

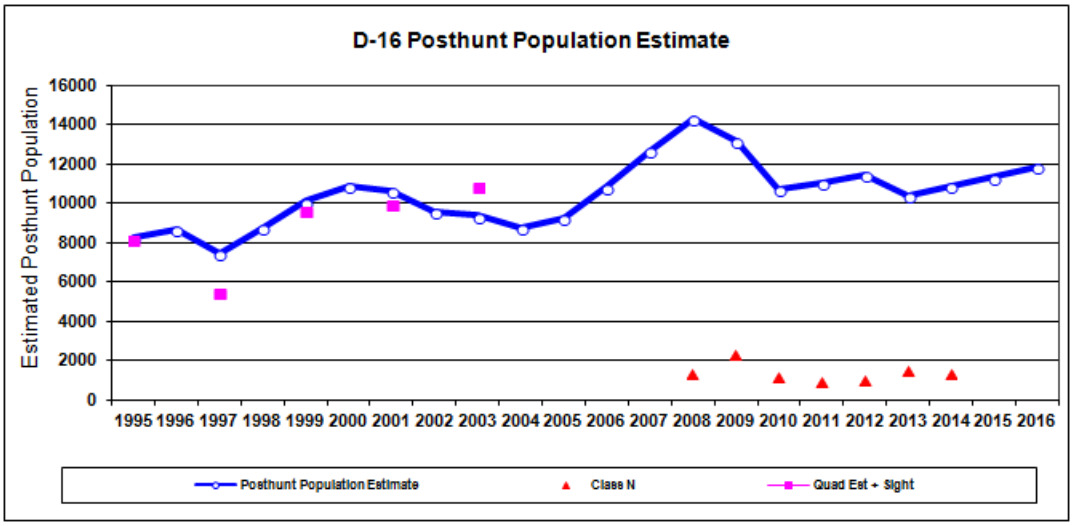

Figure 5. D-16 post deer hunt population estimate from 1995-2014 derived from a population model

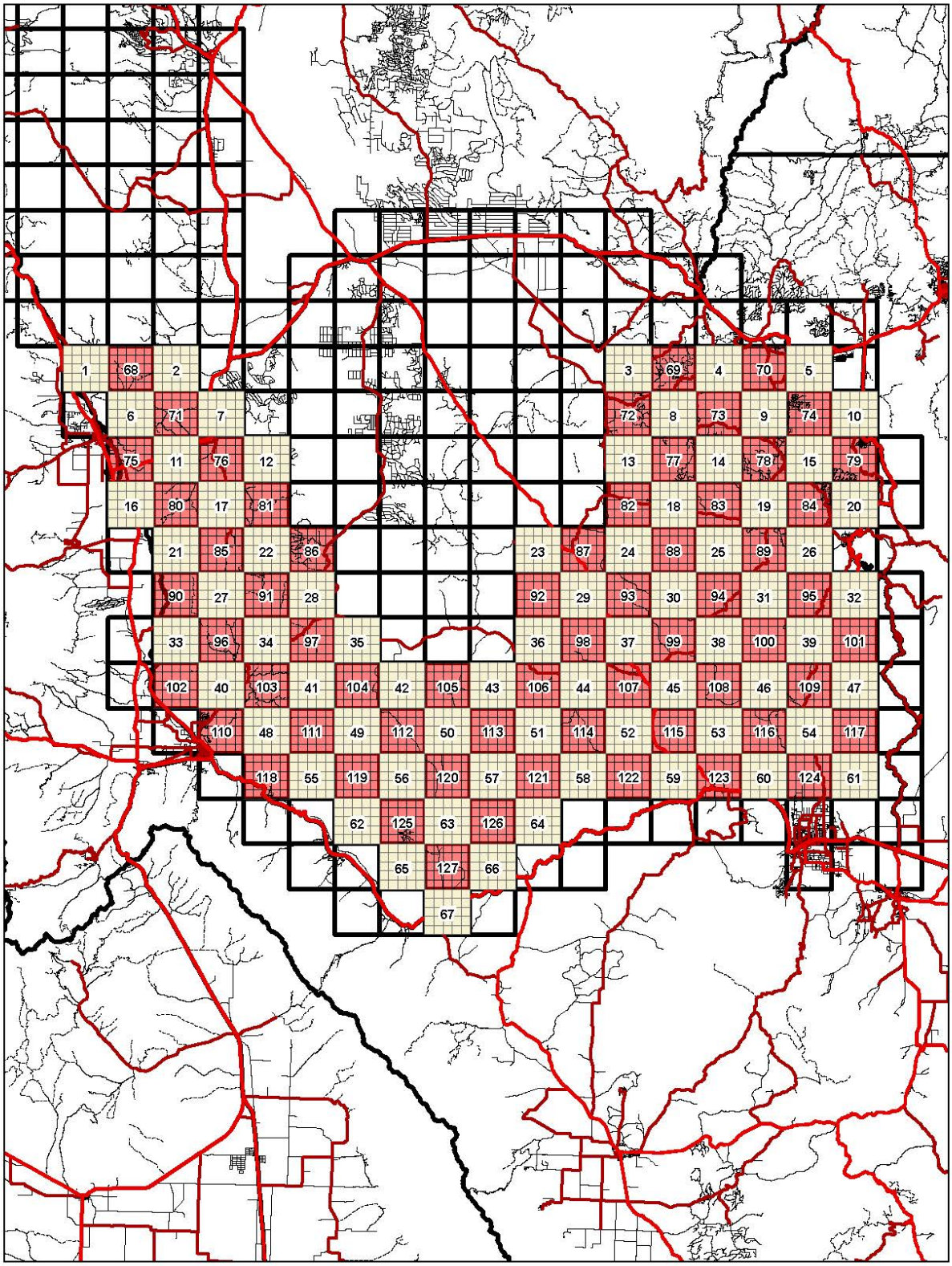

Figure 6: Noninvasive genetic sampling grid overlaid on D-16 study area.

K. Appendix I.

Compliance

Endangered Species Act

The project work in this proposal is non-invasive in nature and does not include any ground disturbing activities. The on-the-ground activity associated with this project will be the capture of cougars using hounds, cage traps, foot hold snares and free-range darting and the capture and radio-collaring of mule deer (Appendix I and II for approved capture and handling guidelines). This project does not involve aquatic work therefore there will be no effect to aquatic species.

Capture of deer and cougars may result in minor disturbance to some threatened species, Gunnison prairie dog, Boreal toad, Mexican spotted owl, and Canada lynx. Because all these species and/or their habitat are conspicuous and easily recognized, if any of these species are encountered, researchers will avoid capture activities in the area near these animals to limit disturbance. Deer and cougar capture has routinely been conducted throughout Colorado, across the range of all these species, and no negative effects have been documented. Therefore, we have determined this project may affect but is not likely to adversely affect the above listed species.

Animal Welfare Act

Prior to capture, this study will gain capture approval through Colorado Parks and Wildlife's Animal Care and Use Committee. Once gained, project approval numbers will be provided. Capture and Handling guidelines are already approved

NEPA

To comply with the National Environmental Policy Act, an Environmental Assessment is being developed by USDA Wildlife Services which will include all above mentioned project activities and their potential impacts.

Other Landscape-Oriented Federal Acts

This project will have no negative impact on the landscape, therefore it will not violate provisions of Federal Legislation governing floodplains, wetlands, historical sites, and prime and unique farmlands.

Americans With Disabilities Act

When hiring personnel as part of this project, qualified individuals will not be discriminated against based on disability. No structures or access points will be constructed as part of this research, and thus accessibility is not applicable.

Federally listed, proposed and candidate species considered for: Teller, Park, Freemont, Chaffee, Custer, Pueblo and Huerfano counties.

Canada Lynx
Wolverine
Preble's Jumping Mouse and critical habitat
Mexican Spotted Owl and critical habitat
Least Tern
Gunnison Sage Grouse
Whooping Crane
Arkansas Darter
Bony Tail Chub
Pike Minnow
Green Back Cutthroat Troat
Hump Back Chub
Pallid Sturgeon
Razor Back Sucker
Penland Alpine Fen Mustard
Western Prairie Fringed Orchid
Pawnee Montane Skipper

Uncompaghre Fritillary Butterfly

APPENDIX C: BIOLOGICAL ASSESSMENT FOR INFORMAL SECTION 7 CONSULTATION

BIOLOGICAL ASSESSMENT FOR INFORMAL SECTION 7 CONSULTATION
U. S. DEPARTMENT OF AGRICUTLURE, ANIMAL AND PLANT HEALTH INSPECTION SERVICE, WILDLIFE SERVICES – COLORADO PROGRAM
For Predator Damage Management environmental assessment

July 29, 2016

The Wildlife Services (WS) Colorado program requests an informal Section 7 Consultation for federal listed threatened and endangered species in Colorado for a predator damage management (PDM) program to protect livestock, wildlife species of management concern, and human safety. We are preparing an environmental assessment to examine issues, alternatives and environmental consequences of PDM to protect these resources. The WS Colorado Program most recently completed an environmental assessment for predator damage management in 2005. The enclosed analysis includes references to previous informal Section 7 consultations, portions of the environmental assessment to provide scope and effect, and an appendix with descriptions of methods that would be used during PDM.

WS is a federal program within the United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS) with responsibility to manage wildlife damage to protect agriculture, human health and safety, natural resources and property. This responsibility is conducted under the Act of March 2, 1931, as amended (7 USC 426), and the Act of December 22, 1987 (7 USC 426c). The program manages damage by providing technical assistance, operational management, educational programs, and liaison with state and federal regulatory agencies for permits, technical information, and seminars and workshops. Activities conducted by WS are closely aligned with management goals of the Colorado Department of Agriculture, Colorado Parks and Wildlife and the U. S. Fish and Wildlife Service (USFWS).

WS has been conducting PDM activities in Colorado since 1916. These wildlife damage management activities continue to change and evolve to reflect societal values and minimize impacts to people, wildlife and the environment. Moreover, the science of wildlife management continuously evolves as new information becomes available in scientific publications. We continuously review and incorporate this new information into program activities and research conducted by the National Wildlife Research Center, the research branch of Wildlife Services. PDM is very complex, often brings strong emotional response from the public and can take years to produce observable effects. Conflicts involving predation on livestock or wildlife species of concern are contentious with some members of the public because methodologies they want implemented may be less effective, harmful to the environment, or are harmful to resources which other members of the public want protected. Some of these conflicts among user groups may actually be harmful to some threatened or endangered species.

Section 7 of the Endangered Species Act of 1973, as amended ((ESA) 16 USC 1531-1543), requires each Federal agency to ensure that its actions will not jeopardize the continued existence of listed species or destroy or modify such species' critical habitat. If one or more protected species may be affected within the area of a proposed action, then the agency must determine whether and how the action will or could potentially affect such species. If a "may affect" determination is made, the agency must consult with the USFWS to determine whether the action is likely to adversely affect or jeopardize the continued existence of the species. If USFWS determines that the proposed action is likely to adversely affect or jeopardize the continued existence of a protected species, the agency must avoid or mitigate the proposed action so that the adverse action is avoided or the adverse impact is reduced to an acceptable level. This Biological Assessment considers all Federal listed threatened and endangered (T&E) species, experimental populations, and proposed and candidate species from the Federal list and determines whether or not PDM will have an effect on these species.

The WS Colorado Program is part of the national WS program, which has been previously reviewed under a formal consultation between WS and USFWS, resulting in a biological opinion (BO) from USFWS in 1992. Changes to WS Colorado PDM activities and new T&E Species listings prompted this request for an updated Section 7 consultation. Since the 1992 BO, WS in Colorado has consulted under Section 7 of the ESA with USFWS for the aquatic rodent damage management (ARDM) program (WS 2003, USFWS 2003), for potential impacts to Canada lynx from the WS PDM program (WS 2009, USFWS 2009) and for a programmatic review of the WS Colorado program activities in (WS 2011, USFWS 2011).

Populations of listed species designated as Non-essential experimental populations (NEPs) are treated as "proposed" for listing for purposes of Section 7 consultation when they do not occur on National Wildlife Refuge (NWR) System or National Park Service (NPS) property in their designated NEP area. Changes in distribution of NEP species and new listings warrant a review to analyze possible impacts from WS Colorado PDM program activities. When an individual from an NEP travels outside of the designated area, its status changes to that of an endangered species until USFWS returns it to the experimental range or increases the experimental range to include the new area where the animal has been found. For example, California condors from the NEP in northwestern Arizona and de-listed gray wolves from Idaho, Montana, and Wyoming have wandered into Colorado where they are listed as endangered.

Also, new species have been listed for protection under the ESA requiring a review of agency actions and potential effects on those species. As a result of these changes, WS Colorado has made the decision to conduct this Section 7 consultation with the USFWS to ensure that the ongoing PDM program would not have an adverse effect on T&E species. In most cases, the PDM methods used and species affected have not changed since the 2011 Biological Assessment and WS continues to abide by that consultation. This Biological Assessment and correspondence from the USFWS will be included in NEPA documents prepared by WS Colorado program and will provide WS guidance for PDM. This consultation is also being conducted to distribute to WS personnel to ensure that all personnel are aware of the T&E species in the State, especially those recently listed, and to reemphasize the mitigation measures in place for species which could be affected by PDM. This Biological Assessment covers all WS PDM activities, including species and methods that have not been previously discussed or used in Colorado, but could potentially be used in the future.

DESCRIPTION OF PROPOSED ACTION

Scope and Effect

Wildlife Services has long-standing statewide programs to protect livestock from predation and occasionally is requested to conducted PDM projects to protect native wildlife from predation. Livestock, especially sheep and cattle, are depredated by coyotes, black bears, mountain lions, golden and bald eagles, red foxes, bobcats, and feral or free ranging dogs. Smaller livestock, such as poultry and domestic waterfowl are reported to be depredated by swift fox, red fox, red-tailed hawks, skunks, raccoons, bobcats, black bears, and mountain lions. Less abundant livestock including alpacas, horses, and goats are depredated by coyotes, feral or wild dogs, mountain lions and black bears. Wildlife Services has been requested to protect threatened or endangered species (e.g. Gunnison sage grouse, black-footed ferret, piping plovers, least terns) from predation. Other wildlife species we have been requested to protect are species of management concern that are declining in abundance locally (e.g. mule deer). We have also been consulted about predation on other wildlife species in local situations due to mountain lion predation on big horn sheep and coyote and mountain lion predation on elk. Less frequently, Wildlife Service is requested to assist homeowners and local communities and governments when wild predators depredate companion animals or attack or threaten to attack people. We have become involved when coyotes, red fox or mountain lions kill pet dogs and cats. WS has also become involved when wild carnivores, especially bears, lions and coyotes, have attacked or threatened humans.

Protecting livestock from Predation

WS conducts PDM to protect livestock from predation statewide on public, private and tribal lands. For the federal fiscal years (FYs) 2010 to 2015 (FY 2011 = October 1, 2010 to September 30, 2011), WS had

agreements (Work Initiation Documents) in place to conduct livestock protection by managing predation on 4.958 million acres of land or 7.4% of the Colorado land area. Private land comprises 2.967 million acres or 60% of land where WS Colorado conducts PDM for livestock protection. Other land types where PDM is conducted by WS Colorado for livestock protection include 197,771 acres of state lands, 2,541 acres of tribal lands and 1.791 million acres of Bureau of Land Management or Forest Service lands. Colorado can be divided into three different regions based on the primary livestock protected, land types worked, and density and species diversity of predators (Table 1).

Western Slope: PDM for livestock protection on the western slope primarily protects sheep from coyote, black bear and mountain lion predation. Sheep are primarily raised on range that requires moving every few days to new grass to graze. Additionally, some ranches raise cattle, goats, alpacas, horses and donkeys. An annual average of 9.2 staff years were spent by field employees reducing predation on livestock and wildlife species of management concern. Wildlife Services expends the greatest effort protecting livestock from January to May using aerial predator damage management to remove coyotes from grazing and lambing grounds on the western slope. Corrective management action to protect newborn lambs is most intensive during mid-April to early June. Management tools used by Wildlife Services for corrective management action includes aerial predator damage management, calling and shooting, decoy dogs to attract and shoot territorial coyote pairs, and trapping with foot hold traps, snares and M-44's[19]. Livestock producers use guard dogs, herders, range riding, habitat management (e.g., brush removal), husbandry and shooting to protect livestock during this period. After June, predation on livestock from coyotes generally declines due to removal of territorial coyote pairs around the lambing and grazing grounds, and coyotes switching to newly available deer fawns, rabbits and their young, rodents and other wildlife for food. While coyote predation on lambs and sheep declines, bear predation accelerates greatly during the summer on the western slope. Lion predation on lambs and sheep occurs less often than bear or coyote predation. Bear and lion predation corrective action usually requires using hounds to track, tree or corner depredating animals. Shooting with night-vision is another common method to remove bears and lions killing livestock on the western slope. Ranches or grazing allotments on the western slope may be all private land, a mix of public and private land or all public land. Ranches and grazing allotments on the western slope tend to be large, covering thousands or tens of thousands of acres due to the need to graze lands lightly to avoid excessive grazing. This form of livestock production keeps large tracts of habitat intact.

Southeastern Colorado: Livestock protection activities in southeastern Colorado primarily protect calves from coyote predation. An annual average of 1.2 staff years were spent by field employees reducing predation on livestock. Wildlife Services expends the greatest effort protecting cattle from February to May using aerial predator damage management to remove coyotes from calving grounds in southeastern Colorado. Also, there are several types of bird production operations raising domestic chickens, ducks, geese, ostriches and other small farm animals (e.g., rabbits) that are depredated by coyotes, red fox, bobcat and raccoons. Corrective management action to protect newborn calves is most intensive during March through April. Management tools used by Wildlife Services for corrective management action includes aerial predator damage management, calling and shooting, shooting, decoy dogs to attract and shoot territorial coyote pairs, and trapping with foot hold traps, snares and M-44's[1]. Livestock producers use guard dogs, range riding, grazing pastures with less predation, fencing and shooting to protect livestock during this period. Some smaller livestock producers can pen livestock at night to reduce predation. Bird and small animal production ranches generally using fencing, night penning, bringing animals in at night, cage traps, husbandry and shooting to manage predation by coyotes, foxes, bobcats and raccoons. Bear and lion predation on livestock is common in southeastern Colorado but less frequent than the western slope. Ranches and grazing allotments in southeastern Colorado often are entirely private land. Some ranches or grazing allotments are a mix of private or public land. Public-land-only ranches or grazing allotments are uncommon. Ranches and grazing allotments in southeastern Colorado tend to be smaller, covering several hundred to several thousand acres. A few ranches are larger covering tens of thousands of acres, but these are uncommon.

Northeastern Colorado: Livestock protection activities in northeastern Colorado primarily protect calves from coyote predation. However, there is a mix of livestock raised in northeastern Colorado, including sheep on range or pasture, alpaca on pasture, and various livestock in feedlots. An annual average of 0.75

[19] Use of foot hold traps, snares and M-44's for livestock protection is limited to private land only.

staff years were spent by field employees reducing predation on livestock. Wildlife Services expends the greatest effort protecting cattle and sheep from February to May using aerial predator damage management to remove coyotes from calving and lambing grounds in northeastern Colorado. Corrective management action to protect newborn calves and lambs is most intensive during March through April. Management tools used by Wildlife Services for corrective management action includes aerial predator damage management, calling and shooting, shooting, decoy dogs to attract territorial coyote pairs, and trapping with foot hold traps, snares and M-44's[1]. Livestock producers use guard dogs, range riding, grazing pastures with less predation, fencing, habitat management, husbandry and shooting to protect livestock during this period. Some smaller producers can pen livestock at night to reduce predation. Bear and lion predation on livestock is uncommon in northeastern Colorado, but it does occur. Ranches and grazing allotments in northeastern Colorado often are entirely private land. Some ranches or grazing allotments are a mix of private or public land. Public-land-only ranches or grazing allotments are much less common. Ranches and grazing allotments in northeastern Colorado tend to be smaller, covering several hundred to several thousand acres. There are also some small livestock producers raising a few animals for personal use or specialty markets (e.g., wool, food). There are a few ranches covering more than 10,000 acres, but these are uncommon.

Table 1. Counties by regions of Colorado where predation management activities were conducted by the Wildlife Services program of the United State Department of Agriculture, Animal and Plant Health Inspection Service to protect livestock or wildlife species of management concern from predation, FY2010 – 2015.

Western Slope	Northeast	Southeast
Archuleta	Arapahoe	Baca
Delta	Cheyenne	Crowley
Dolores	Elbert	Douglas
Eagle	Morgan	El Paso
Garfield	Morgan	Fremont
Grand	Washington	Huerfano
Gunnison	Weld	Huerfano
Gunnison		Kiowa
Hinsdale		Las Animas
Jackson		Las Animas
La Plata		Lincoln
Larimer		Otero
Mesa		Prowers
Moffat		Pueblo
Montrose		Teller
Ouray		
Pitkin		
Rio Blanco		
Routt		
San Juan		
San Miguel		

Aquaculture also occurs in Colorado. Requests for assistance for predation on food fish are less common. However, WS Colorado has been requested by producers to provide technical assistance on farm raised trout, catfish and other food fish. Predation on farm raised fish is generally from meso-carnivores or migratory birds.

WS works with, or could potentially work with, several species of wildlife that depredate livestock. The species that WS Colorado could possibly encounter during PDM includes a few state managed mammals and a handful of migratory birds. These “possible” species include carnivorous and omnivorous predatory mammals (canids, felids, black bear, raccoon, mustelids, opossum, and feral dogs and cats) and a small number of birds (gulls and raptors). The abundance of PDM operations for many of these “possible” species to protect livestock or wildlife species of management concern varies widely. From FY2011 to FY2015, WS in Colorado conducted PDM activities (direct control and technical assistance) involving 11 different predatory species (Table 2).

Table 2. Animal species taken by Wildlife Services Colorado while conducting livestock protection programs, FY2011-2015.

	Target Species		Non-Target Species	
Species	Killed, total 5-years	Killed, annual average	Killed	Released, unharmed
Badger	5	1		
Black Bear	349	70		
Bobcat	6	1		
Coyote	9,300	1,860		
Crow	8	2		
Feral cat	1	0		
Mountain lion	49	10		1
Raccoon	76	15	1	
Red Fox	278	56	1	
Swift Fox	4	1		
Striped Skunk	10	2		
Raven			1	

Livestock producers implement most non-lethal methods and a few lethal methods to protect their livestock or farm raised fish. WS Colorado is often requested to abate predation when specialized skills are required or legal limitations exist. Whereas WS Colorado uses non-lethal methods where appropriate or for demonstration, we often implement lethal methods to abate predation where producers are unable to resolve, special skills are required or legal restraints limit methods producers may use. There are a number of methods used to capture or kill predatory species depredating livestock (Table 3). The methods used to capture or take the predatory animals were combined due to similarity and summarized. Examples of combining methods would be shooting coyotes from a fixed-wing aircraft versus a helicopter into a category called aerial. Similarly, the category for taking animals with firearms includes animals which were shot, called into range and shot, decoyed with dogs and shot, treed or corned with dogs and shot, or located with night-vision goggles or thermal imaging and shot. We analyzed take of predatory species depredating livestock as well as non-target species taken unintentional and their fate. In summary, WS Colorado killed 10,080 target predatory animals to protect livestock over the 5-year period with only 4 non-target animals captured. One of the non-target animals captured in a neck snare was released alive unharmed (Table 2 and 3).

Predator animals may also be hazed with shooting or dogs. This non-lethal approach can be effective at times for stopping a predation incident. This approach was used for specific predation incidents to disperse 2 mountain lions, 5 black bears and 16 coyotes during the 5-year period.

Protecting Wildlife from Predation

PDM involves several species of predators in Colorado (Table 2), but especially the coyote, black bear and red fox. Predator damage management activities are for the protection of livestock and some wildlife (e.g., mule deer, Gunnison's sage grouse, black-footed ferret, piping plover, least tern) in Colorado. Requests to protect wildlife species of management concern are less frequent and may not occur every year. The T&E species that have the greatest chance of being affected by PDM programs are the potential appearance of gray wolves or California condors in the State.

Table 3. Methods used by Wildlife Services Colorado to capture or kill predatory animals and non-target animals to protect livestock, FY2011-2015. Numbers in parentheses are percentages of total take.

Method Used	Target species, killed	Non-target species killed	Non-target species released alive
Aerial[a]	6,345 (63%)		
Firearms[b]	2,681 (27%)		
M-44	83 (1%)	2 (<1%)	

Snare, foot	7 (<1)		
Snare, neck	287 (3%)	1 (<1%)	1 (<1%)
Trap, cage	46 (<1%)		
Trap, foot-hold	631 (6%)		
Dens, Gas cartridge	7 (<1%)		
TOTAL	10,080	3	1

a. Aerial is comprised of shooting from fixed-wing aircraft and helicopters.
b. Firearms summarized taking by shooting, shooting aided by night-vision or thermal imaging, calling and shooting, using dogs to tree or corner then shoot, decoying with dogs followed by shooting.

Predatory species involved in Predator Damage Management

PDM activities conducted by WS Colorado from FY2011 through FY2015 involved 22 species depredating, injuring, or threatening 26 agricultural or natural resources (Table 4). Predatory animals were comprised of 9 mammal and 13 bird species. All the predatory species are common or abundant in Colorado, though some species are infrequently or rarely seen by people due to the animal's nocturnal or secretive lifestyle. An example of a common animal which is rarely seen in Colorado would be a mountain lion. Other wildlife and feral species depredate agricultural and natural resources but WS Colorado did not receive any requests for assistance involving these other depredating species during this five year period.

WS has also previously worked with, or could potentially work with, several species of wildlife that come into conflict with human activities, including mammals (coyotes, foxes, mountain lion, bobcat, black bear, raccoon, ringtail, mink, river otter skunks, opossum), feral animals (feral swine, feral or wild dogs, and feral cats), birds (grebes, pelicans, cormorants, herons, gulls, raptors, corvids) and a few fish. PDM operations for many of these "possible" species have historically been provided by WS or have been conducted by other WS programs and have potential in Colorado. Technical assistance projects for these species are not considered a federal action and, therefore, would be excluded from PDM activities. With the exception PDM for bald and golden eagles in Table 1, all species have been relatively common. People requesting information for PDM involving T&E species such as Canada lynx and gray wolf (should a problem arise) or eagles are told to consult with USFWS for any necessary permit should any action such as hazing, nest removal, or lethal management actions be required to resolve the problem.

Table 4. Wildlife and feral animals reported to Wildlife Services – Colorado program that depredated, injured or threatened agricultural and natural resources in Colorado from Federal Fiscal Year 2011 through 2015.

Resource	Predator	No. of Incidents[A]
Catfish, trout, food fish (farm raised)	Cormorant, Double-crested	9
	Crow, American	1
	Gulls	22
	Heron, Great Blue	15
	Kingfisher, belted	3
	Merganser, Common	2
	Night Heron, Black-crowned	9
	Pelican, White	4
	Raven, Common	1
	Bear, Black	1
Game birds (pen raised)	Badger	1
Elk (pen raised)	Mountain lion	4
Exotic or native large mammals, fallow deer (pen raised)	Coyote	1
	Mountain lion	3
Alpaca	Mountain lion	7
Cattle (cows, calves)	Bear, Black	25
	Bobcat	1
	Coyote	115
	Dog, Feral	5
	Mountain lion	14
	Raccoon, Stripped skunk	2
Donkeys or burros	Mountain lion	2
Goats (meat, mohair, other)	Crow, American	1
	Bear, Black	19
	Coyote	23
	Dog, Feral	1
	Mountain lion	53
Horses	Coyote	11
	Dog, Feral	1
	Mountain lion	11
Llamas	Bear, Black	2
	Mountain lion	6
Mules	Mountain lion	1
Rabbits (domestic)	Raccoon	2
Sheep (ewes, rams, lambs)	Bear, Black	858
	Bobcat	2
	Coyote	925
	Dog, Feral	1
	Mountain lion	124
	Red Fox	63
Swine (domestic)	Bear, Black	2
	Dog, Feral	3
	Mountain lion	1

Chickens	Bear, Black	5
	Bobcat	2
	Coyote	6
	Mountain lion	3
	Raccoons	6
	Fox, Red	12
	Skunk, Striped	1
	Hawk, Red-tailed	1
Ducks (domestic)	Coyote	2
	Fox, Red	3
Geese (domestic)	Coyote	1
Ostrich (domestic)	Coyote	1
Pea Fowl	Mountain lion	1
Pigeon (domestic)	Coyote	1
	Bear, Black	1
	Fox, Red	1
	Mountain lion	2
	Raccoons	1
Trout and other fish (wild)	Raccoons	1
	Cormorant, Double-crested	8
	Crow, American	1
	Gulls	13
	Heron, Great Blue	13
	Kingfisher, belted	5
	Merganser, Common	2
	Night Heron, Black-crowned	3
	Pelican, White	6
	Raven, Common	1
Least Tern (T&E Species)	Gulls	3
Piping Plover (T&E Species)	Gulls	3
Mule Deer	Coyote	1
Pets (cats, dogs)	Coyote	5
	Fox, Red	2
	Mountain lion	2
	Raccoon	5
	Skunk, Striped	1
Zoo animals	Mountain lion	1

A. An incident can involve one or more animals.

From FY2011 to FY2015, WS worked with 3 species of mammals and 1 species of bird where lethal take averaged more than 100 annually and could be involved with PDM. A species may have been taken more than 100 times but could be taken to protect other resources, such as human safety at airports. Those species lethally taken more than 100 times annually over the 5 years to protect agricultural or natural resources from predation were coyotes and raccoons.

PDM involves several species of predators in Colorado (Table 4), but especially the coyote, black bear and red fox. The T&E species that have the greatest chance of being affected by PDM programs are larger mammals such as Canada lynx and potentially the appearance of a gray wolf or California condor in the

State. Canada lynx in Colorado live at higher elevations in spruce-fir forests where their primary food source (i.e. snowshoe hare) is found. Few livestock graze in these areas, and WS conducts very little PDM in lynx habitat. Whereas it is possible that WS Colorado would encounter a lynx at lower elevations, we have captured none since their reintroduction while conducting PDM. Another T&E species WS Colorado would encounter while conducting livestock protection would be Gunnison sage grouse and we are unlikely to affect them.

PDM Methods Available for Use

A variety of methods are used by WS personnel in PDM (Table 5, Appendix A). These methods involve three main strategies: resource management (habitat modifications and cultural practices such as night-penning, guard animals, and carcass removal), physical exclusion (netting, conventional and electrical fencing), and wildlife management (foot-hold and cage traps, snares, aerial predator damage management, M-44 devices, hand capture, scare devices such as pyrotechnics and scarecrows, and immobilization drugs such as ketamine compounds). Some methods or tactics are used for many different predator species (e.g., foot hold traps, shooting), and others are specific to individual species (e.g., culvert traps for bears). WS conducts direct control activities involving take on private lands only where signed *Work Initiation Documents* have been executed. WS conducts direct control activities on municipal, county or other government lands only if *Work Initiation Documents* or Work Plans are in place covering the government land. These agreements and work plans list the intended target animals and the methods to be used.

Table 5. Summary of methods used by WS operationally for predator damage management and their potential to negatively affect T&E species.

Method	Direct PDM use by WS	Species Targeted	T&E Spp. Potentially Affected	Negative Affect	SOPs to Reduce Affect
Resource Management Methods					
Guard Dogs	Potential	Canids	M/B	Min	No
Habitat Management*	Potential	All	All	Neg	Yes
Physical Exclusion					
Fencing	Potential	Canids, raptors	M/B	Min/Neg	Yes
Wildlife Management					
Frightening Devices					
- Harass/Pyrotechnics/Propane Cannon	High	All	M/B	Min	Yes
- Elec. Sirens/Lights	Low	Canids	M	Min	Yes
Electrical barriers	Potential	Canids, swine	A/F	Min	Yes
Capture/Take Methods					
- Foothold Trap	Medium	Canids, meso-carnivors	M/B	Neg	Yes
- Cage Traps	Medium	All	M/B/R/A/F	Min	Yes
- Cannon Nets/Net Gun	Low	Birds	None	0	-
- Drive Trap	Low	Waterfowl	None	0	-
- Raptor Traps, e.g. Bal Chatri	Medium	Raptors	B	Min	Yes
- Pole Traps (modified foothold for perching bird)	Low	Raptors	B	Neg	Yes
- Snares (body, foot)	Medium	Mammal predators	M/B	Neg	Yes
- Snares (break-away)	Potential	Mammal predators	P	Min	Yes
- Quick Kill	Low	Meso-carnivores	M/B/F	Neg	Yes
- Denning	Medium	Canids	None	0	-
- Shooting	High	All	M/B	Min	Yes
- Aerial Shooting	High	Canids, swine	M/B	Min	Yes
- Dogs	High	Canids, meso-carnivores	None	0	-
- Nest/Egg Destruction	Low	Corvids	None	0	-
- Electrofishing/Gill Nets	Potential	O	A/F	Neg	Yes
- Chemical Immobilization/Euthanasia	Low	All	None	0	-
Chemical Toxicants					
- Sodium Cyanide	Medium	canids	M/B	Neg	Yes
- DRC-1339	Medium	Corvids, gulls	B	Min	Yes
- Gas Cartridge (largel)/Fumigants	Medium	Canids	M/R/A	Neg	Yes
Chemosterilants/Contraception	Potential	Canids	None	0	-

* - Requires site-specific consultation with USFWS where T&E species or their habitat is present.
Methods Used by WS - High = Frequently Year-round, Medium = Frequently Seasonally/Infrequent Year-round, Low = a few times a year to rarely, Potential = not used but could be.
T&E Spp. Affected - M - mammals, B - birds, R - reptiles, A - amphibians, F - fish, I - invertebrates, P – plants

PDM methods used by WS to alleviate predation damage have varying potential to affect T&E species, and are summarized in Table 5 along with the level of use. WS direct operational PDM efforts for different wildlife can include the use of any PDM methods, but primarily involve site-specific "hands-on" wildlife management techniques. This is primarily because land managers can and do conduct their own resource management and physical exclusion techniques. Many of the methods in PDM that are used by WS are used lethally. Some of the nonlethal PDM techniques such as foothold, cage and drive traps, foot and neck snares, immobilization drugs, and hand capture can result in a lethal take if, as a result of capture, the animal is euthanized using methods such as Beuthanasia-D®, cervical dislocation, a gunshot to the brain, or asphyxiation with CO_2. Other non-lethal methods used in PDM have minimal to no impact on T&E species in most circumstances and these would include hazing methods (e.g,. lasers, pyrotechnics, distress calls, mylar tape and eyespot balloons, effigies), exclusion (e.g., netting, sealing broken doors or windows) or cultural methods (removing anthropogenic food sources).

WS is prudent and professional with its use of the different methods, especially those listed in Table 2 that could have the potential to affect T&E species in their occupied areas. From FY2011 to FY2015, WS did not take any T&E species incidentally with the methods in Table 2. WS presently uses an integrated PDM approach which employs a variety of methods for managing wildlife damage. Integrated PDM allows WS personnel greater flexibility and more opportunity to tailor an effective damage management strategy for each specific problem that is encountered. In selecting control techniques, consideration is given to the type, magnitude, duration, frequency, and location of damage. Consideration is also given to

the status of potential non-target species, especially T&E species, and social considerations. The decision-making steps taken by WS personnel when addressing wildlife damage are described in the "WS Decision Model" which is discussed in great detail in WS (2003, 2005 and 2013) and Slate et al. (1992).

All PDM methods have limitations and some can potentially affect T&E species. Table 5 summarizes the potential PDM methods used by WS in Colorado, the frequency of their use, the species they are intended to target, and potential to affect T&E species. When WS Specialists receive a request for assistance, they consider a wide range of methods to use and their limitations as they apply the decision making process to determine what method(s) to use to resolve a wildlife damage problem (Slate et al. 1992). The effect that PDM methods have on T&E species can range from having none to a highly negative effect. The potential negative effects are offset with standard operating procedures (SOPs) and other measures to reduce the risks associated with them. When these measures are in use, the risk of an impact on the T&E species is likely to be very minimal or avoided. It should be noted that several PDM methods also have a positive effect for some species by reducing predators or competition with the species targeted. For example, the use of DRC-1339 to take cowbirds in the range of the southwestern willow flycatcher would have a positive impact on the flycatcher by reducing nest parasitism. Appendix A gives descriptions and SOPs to minimize or nullify potential take for all PDM methods being used by WS, but not all of these methods are currently being used by WS- Colorado.

ANALYSIS OF POTENTIAL IMPACTS ON THREATENED AND ENDANGERED SPECIES

A current list of threatened and endangered (T&E) species was obtained from USFWS for Colorado in April 2016 (Table 6). Of the species and subspecies currently listed under provisions of the ESA, excluding those listed but not in Colorado, 15 species are federally listed as endangered in Colorado: 8 animals and 7 plants. Eighteen species in Colorado are listed as federally threatened: 9 animals and 9 plants. Following WS's analysis section will be a section specifically listing the SOPs that WS will adhere to for the protection of T&E species in Colorado.

The location, habitat, and diet of T&E species is important information to determine impacts that PDM may have. PDM activities conducted by WS for mammalian and avian predators is most commonly conducted in agricultural fields, open forests, grasslands, rangelands, and urban areas; therefore, these activities have little or no impact to wetlands and dense forests where some T&E species are found.

It should be noted that the grizzly bear (*Ursus arctos horribilis*) and gray wolf are listed in Colorado, but the grizzly bear does not occur within the state and was not included in Table 6. Grizzly bear populations will not be discussed in this Biological Assessment because WS will have ***no effect*** on them with PDM since they are not present. However, gray wolves are a more frequent visitor and likely will establish breeding individuals in the not so distant future. Individuals from the gray wolf and California condor NEPs have come into Colorado where they are considered endangered species while they are outside their NEPs or de-listed range. Until USFWS return them to their NEP range or de-listed range or expands the experimental range to include the new location they are considered an endangered species. Gray wolves have been entering Colorado more frequently in recent years. In summary, individual gray wolves, including the northern Rocky Mountains and Mexican subspecies, and California condors from their NEPs have the potential for coming into the State and will be discussed later in the biological assessment under NEP conferencing. If any of these species' status changes, WS would request a separate consultation.

Table 6. Colorado Federally listed endangered and threatened species, their location, habitat, diet, and potential for impact from PDM.

SPECIES	Scientific Name	Status	Locale	Habitat	Diet**	PDM
MAMMALS						
Preble's Meadow Jumping Mouse	*Zapus hudsonius preblei*	T	Central-North central	W	Gi	-, 0, +
New Mexico Meadow Jumping	*Zapus hudsonicus luteus*	E	Las Animas	GW	GI	-, 0, +
Black-footed Ferret* NEP	*Mustela nigripes*	E	Statewide	R	S	-, 0, +
Canada Lynx	*Lynx canadensis*	T	West, Central Mountains	F	SI	-, 0, +
BIRDS						
Gunnison Sage-Grouse	*Centrocercus minimus*	T	Central-Westcentral	R	GI	-, 0, +

Whooping Crane (not listed for CO)	*Grus americana*	E	East	R	Gis	-, 0, +
Piping Plover	*Charadrius melodus*	T	East	W	I	-, 0, +
Least Tern (Interior Population)	*Sterna antillarum*	E	East	W	AI	-, 0, +
Yellow-billed Cuckoo (Western pop.)	*Coccyzus americanus*	T	West	F	I	0
Mexican Spotted Owl	*Strix occidentalis lucida*	T	West	F	S	0
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	E	Southwest	F	I	-, 0, +
FISHES						
Greenback CutthroatTrout	*Oncorhynchus clarki stomias*	T	Central	LSg	AI	-, 0, +
Colorado Pikeminnow	*Ptychocheilus lucius*	E	West	Lg	A	0
Humpback Chub	*Gila cypha*	E	West	LSg	A	0
Bonytail Chub	*Gila elegans*	E	West	LSg	A	0
Razorback Sucker	*Xyrauchen texanus*	E	West	Lg	A	0
INVERTEBRATES						
Uncompahgre Fritillary Butterfly	*Boloria acrocnema*	E	Southwest	F	N	0
Pawnee Montane Skipper	*Pseudocopaeodes eunus obscurus*	T	Douglas/Jefferson/Park/Teller	G	N	0
PLANTS						
Mancos Milk-vetch	*Astragalus humillimus*	E	Montezuma	R	-	0
Osterhout Milk-vetch	*Astragalus osterhoutii*	E	Grand	R	-	0
Clay-loving Wild Buckwheat	*Eriogonum pelinophilum*	E	Delta/Montrose	R	-	0
Penland Alpine Fen Mustard	*Eutrema penlandii*	T	Lake/Park/Summit	RW	-	0
Colorado Butterfly Plant	*Gaura neomexicana var. coloradensis*	T	North Central	RW	-	0
Pagosa Skyrocket	*Ipomopsis polyantha*	E	Archuleta	FG	-	0
Dudley Bluffs Bladderpod	*Lesquerella congesta*	T	Rio Blanco	R	-	0
Knowlton Cactus	*Pediocactus knowltonii*	E	La Plata	R	-	0
Parachute Beardtongue	*Penstemon debilis*	T	Garfield	R	-	0
Penland Beardtongue	*Penstemon penlandii*	E	Grand	R	-	0
North Park Phacelia	*Phacelia formolusa*	E	Jackson/Larimer	R	-	0
DeBeque Phacelia	*Phacelia submutica*	T	Garfield/Mesa	R	-	0
Dudley Bluffs Twinpod	*Physaria obcordata*	T	Rio Blanco	R	-	0
Colorado Hookless Cactus	*Sclerocactus glaucus*	T	Delta/Garfield/Mesa/Montrose	R	-	0
Mesa Verde Cactus	*Sclerocactus mesae-verdae*	T	Montezuma	R	-	0
Ute Ladies'-tresses	*Spiranthes diluvialis*	T	Northwest-North central	RW	-	0, +

* - believed extirpated

**Diet - Capitals = large proportion of diet - Lower case = small proportion of diet.

STATUS
E - Endangered
T - Threatened
P - Proposed

HABITAT
F - Forests/riparian borders
G - Grassland/meadow
R - Range/sage/high desert
W - Wetland/marsh/sandbar
L - Lakes, Rivers
S - Springs/creeks/ponds
g – gravel bottom

DIET
A - Aquatic- fish/invertebrates/plants
G - Grains/grass/brush/seeds
L - Large Vertebrates
M - Mast/fruit & nuts
N - Nectar/sap
S - Small vertebrates (i.e. rodents, birds)
C- Carrion

PDM - Impacts
(-) - Negative
0 - none
(+) - Positive

Some species are listed in Colorado or particular counties from the standpoint of water depletions in river basins. All species listed for the western slope in the Upper Colorado River and San Juan River Basins are listed in the State because they occur in some counties, but are listed in some counties from the standpoint of water depletions. Most species associated with the Platte River in Nebraska which could be affected by water depletions in the North and South Platte, and Laramie River Basins in Colorado, including the whooping crane, pallid sturgeon (*Scaphirhyncus albus*), and western prairie fringed orchid (*Platanthera praeclara*) do not occur in Colorado. The only exception is the whooping crane which has been documented in some counties of eastern Colorado, but rarely. Only those species found in the State will be discussed in this Biological Assessment; the others will not because PDM has ***no effect*** on water depletions, specifically regarding the two species in Nebraska.

MAY AFFECT SPECIES

WS has the potential to impact some T&E species, but this potential is low when SOPs of the WS PDM program are implemented. The following are species that could be affected by WS PDM. WS believes that formal consultation for these species be initiated/reinitiated as all were considered in the 1992 consultation between USFWS and WS (USDA 1992). However, new programs that were not conducted in 1992 currently have the potential to affect some of them.

Black-footed Ferret: Endangered (32 FR 4001; March 11, 1967) without critical habitat, NEP population designated (61 FR 11320, March 20, 1996)

Black-footed ferrets were once found in Colorado among black- and white-tailed and Gunnison's prairie dog colonies, their principal food sources. Verified sightings in Colorado, however, have been rare with the last verified sighting in 1946. Ferrets were likely always scarce throughout the West and Colorado, but declined with the westward expansion of people and agriculture which reduced their principle habitat, prairie dog towns. Black-footed ferrets are closely associated with prairie dogs which declined dramatically from temporary and permanent conversion of native grasslands to crops, poisoning and disease (USFWS 2013). Prior to the establishment of the Moffat/Rio Blanco County BLM NEP, black-footed ferrets were probably extirpated in Colorado as a result of intensive prairie dog poisoning campaigns. Prairie dog towns were significantly reduced by over 95% by the mid-20th century across the United States which inherently reduced the ferret population. The last population of ferrets was discovered in 1981 in Meeteetse, Wyoming. As a result of a canine distemper outbreak in 1985, and probable sylvatic plague, the population of over 100 ferrets was reduced to about 20. The remaining ferrets were taken into captivity and used to establish a breeding colony. Over the next year, 18 of the ferrets taken into captivity survived the quarantine period. The breeding colony was successful and used to establish several breeding colonies at facilities throughout the country, including several zoological gardens. These have produced thousands of ferrets, many of which have been released into 9 NEPs. The likelihood of discovering another wild population today is very minimal.

The primary methods that were considered to have the potential to adversely impact ferrets in the 1992 BO were traps without pan-tension devices used in and around prairie dog towns for predator damage management, primarily coyotes, and control of prairie dogs with zinc phosphide baits and fumigants, from primary and secondary poisoning as well as the removal of their prey base. Further analysis by USFWS has restricted the risk of primary or secondary poisoning of black-footed ferrets to fumigants, as stated in the Safe Harbor Agreements. These risks are limited to western Colorado outside of the block-cleared area, as discussed below. USFWS determined that the removal of predators, though, including those removed with traps fitted with pan-tension devices that preclude capture of ferrets, could have beneficial impact on ferrets by reducing direct predation and the spread of disease. The 1992 BO provided Reasonable and Prudent Alternatives (RPAs) for WS to follow to preclude jeopardy. USFWS provided an Incidental Take Statement in the 1992 BO, but stated that no incidental take by WS, guided by the RPAs, was anticipated. WS in Colorado has abided by the RPAs established in the 1992 BO and has never had any known effect on ferrets. In addition, pan tension devices are used on foothold traps for PDM near prairie dog towns that preclude the capture of ferrets. WS worked with Colorado Parks and Wildlife (CPW) to provide protection for black-footed ferrets from predators (coyotes, badgers, and red fox) in the northwestern Colorado NEP which will be discussed under NEP populations below.

WS Colorado has taken a more active role since 2014, working with CPW and the USFWS to re-establish populations of black-footed ferrets in black-tailed prairie dog towns of eastern Colorado. WS treats prairie dog towns with deltamethrin, a pesticide registered with Colorado Department of Agriculture to kill fleas that may infect prairie dogs or ferrets with sylvatic plague. The treatment of prairie dog towns with deltamethrin (trade name Delta Dust) prior to release of ferrets is now a standard operating procedure in Colorado to ensure survival of released ferrets and their food supply. Wildlife Services treated 5,884 acres in 2015 at 5 sites to ensure the survival of released ferrets.

WS continues to use methods that could pose a hazard to ferrets and conducts programs that could be beneficial for them. The methods that may affect the black-footed ferret are foothold traps without pan-tension devices used for smaller predators, cage traps, and prairie dog fumigants and toxicants. WS believes that PDM, including the use of traps and fumigants, will have no effect on the black-footed ferret in urban, cultivated, or right-of-way areas. Moreover, the use of Safe Harbor Agreements by the USFWS with landowners to allow the restoration of black-footed ferrets allows landowners to manage and use their lands as the landowner desires, except for no toxicants or fumigants for prairie dogs is allowed in designated conservation zones. Safe Harbor Agreements are usually in effect for 10 years. If the landowner needs to manage prairie dogs within the Safe Harbor then the use of zinc phosphide treated baits and shooting are allowed within designated management zones. No anti-coagulant rodenticides can be used within the designated conservation or management zones. If WS Colorado was requested to conduct prairie dog damage management we could check the site for listed threatened and endangered species by consulting the USFWS in Colorado or their website: https://ecos.fws.gov/ipac/.

USFWS has "block-cleared" eastern Colorado, and all black-tailed prairie dog (Cynomys ludovicianus) habitats in Colorado, from the requirement to conduct ferret surveys because it is believed that no other wild ferret populations exist in this area. Likewise, ferrets were re-introduced to Moffat and Rio Blanco Counties in 2001 because no ferrets were known to occur there.

Thus, the RPAs would be for western Colorado, or all Gunnison's (C. gunnisoni) and white-tailed (C. leucurus) prairie dog habitats. WS believes that a new BO is appropriate at this time for western Colorado outside the block-cleared zone, especially because the USFWS surveyed for ferrets in the NW Colorado NEP zone and found none.

WS Colorado has implemented all reasonable and prudent measures (RPMs) identified in previous consultations. Additionally, other measures have been implemented to reduce the risk of harm to ferrets. We conducted an analysis of ferret reintroduction sites and locations where WS Colorado conducts PDM where foothold traps would be used to catch wild canids and bobcats. We have conducted no PDM activities where ferrets have been reintroduced in the last 5 years. We did conduct predator damage management around the Wolf Creek NEP zone to enhance the survival of ferrets with no harm to ferrets. There is a low likelihood of WS Colorado conducting PDM to protect livestock, primarily calves, from coyote or lion predation in ferret reintroduction areas of southeastern Colorado over the next 5 years.

WS requests USFWS to update the 1992 BO for the black-footed ferret.

MAY AFFECT SPECIES, NOT LIKELY TO ADVERSELY AFFECT SPECIES

WS has determined that PDM activities could potentially have an impact on some T&E species, but are not likely to have an adverse impact on them. The effects range from a slight potential negative impact to a positive impact (benefit) for the species. These are discussed below and include SOPs to avoid or mitigate impacts where necessary. In addition, some T&E species could potentially be affected by one or more PDM tools, but WS PDM currently has no effect on these species because PDM is not conducted in their range, or WS in Colorado does not use the PDM methods that could potentially impact them. Whereas WS currently has no effect on these species, the potential exists, and they are included here.

Preble's Meadow Jumping Mouse: *Threatened (63 FR 26517, May 13, 1998), exemptions for incidental take 66 FR 45829, Aug. 30, 2001)*

This Federally listed threatened species lives in densely vegetated, shrub-dominated, riparian habitats along the Front Range of Colorado from Colorado Springs north into Wyoming. Their diet is mostly grass seeds and occasional insects. Jumping mice are the smallest true hibernators and hibernate longer than any mammal. In late summer they store fat for fuel before retiring for the long winter (September to May) to a burrow in a well-drained site above the spring flood-line and below the winter frost-line.

PDM methods that have the potential to impact this species are habitat management, the use of rodenticides and other methods to reduce rodent density in their habitat, and potentially the removal of beaver dams in ARDM. WS will not conduct habitat management in their range without consulting further with USFWS. If WS recommends habitat management to reduce wildlife damage such as at an airport to a landowner/manager, WS will recommend that the landowner/manager consult with USFWS prior to undertaking such actions. Thus, habitat management will not have an effect on the mouse.

PDM intended to reduce rodent density, such as the use of toxicants, could have a negative impact on this species. These activities are almost exclusively used on lands already developed for agricultural, industrial, or residential use, and are highly unlikely to occur in the riparian areas associated with the Preble's meadow jumping mouse. To eliminate possible impacts, WS will not use or recommend toxicants within the range and habitat of this species. The use of foothold traps during predator damage management activities will not impact the mouse because its weight is insufficient to trigger even a small predator trap.

WS ARDM methods, with the exception of beaver dam removal, will have no effect on this species, mostly as a result of their size. Beaver dam removal is generally conducted because an area becomes flooded that previously was not and is done soon after the beaver dam is built, but prior to the area becoming an established wetland. Many beaver dam removals are in irrigation ditches and structures which were specifically exempted by rule (66 FR 45829, Aug. 30, 2001). The removal of dams in these areas was seen to have a positive benefit for the mouse. Flooding from a newly established beaver dam could jeopardize jumping mouse habitat by inundating it with water and flooding their hibernation dens. If a beaver dam were in place for several years, jumping mouse habitat could form along with a true wetland as the flooded vegetation above the previous high water mark is replaced with vegetation above the new high water mark. Beaver dams, in time, can establish new wetlands that meet 3 requirements, per federal definition (40 CFR 232.2), including hydric soils, wetland hydrology, and hydrophytic vegetation. For the jumping mouse, hydrophytic vegetation and associated vegetation above the high water mark are the most important. If a beaver dam had been in place for several years, vegetation in the general area, especially along the Front Range, could benefit and develop into dense stands providing habitat for this species. However, these beaver ponds could not be removed without the appropriate permits or exemption per Section 404 of the Clean Water Act. It is WS' conclusion that the indiscriminate removal of beaver dams from streams with associated dense vegetation above the high water mark occupied by this mouse species could adversely affect the mouse's long-term survival. Because ARDM, and in particular beaver dam removal, typically does not eliminate wetland habitat, this species would not be impacted. If WS is requested to remove a beaver dam along the Front Range in the range of the Preble's meadow jumping mouse that has dense vegetation associated with it, a site-specific consultation with USFWS will be requested and the landowners will be required to request the necessary Section 404 permit should it be required. These minimizing measures will ensure that WS does not have an effect on the Preble's meadow jumping mouse.

Finally, it should be noted that if a feral swine population developed along the Front Range in habitat occupied by the jumping mouse, their removal would be beneficial. WS has not conducted feral swine damage management in this area, but could at some time in the future with the expansion of swine populations throughout the United States.

WS believes that habitat management, rodent control, ARDM and feral swine damage management activities conducted by WS will have no to minimal negative or a beneficial effect on the Preble's meadow jumping mouse. WS concludes that PDM will have ***no effect*** on this species because WS will not use PDM methods that could impact the mouse in its range. The removal of beaver dams in irrigation structures and ditches and potential feral swine damage management in the future could be wholly beneficial for the species. With these provisions in place, WS in Colorado concludes it ***may affect, but is not likely to adversely affect this species.***

USFWS Concurrence Requested

Piping Plover: *Threatened Northern Great Plains/Atlantic Coast, Endangered Great Lakes Watershed on June 29, 2010 (50 FR 50726, Jan. 1986)*

The piping plover is a small, sand-colored, sparrow-sized shorebird that nests and feeds along sandy and gravel beaches, riverbed sandbars, and sometimes sandy wet pastures. An important aspect of this habitat is that of sparse vegetation. The plover depends on its coloration for camouflage and protection. The South Platte and Arkansas River drainages in eastern Colorado are the best places to find this species where it is a rare local breeder. Recreational and off-road activities during the breeding season can be disruptive to this species. PDM methods used to haze birds, primarily from airfields, have the potential for having an effect on this species, but are not likely to adversely affect them. Methods include harassment with various sound-scare devices. WS frequently conducts hazing with sound-scare devices at airfields in eastern Colorado including some in Denver, Adams and El Paso Counties where piping plovers have been documented. Thus, WS has the potential to inadvertently scare a plover from an airfield, but field personnel may not know they are present. The most likely time to see this species would be during spring and fall migration at airfields in these Counties. WS believes that whereas this may be considered take under ESA, it would actually be beneficial because birds scared away from the air

operating area are not as likely to be struck and killed by aircraft. Therefore, WS concludes that the use of sound-scare devices ***may affect, but would not likely adversely affect*** the piping plover. If a piping plover is seen at an airfield and becomes a persistent threat, WS would obtain the appropriate permit to target the bird with harassment devices to scare them away from the airfield and keep them away. It should be noted that no piping plover has been documented to be struck at an airport in Colorado from January 1990 to September 2010, but an unidentified plover has been. On the other hand, WS has PDM programs to protect nesting plovers, especially from avian predators (gulls (Laridae) mainly) and mammalian predators such as raccoons (*Procyon lotor*). If such an activity were requested, WS would consult further with USFWS.

USFWS Concurrence Requested

Mountain Plover: *Proposed threatened, reinstated on June 29, 2010 (75 FR 37353 June 29, 2010)*

This species is associated with dry upland prairies and plains where it feeds on insects and other invertebrates. Colorado is the primary breeding ground for the mountain plover; more than half of the world's population nests in the state. Despite their name, mountain plovers do not breed in the mountains, but the shortgrass prairies. Mountain plovers inhabit prairie grasslands, arid plains, and fields. Nesting plovers choose shortgrass prairies grazed by prairie dogs, bison and cattle, and overgrazed tallgrass and fallow fields. However, from year to year they do not necessarily nest at the same location. Plovers arrive at their Colorado breeding grounds in March. Trend information for the Central Breeding Bird Survey (BBS) area shows a decline of -1.71%/year from 1966 to 2012, but a smaller decline for the Colorado BBS area from 2002 to 2012 (Sauer et al. 2014). Whereas populations have declined in many traditional breeding areas, additional inventories conducted since 1995 suggest that mountain plovers are more widely distributed than previously known.

Threats include conversion of native prairie grasslands to cultivation, and possibly loss of prairie dog colonies, predation from expanding swift fox (*Vulpes velox*) populations, oil and gas exploration, and increased recreational use of public lands. This species has been seen in most counties of Colorado, but are mostly found in eastern Colorado. Prairie dog towns and livestock grazed habitat are often used by this species (Sager 1996) and PDM activities involving prairie dogs could be a concern. WS conducts prairie dog control mostly in urban, cultivated, and other developed areas where the plover is less likely to occur, though some work has been conducted on prairie dog towns in areas that they inhabit. However, work was conducted following the breeding season, primarily in fall and winter when mountain plovers were not present. WS anticipates that prairie dog damage management will have no effect on this species. The only other PDM activity that has the potential to impact this species negatively would be harassment with sound-scare devices such as pyrotechnics. This would primarily be at an airport where grass in the air operating area is normally kept short. However, this would likely be a beneficial impact on the species if it were used because it would reduce the likelihood of them being struck and killed by aircraft (1 unidentified plover was struck at an airport in Pueblo County). Because this plover's diet is primarily insects, PDM toxicants used by WS in Colorado for rodent control will have no effect on this species. PDM is often cited as a concern for many species, but WS uses pan-tension devices on traps which precludes capture of this and other species. No other method employed by WS in PDM would have the potential for impact on this species. PDM activities focused on the removal of coyotes, skunks, and possibly swift fox within the breeding range of this species could be beneficial because these predators could impact nesting success. WS concludes that the current program in Colorado ***may affect but would not likely adversely affect*** the mountain plover, but WS believes that it will likely have no effect on the species.

USFWS Concurrence Requested

Least Tern (Interior Population): *Endangered (35 FR 8495, June 2, 1970)*

This small endangered tern species is known primarily from eastern Colorado, but has been seen in many counties throughout the state, primarily during migration. It has been known to breed in southeast Colorado along the Arkansas River drainage of Otero, Bent, and Prowers Counties. It nests on sandbars

and feeds on small fish, insects, and crustaceans. The 1992 BO found that this tern's aquatic feeding habits precluded it from exposure to PDM, and that impacts from PDM activities for foxes, skunks, and raccoons would be beneficial. A few PDM methods do have the potential for having an effect on this species, but are not likely to adversely affect them. Methods include harassment with various sound-scare devices and exclusion methods such as overhead wire grids or netting. These methods are usually used to protect aquaculture facilities and airports, but have only a small potential for affecting this species. WS in Colorado frequently conducts hazing with sound-scare devices at airfields including some in Denver and El Paso Counties, but has not conducted these other activities. Thus, WS has the potential to inadvertently scare a tern from an airfield, but field personnel may not know they are present. WS believes that whereas this may be considered take under ESA, it would actually be beneficial because birds scared away from the air operating area are not as likely to be struck and killed by aircraft. On the other hand, if a nesting colony was being unsuccessful due to predation, WS could conduct PDM for their benefit. Mammalian and avian predators such as raccoons and gulls could have an impact on them. If WS were to conduct PDM for their benefit where predation was a limiting factor, WS would consult further with USFWS prior to undertaking such an activity. CPW or USFWS would likely be the agency requesting such an action. Therefore, WS concludes that the use of sound-scare devices ***may affect, but would not likely adversely affect*** the tern. It should be noted that if a tern became a persistent threat at an airfield, WS would obtain the appropriate ESA permit to target the bird with harassment devices to scare them away from the airfield and keep them away. No least terns, though, were documented to be struck at airports from January 1990 to September 2010 (FAA 2011) illustrating the minimal potential for such an occurrence.

USFWS Concurrence Requested

Southwestern Willow Flycatcher: Endangered (60 FR 10694, February 27, 1995) with critical habitat (50 CFR 60886, October 19, 2005)

This flycatcher occurs in riparian habitats with dense vegetation such as willows (*Salix spp.*), tamarisk (*Tamarix spp.*), or Russian olives (*Elaeagnus angustifolia*). It is found in southwestern Colorado from spring through summer. This species is highly insectivorous, taking insects on the wing or gleaning them from vegetation. Several reasons have been cited for their decline including habitat degradation, water changes, fire, invasive plant encroachment, nest parasitism by cowbirds, and predation (especially nestling/egg predation by great-tailed grackles and possibly corvids).

WS PDM methods that have the potential for affecting the flycatcher are either related to ARDM, bird damage management, or feral swine damage management. Beaver damage management projects involving the removal of established beaver dams have the potential for impacting this species. However, WS in Colorado removes only recently built dams, and their removal would likely be more of a benefit to this species. Recent beaver activity does have the potential to impact this species by cutting down the flycatchers' nesting trees and, thus, beaver damage management could benefit the species. The presence of WS personnel near nesting sites during ARDM or feral swine damage management has been discussed as a potential impact. However, WS personnel usually do not remain in any area for long periods and move on shortly after conducting management activities. WS believes that such encounters will have no or minimal effect on this species. Additionally, in extreme southwestern Colorado where the flycatcher nests, WS will not conduct beaver dam removal except by hand from April through July. WS removes few beaver in the range of the flycatcher.

Bird damage management activities that have only a theoretical potential for effect are mostly associated with harassment programs such as those at airports and agricultural fields. WS in Colorado has only conducted hazing operations in response to wildlife hazards on airports, and not in southwestern Colorado. However, this is only a theoretical risk and would not likely have any impact because these are used in habitats not associated with flycatcher habitat.

A limiting factor for the flycatcher was reported by Harris (1991) to be cowbird parasitism. Bird damage management methods and projects that target cowbirds, especially lethal methods, could have a positive

effect on this species by reducing parasitism rates. In addition, any effort to reduce grackle or other potential nest predator in the range of the flycatcher could have a positive impact by reducing nest and nestling predation.

Considering the flycatcher's habitat preference (riparian area with dense growth), seasonal presence (summer vs. winter when most PDM methods are used), and diet (insectivorous), it is very unlikely that this species would be affected by any PDM method in Colorado. WS conducts activities such as blackbird damage management at feedlots where species such as grackles and cowbirds could be taken which could have a positive effect on the flycatcher. Therefore, WS in Colorado believes that PDM ***may affect, but is not likely to adversely affect*** this species.

USFWS Concurrence Requested

Gunnison Sage Grouse: threatened status for species (79 FR 69192; November 20, 2014), and designation of critical habitat (79 FR 69312; November 20, 2014).

Gunnison sage grouse occur on sage brush habitats and rangelands with a sage brush component in central Colorado in and near the Gunnison Basin. The species has declined in abundance due to substantial changes in habitat from human disturbance and small population size (Gunnison Sage Grouse Rangewide Steering Committee 2005). These population declines are exacerbated by the interaction of predation with habitat loss and small population size (Gunnison Sage Grouse Rangewide Steering Committee 2005). Changes in habitat affect the distribution of Gunnison sage grouse on the landscape. Some habitat changes have resulted in increases in wildlife species that depredate Gunnison sage grouse resulting in negative population effects.

The decline of Gunnison sage grouse is due to poor or no productivity (Davis et al. 2015), especially among the 7 small satellite populations (Davis et al. 2015, Oyler-McCance et al. 2005). Taylor et al. (2012) found female survival and chick survival were the most important vital rates for greater sage grouse population growth, which is similar to little to no population growth afflicting Gunnison sage grouse populations. The poor productivity and survival of chicks is likely attributed to declining habitat quality and introduction of anthropogenic habitat alterations harmful to sage grouse survival. Many studies report habitat characteristics that have changed to the detriment of Gunnison and greater sage grouse (Hovick et al. 2014, Aldridge et al. 2012, Hess and Beck 2012). Whereas habitat loss or change may be the proximate cause of sage grouse decline, these changes introduce ultimate factors, such as predation, that cause population loss (Gregg and Crawford 2007).

Raven and corvid populations have increased significantly over the last 40 years as man has introduced anthropogenic structures into sagebrush habitat (Coates et al. 2016, Coates and Delehanty 2010, Manzer and Hannon 2005). Ravens are one of the predators depredating sage grouse and in some locations are impacting population growth and survivability of nests and eggs (Coates and Delehanty 2010,). These population losses normally would not occur in pristine sage brush habitat. WS Colorado has conducted limited raven damage management to protect Gunnison sage grouse at one satellite population.

Most PDM projects have little potential to impact T&E species in Colorado because they are conducted in areas where T&E species, except Gunnison sage grouse, are known to rarely be present. Many different methods and strategies are used to abate predation to livestock and wildlife species of management concern. However, two routine methods may disturb Gunnison sage grouse. Aerial predator damage management and calling and shooting coyotes with or without decoy dogs may disturb Gunnison sage grouse on leks during late winter and early spring. WS Colorado conducts aerial predator damage management on the Cerro Mesa, Sapinero Mesa (Gunnison Basin) and Crawford 0-2 times per year for 15-30 minutes per location to remove coyotes that may depredate sheep. Eleven aerial predator damage management flights were conducted over the 5 years with only 2 flights occurring after March 15. Gunnison sage grouse were observed on leks during aerial operations over the years with about half the grouse staying on the lek and the other half dispersing into the sagebrush. Calling and shooting coyotes with or without the aid of decoy dogs has resulted in the dog or WS employee walking by or running by

sage grouse with grouse displaying various behaviors from observation, hiding and walking away from the dog or WS employee. These interactions are infrequent and do not happen in all years. In summary, the disturbances are infrequent and of short duration, resulting in no harm to the Gunnison sage grouse. The removal of coyotes to protect sheep has collateral benefits to Gunnison sage grouse by removing a potential predator, especially since the sage grouse populations are low to very low on some sites where individual grouse are important to population recovery. WS in Colorado believes that PDM ***may affect, but is not likely to adversely affect*** this species.

USFWS Concurrence Requested

MAY AFFECT SPECIES COVERED BY AN EXISTING BO

WS has determined that PDM activities could potentially have an impact on some T&E species that are already covered under an existing USFWS BO. WS believes that the current BO is effective and would want to evaluate the potential impact on this species for predator damage management activities because lynx have expanded their range and abundance in Colorado.

Canada Lynx: Contiguous U.S. population threatened (65 FR 16052; March 24, 2000), *critical habitat designated, revised* (74 FR 8615, Feb. 25, 2009))

The Canada lynx, a medium sized member of the cat family, is adapted to living in areas with deep snows. Its historic range in the United States included the high country of Colorado where its main prey, the snowshoe hare (Lepus americanus), is found. A resident population of lynx in the southern Rocky Mountain region of Colorado was considered extirpated and, therefore, CPW undertook reintroduction efforts from 1999 (prior to their listing) to 2006. CPW released 218 adult lynx during this time. As a result of their listing in 2000, WS consulted with USFWS, and was issued a BO on August 25, 2005 (ES/GJ6-CO-05-F-002). The incidental take statement from that BO ended December 31, 2008. Thus, WS consulted further and another BO was issued by USFWS (ES/GJ-6-CO-09-F-007) on Dec. 7, 2009. CPW conducted a predictive analysis of habitat used by lynx in Colorado and found lynx strongly associated with spruce-fir forests at high elevations with deep snow during winter months (Ivan et al. 2011). The best winter habitat for lynx in Colorado was predicted to be the San Juan, Culebra, and Wet Mountain ranges in southern Colorado, Sawatch and West Elk mountain ranges along the Grand Mesa, and Park Range and Flat Tops in northern Colorado (Ivan et al. 2011). Summer habitat was similar to winter habitat with some stronger associations including the use of lodgepole pine and aspen habitat in the Sawatch Range of central Colorado and the use of the Medicine Bow and Front Range of northern part of Colorado (Ivan et al. 2011). We believe that PDM implemented by WS continues to be the same as that identified in the 2009 BO. It is expected that the determination that WS **may affect, but is not likely to jeopardize** the continued existence of this species is still valid. We believe that the lynx BO needs to be updated due to increases in lynx range and abundance. WS will continue to abide by the RPMs and T/Cs as given in 2009 BO until a new BO is provided.

USFWS Biological Opinion Update Requested

NO EFFECT SPECIES BECAUSE WS PDM SOPs PRECLUDE TAKE

WS has determined that PDM activities could potentially have an impact on some T&E species, but will not, as conducted under current policies. Thus, following WS PDM SOPs, WS believes that it will have no effect on these species.

Whooping Crane: *Endangered (32 FR 4001, March 11, 1967) critical habitat (43 FR 20938: May 15, 1978 and 43 FR 36588, Aug. 17, 1978)*

This species, the tallest bird in North America, breeds in northern Canada at Wood Buffalo National Park and winters in Texas, mostly at Aransas National Wildlife Refuge. In Colorado, they are only rarely found during migration in October-November and March-April. They most always migrate through the

Central Plains States east of Colorado. Cranes from this population have only been seen in eastern Colorado a few times over the last forty years. However, an experimental population from Grays Lake Idaho, where whooping cranes were fostered with sandhill cranes, did migrate through Colorado. This population was unsuccessful, because the two species hybridized. The last whooping crane from that flock died in 2002 and they are no longer seen in Colorado. Whooping cranes associate with large open wetlands, croplands, and pastures, both natural and man-influenced. They are omnivorous and feed on insects, crayfish, frogs, fish, clams, acorns, berries, and cultivated crops (e.g., barley, corn, milo, and wheat) in open fields following harvest. USFWS and WS consulted on the whooping crane in the 1992 BO. The primary methods that were considered to have the potential to adversely impact whooping cranes were the use of avicides and rodenticides. USFWS did not believe that the use of traps or hazing would have an effect on the crane. WS does not use or recommend toxicants where whooping cranes are known or believed to be present and would discontinue the use of traps, snares, and bird hazing where they were present. If they were found at an airport, WS would discuss hazing the birds away from the air operating area with USFWS. This activity would be beneficial for the crane because it would minimize the potential for cranes to be struck by aircraft, but would have to be conducted under a Section 10 permit. USFWS provided an Incidental Take Statement in the 1992 BO, but stated that no incidental take by WS, following WS SOPs, was anticipated. WS in Colorado has abided by the SOPs discussed in the 1992 BO, and has never had any known effect on whooping cranes, including those that migrated through central Colorado to Bosque del Apache National Wildlife Refuge in New Mexico. The USFWS 1992 BO concluded that no aspect of the WS program under current policy would adversely affect this species. WS believes this to still be true and does not anticipate taking any cranes, especially considering that they are only accidentally found in Colorado. Thus, WS believes it will have ***no effect*** on whooping cranes in Colorado**.**

USFWS Concurrence Requested

Greenback Cutthroat Trout: *Threatened (43 FR 16343, April 16, 1978) without critical habitat*

The greenback cutthroat trout occurred in much of the Front Range foothills and mountain lakes and streams in the Arkansas and South Platte River systems. Unfortunately, their populations were drastically reduced and they now occupy a small percentage of their original range, in 10 counties from central Colorado to Wyoming in the Platte and Arkansas River systems. This species tends to prefer cold, clear gravelly streams or mountain lakes with an abundance of invertebrates such as freshwater shrimp and insects. WS PDM has little potential to impact this threatened fish species.

This species will inhabit smaller streams and ponds, and other wetlands and have the potential to be impacted by a few aspects of WS PDM. In areas inhabited by beaver, beaver dams can be built. Beaver ponds can be beneficial or detrimental to the T&E fish species depending on the extent of beaver activity, the historic and present stream characteristics, and available spawning grounds (gravel bottoms for greenback cutthroats). Beaver ponds can provide the fish with deep water refugia during times of low flow and droughts. However, if the streams already have naturally occurring deep pools, beaver ponds could reduce necessary spawning habitat from sedimentation and loss of water through percolation (downstream waters can be lost to percolation into the sandy soils, especially where no historic wetland had existed). Additionally, beaver dams are known to alter competitive relationships among fish species, and could help non-native fish species out-compete native species (Collen and Gibson 2001). Beaver dam building activity in some areas of the state may be a long-term management goal of CPW or other management entity, but WS works closely with these entities to determine where beaver activity is wanted. It is anticipated that WS will only remove dams from developed areas such as irrigation canals and urban areas where flooding is causing problems and the greenback cutthroat is unlikely to occur. The removal of beaver dams, primarily with the use of heavy equipment or explosives, could impact the trout from the quick release of water and sediment from the bottom of a pond. However, the 58 reservoirs where this species is found are typically not associated with areas where WS would conduct beaver dam removal. In this species' range, WS will remove beaver dams by hand or slow breaching. The slow breaching of a dam would not cause excessive flooding or heavy sediment loads to go down stream and would have no effect on any fish. Additionally, WS does not remove dams that have created wetlands. Wetlands are created after an area is flooded for many years, typically more than 5 years where wetlands did not previously exist. Recent beaver activity merely alters the flow of water, typically flooding areas above

the high water mark and usually has retained little sediment. Beaver dams alter the substrate from increased sediment which reduces habitat for fish requiring rocky riffles, which is a needed by the greenback cutthroat. Many WS States, especially those in the Southeast have conducted beaver damage management for the benefit of T&E species of fish and invertebrates (rocky, riffle habitat has decreased dramatically in many states because of the beaver activity). WS Colorado has not specifically conducted beaver damage management of this scale to protect the trout, but it could be done in particular areas. If WS needs to use explosives in this fish's range, WS will consult further with USFWS.

Declines in the greenback cutthroat trout population have been linked to the introduction of nonnative fishes, particularly competition and hybridization with the rainbow trout (*Oncorhynchus mykiss*). Many T&E species of fish have declined precipitously due to the introduction of nonnative species of mammals, amphibians, fish and invertebrates (e.g., crayfish) or artificially subsidized populations of native species far beyond historic population levels. Nonnative species and artificially high populations can compete for the same food supply and habitat or predate or hybridize with the native T&E species resulting in their decline. Thus, the removal of nonnative species can benefit some native T&E species. However, WS Colorado has not conducted such activities for the cutthroat. Any of these activities would only be conducted after further coordination and consultation with USFWS.

Feral swine can damage all types of wetlands, especially smaller systems. WS Colorado has conducted some feral swine damage management which undoubtedly, though inadvertently, could have benefitted native fish species, but none of the feral swine removal occurred in the range of the cutthroat. WS could conduct such activity within the cutthroat's range, which could help the cutthroat.

Any of these activities conducted by WS could have the potential for minimal negative to positive effects. WS concludes that current PDM in Colorado, though, will have ***no effect*** on greenback cutthroat trout because WS will consult further with USFWS should WS need to use explosives to remove a beaver dam in the range of the trout.

USFWS Concurrence Requested

NO EFFECT DETERMINATIONS

Mexican Spotted Owl: *Threatened (58 FR 14248, March 16, 1993) with critical habitat (69 FR 53182, August 31, 2004)*

The spotted owl lives in mixed-conifer old-growth forests in mountainous areas and heavily forested canyons along the southern Front Range and in southwestern Colorado where they feed on small rodents. The logging of old-growth forests and forest fragmentation are considered primary factors in their decline (58 FR 14248, March 16, 1993). PDM methods used by WS are not likely to impact this species because they are not typically used in the densely forested habitats inhabited by the owl. Most all WS PDM is conducted in developed areas or along "edge" habitat where animals are likely to travel. WS PDM activities rarely take place in densely forested tracts of land because wildlife typically do not cause damage in this habitat. Of all methods used by WS, the only PDM methods that have the potential to take Mexican spotted owls are rodenticides and foothold traps. WS has not used rodenticides in spotted owl habitat and does not anticipate using them in such areas. The concern would be high particularly with anticoagulants because of their potential secondary poisoning risk. The risk of take with foothold traps is nullified by using pan-tension devices and not setting traps in spotted owl habitat (typically these areas are not conducive for taking target wildlife). Therefore, WS concludes that PDM will have ***no effect*** on this species.

USFWS Concurrence Requested

New Mexico meadow jumping mouse: Endangered (79 FR33119, June 10, 2014).

The New Mexico meadow jumping mouse is endemic to New Mexico, Arizona and a small area of southern Colorado (USFWS 2016). The jumping mouse is a habitat specialist that nests in dry soils but

uses moist, streamside, dense riparian/wetland vegetation. The habitat used by the jumping mouse is persistent emergent herbaceious wetlands comprised of sedge and reed canarygrass or perennial streams comprised of alders and willows. The jumping mouse accumulates fat reserves by consuming seeds for a nine month hibernation. The jumping mouse is currently at risk due to small populations, low viability and loss of large habitat patches along wetland habitats (USFWS 2014). PDM activities rarely occur within the current range of the jumping mouse in Colorado and outside of wetland habitats comprised of willow, alder or sedges that are used by the jumping mouse. Therefore, WS concludes that PDM will have ***no effect*** on this species.

USFWS Concurrence Requested

Colorado Pikeminnow: *Endangered (32 FR 4001, March 11, 1967) with critical habitat (59 FR 13374, March 21, 1994)*

The largest minnow in North America, the pikeminnow, formerly known as Colorado squawfish, can attain a length of 6 feet and weigh 80 pounds. It is dusky-green in color with a long head and large mouth. It prefers turbid rivers with turbulence and seasonal flows. Historically, the pikeminnow occurred in great numbers throughout the Colorado River system from Green River in Wyoming to the Gulf of California in Mexico. In Colorado, they are currently found in the Green, Yampa, White, Colorado, Gunnison, San Juan, and Dolores Rivers. The fish occurs in the warm, swift waters of the big rivers of the Colorado Basin. Adults are migratory, inhabiting pools and eddies just outside the main current. Young can be found in backwater areas. Dam construction and other water diversion projects along the Colorado River system contributed to its decline. The introduction of non-native bait minnows and stocking of predatory game fish species are suspected to have contributed to their decline as well. Recovery actions are underway to remove non-native fish, construct bypasses around in-stream barriers, and restock pikeminnow into native habitat. WS has determined that the current WS PDM program will have ***no effect*** on this species primarily as a result of its habitat preference.

USFWS Concurrence Requested

Humpback Chub: *Endangered (32 FR 4001, March 11, 1967) with critical habitat (59 FR 13374, March 21, 1994)*

This large minnow which can attain lengths of 20 inches has a distinctive hump between the head and dorsal fin. Preferred habitats include areas with fast currents, deep pools, and boulder habitat. Historically, this species occurred in the middle Colorado River Basin. In Colorado this species occurs in the Colorado, Green, Gunnison, and Yampa Rivers. The greatest numbers of humpbacks in Colorado are taken at the Black Rocks area of the Colorado River downstream of Grand Junction. This species is imperiled by habitat loss and degradation through dam construction and operation, but appears to be rebounding in several areas of Colorado. Competition with and depredation by invasive species, and hybridization with other closely related species are possible problems for this species, but habitat selection makes it less vulnerable to these problems than other species. Thus, it is likely that a reduction of these species is not as likely to have a beneficial effect on this species. Thus, no aspect of PDM is likely to be detrimental or beneficial to this species. Therefore, WS has determined that the current WS PDM program will have ***no effect*** on this species.

USFWS Concurrence Requested

Bonytail Chub: *Endangered (45 FR 27710, April 23, 1980) with critical habitat (59 FR 13374, March 21, 1994)*

This large minnow was found in slow water habitats of main stem rivers in the Colorado River Basin. Found historically throughout the Colorado River Drainage, in recent years bonytail chub are mostly found in the Green River of Utah and Havasu and Mohave Lakes. Bonytails were historically found in Colorado, but none were collected until 1984 at the Black Rock area of the Colorado River just west of Grand Junction. This species is threatened by stream flow regulation, habitat loss and degradation, hybridization with similar species and competition with/predation by invasive fishes, and pesticides and

pollutants. The only PDM activity that has any potential to affect this species is the removal of invasive species for its protection, but WS would consult further with USFWS if WS undertook invasive aquatic species removal. Thus, WS has determined that the current WS PDM program will have ***no effect*** on this species.

USFWS Concurrence Requested

Razorback Sucker: *Endangered (56 FR 54957, October 23, 1991) with critical habitat (59 FR 13379, March 21, 1994)*

The critical habitat for the endangered razorback sucker (*Xyrauchen texanus*) includes rivers in Colorado, Utah, portions of the Colorado River in Arizona, California, and Nevada, and portions of the Gila, Salt, and Verde rivers in Arizona. The Razorback Sucker Recovery Plan was updated and supplemented by the Razorback Sucker Recovery Goals (USFWS 2002b). Found historically throughout the Colorado River Drainage, this fish has become very rare above the Grand Canyon. In Colorado, recent specimens have been taken only from the lower, mainstem Colorado, Gunnison, lower Yampa and Green Rivers. CPW reports that less than 70 specimens have been collected in the state since 1979 in Colorado. Predation and competition from nonnative fish species introduced into the Colorado River basin pose the greatest threat to the razorback sucker. Other significant threats to the razorback sucker include loss of riverine and backwater habitats, loss of connectivity of habitats, and changed inflows due to water development. Because this species prefers deeper waters in main stem rivers, the only PDM activity that has any potential to affect this species is the removal of invasive species for its protection, but WS would consult further with USFWS if WS undertook invasive aquatic species removal. Thus, WS has determined that the current WS PDM program will have ***no effect*** on this species.

USFWS Concurrence Requested

Uncompahgre Fritillary Butterfly: *Endangered (56 FR 28712, June 24, 1991) without critical habitat*

This small, 1 inch wing span, rusty brown with black bar butterfly is limited to a few sites in southwest Colorado. It is associated with the snow willow (*Salix reticulata*), providing it food and cover, at elevations above 13,200 feet. It is found in a few colonies in southwestern Colorado. The primary threat to this species is thought to be from overcollection; thus, some sites are not published. Other threats include adverse climatic changes, small population sizes, and trampling by people and livestock. PDM rarely ever occurs at this elevation and WS anticipates such in the future. Thus, WS has determined that PDM would have ***no effect*** on these species.

USFWS Concurrence Requested

Pawnee Montane Skipper: Threatened (52 FR 36176, Sept. 25, 1987) without critical habitat

This small, 1 inch wing span, brownish-yellow skipper subspecies is know from a very restricted range in the South Platte river drainage in a 4 county area of Colorado. It occurs on outcrops of Pikes Peak granite in ponderosa pine (*Pinus ponderosa*) woodlands down fairly steep slopes at an elevation of 6,000-7,500 ft. The areas where it is found has little understory development, but has blue grama grass (*Buteloua gracilis*), the larval food source, and prairie gayfeather (*Liatris spicata*), the primary nectar plant of adults. Construction of a dam and reservoir, roads, and housing has destroyed much of its habitat. It is anticipated that future developments, off-road vehicle activity and recreation could impact it further in the future. It is in an area where little, if any, PDM will ever be conducted. Thus, WS has determined that PDM would have ***no effect*** on these species.

USFWS Concurrence Requested

Threatened and Endangered Plant Species:

PDM, for the most part, has little chance of taking threatened and endangered plants, primarily because most are surviving in areas unlikely to be visited by WS personnel. Most T&E species of plants have specific habitat requirements that limit their distribution and make them vulnerable to stresses in the environment. Most species inhabit rangelands and wetlands in Colorado including talus slopes, high desert, alpine tundra, and scrublands. Few inhabit agricultural, urban, or grassland areas, and forests unless unique conditions exist. Wetlands are susceptible to drought, flooding including from beaver activity, and other conditions. In areas inhabited by T&E plant species, the removal of newly created beaver dams could be beneficial to T&E plants that have been flooded. WS in other states has conducted beaver control and dam removal for the protection of T&E plant species at the request of USFWS. WS in Colorado has not removed beaver dams for T&E plants, but potentially could at the request of a landowner or manager.

Many T&E species of plants have declined from off-road activities. Some WS personnel use 4-wheel ATVs or horses in remote areas to conduct PDM. Off-road activities are typically very minimal and usually confined to roads or developed trails and, therefore, will have no effect on plants.

Other T&E plants have been affected by livestock and wildlife grazing. Feral swine and wild horses can damage all types of rangelands and wetlands, especially smaller systems. WS has conducted some feral swine damage management which undoubtedly, though inadvertently, could have benefitted native T&E plant species because feral swine are very destructive.

Any of these activities conducted by WS could have the potential for minimal negative to positive effects. WS concludes that current PDM in Colorado, though, will have ***no effect*** on the following species because PDM activities that have the slight potential for a negative effect and those with the potential for beneficial effects have not been conducted by WS.

USFWS Concurrence Invited

Mancos Milk-vetch *(Endangered (50 FR 26568, June 27, 1985) without critical habitat)*: This matt-forming perennial grows in clumps (one foot or more) on sandstone rimrock ledges in pinyon pine (*Pinus edulis*)-juniper (*Juniperus spp.*) forests. The plants have persistent spiny leaf stalks. It is found in extreme southwest Colorado with most all specimens found on Tribal lands in Montezuma County in Colorado and San Juan County in New Mexico. The plants grow in small depressions in the sandstone and vegetation is sparse. The primary threat to the Mancos milk-vetch is mineral, oil, gas, and energy development and small distribution. Off-road vehicle use and livestock grazing are not a threat. WS has conducted few PDM activities in the range of this species. The habitat and location for this species preclude it from being disturbed by PDM activities. Thus, WS concludes that PDM will have ***no effect*** on this species.

Osterhout Milk-vetch *(Endangered (54 FR 29658, July 13, 1989) without critical habitat)*: This tall (3 feet) perennial with long linear, bright green stems and long leaflets grows in selenium rich soils of the high desert badlands. The soils are fragile and they grow best in open areas of grassy, big sagebrush (*Artemisia tridentata*) community. The known populations occur in a small area between Muddy and Troublesome Creeks in Grand County. A dam wiped out a significant portion of the population. Off-road vehicle use and oil and gas operations threaten remaining plants. The plant will grow in disturbed areas, areas with grazing and old roads, so it appears to tolerate some disturbance. Another threat to this species is the loss of pollinators which reside in rodent burrows nearby; plants thrive with an abundance of pollinators. Most known plants are on private lands. The Bureau of Land Management in concert with the Nature Conservancy has been trying to obtain the lands. WS conducts little PDM activities in Grand County and does not anticipate harming this plant. The habitat and location for this species preclude it from being disturbed by PDM activities. If beavers dam either creek, it is possible that more plants could be lost to flooding and beaver removal could have a beneficial effect. However, this has not been raised as a concern. WS has not and will not conduct rodent control in the occupied area. Thus, WS concludes that PDM will have ***no effect*** on this species.

Clay-loving Wild Buckwheat *(Endangered with critical habitat (49 FR 28562, July 13, 1984))*: This 4 inch high plant with woody base stems that cover 6 inches of the ground and dark green linear leaves that are woolly underneath is endemic to the rolling clay (adobe) hills and flats immediately adjacent to the communities of Delta and Montrose, Colorado. The Delta/Montrose area is dry, receiving an average of 8 to 9 inches of precipitation a year. The soils where the buckwheat is found are described as whitish,

alkaline, clay soils of the Mancos shale formation which are relatively barren of vegetation in comparison to surrounding areas. The buckwheat is generally found within swales or drainages that are moister than surrounding areas. Plant communities associated with the buckwheat are characterized by low species diversity, low productivity, and minimal canopy cover. The associated vegetation is sparse where the dominant plant species near Delta is mat saltbrush (*Atriplex corrugate*) and, at higher elevations near Montrose, black sagebrush (*Artemisia nova*). The area this species inhabits is threatened by agricultural and urban encroachment which threatens its existence. Associated with these problems is off-road vehicle use which is also a threat. Much of the population is on BLM lands which will not be threatened by development, but off-road vehicle activity in these areas can be high. The only activity that could potentially threaten this species is off-road vehicle use. However, WS personnel use established routes and trails and mostly avoid swales and drainages, which would preclude disturbance from WS PDM activities. WS employees in the area will be notified of the population in this area and told to avoid any off-road activities where the buckwheat occurs. Thus, WS concludes that PDM will have ***no effect*** on this species.

Penland Alpine Fen Mustard *(Threatened (58 FR 40539, July 28, 1993) without critical habitat)*: This small herbaceous perennial herb is found in the Mosquito Range of central Colorado at elevations between 11,900 ft to 13,300 ft. It lives in moist areas dominated by moss (fens). The fens are fed by perennial snowbeds that accumulate on the leeward side of ridges where the alpine fen mustard is found below. PDM rarely ever occurs at this elevation and WS anticipates such in the future. Therefore, WS concludes that PDM will have ***no effect*** on this species.

Colorado Butterfly Plant *(Threatened (65 FR 62302, Oct. 18, 2000) with critical habitat (70 FR 1940, Jan. 11, 2005))*: This plant is a member of the evening primrose family and is a short-lived perennial herb with one to several 2–3 ft. tall reddish, pubescent stems. The lower leaves, 2–6 inch long, are lance-shaped with smooth or wavy-toothed margins while those on the stem are smaller and reduced in number. It is found in subirrigated, alluvial soils on level or slightly sloping floodplains and drainage bottoms, and old, abandoned stream channels with a high water table. Colonies are often found in low depressions or along bends in wide, meandering stream channels. Most populations are found a short distance from the actual channel and may even occur at the base of low, alluvial ridges at the interface between riparian meadows and drier grasslands. It is found in Wyoming, Nebraska, and Colorado at an elevation of 5000-6400 ft. Currently it is found in Jefferson, Larimer and Weld Counties of Colorado, with historical populations in Boulder and Douglas Counties. Of the known populations of the Colorado butterfly plant, the vast majority occur on private lands managed primarily for agriculture and livestock. The most immediate and severe threat to this plant is urban development. Some agricultural practices that impact riparian habitats, such as mowing, haying, application of herbicides, and water management could have an effect on this species. Finally, insect herbivory was noted in the decline of some populations. PDM will have no effect on this species. Beaver damage management could be beneficial where newly created dams may flood them for more than a temporary time. However, WS has not removed dams associated with the plant. It is expected that WS PDM will have ***no effect***, and possibly a minimal beneficial effect on this species.

Pagosa Skyrocket *(Proposed Endangered (75 FR 35721, June 23, 2010))*: This herbaceous perennial phlox grows 12-24 inches tall with a basal rosette of leaves and leaves growing up the stems. Their flowers are small white corolla tubes that are covered with glandular hairs along with the stem. They are found in Mancos Shale derived soils in, at most, lightly grazed grasslands on the edge of ponderosa pine and pinyon-juniper forests at an elevation of just below or above 7,000 feet. It is known from only a few sites close to Pagosa Springs, Colorado in Archuleta County. The two known sites for this plant are threatened with destruction from urban and agricultural development (4 square miles), especially utility installations and grazing. The limited geographic distribution (known only from U.S. Route 84 near Pagosa Springs and 10 miles west along U.S. Route 160) and potential threats to habitat makes this a proposed endangered species. The potential for PDM to impact this species is minimal because it grows in such a limited area, without grazing, where PDM will likely not be conducted. Personnel on ATVs will avoid the areas. Thus, WS concludes that PDM will have ***no effect*** on this species.

Dudley Bluffs Bladderpod *(Threatened (55 FR 4152, Feb. 6, 1990) without critical habitat)*: This very small cushion plant, 0.4-1.2 inch herbaceous perennial, is a member of the mustard family and adapted to surviving in the erosive badland soils of Piceance Basin in Rio Blanco County, Colorado. This species grows on steep barren outcrops derived from calcareous sandstone and shale that are exposed in drainages from the downcutting of streams. The bladderpod grows on level areas of the outcrop. This species is vulnerable because of its limited habitat, small population sizes, and potential for oil shale mining. Most of the plants are on BLM lands which are now protected sites. WS PDM has almost no potential to affect this species because it is found on outcrops of steep slopes. WS personnel would not need to access this habitat type to conduct PDM. WS concludes it will have ***no effect*** on this species.

Knowlton's Cactus *(Endangered (44 FR 62244, Oct. 29, 1979) without critical habitat)*: Knowlton's cactus is a tiny plant that has solitary or clustered stems measuring just over 2 inches tall and 1 inch in diameter. Flowering peaks in early May, with large white blooms, and fruits ripen in June and July. Most of the rest of the year, the cactus is inconspicuous. The species occurs on rolling, gravelly hills in a pinyon-juniper-sagebrush community at about 6,200-6,300 ft. This cactus is known only from northern New Mexico on lands purchased by the Nature Conservancy, but very close to the border in La Plata County, Colorado. The primary threat to this species was collecting prior to its listing and the small distribution. Additional threats included oil and gas exploration, livestock trampling, and possible recreational activities. PDM is conducted minimally in the habitat of this species. WS concludes that PDM will have ***no effect*** on this species, especially considering no known populations exist in Colorado.

Parachute Beardtoungue *(Proposed Threatened (75 FR 35721, June 23, 2010))*: This matt-forming, perennial herb with bluish leaves and white funnel-shaped flowers grows on steep oil shale outcrops and talus slopes in the Roan Plateau of Garfield County, Colorado at an elevation of approximately 8,000 feet to 9,000 feet. It is highly adapted to unstable soil conditions and disappears where soil becomes stable. It is a proposed threatened species because it has a limited geographic distribution and a very specialized habitat. The potential for PDM to impact this species is nil because it grows in an area where PDM will not be conducted and WS ATVs will not travel. WS concludes that PDM will have ***no effect*** on this species.

Penland Beardtoungue *(Endangered (54 FR 29658, July 13, 1989) without critical habitat)*: This member of the snapdragon family at about ten inches tall grows in selenium rich, clay soils in alkaline shale formations of the high desert badlands. The soils are fragile and they grow best in open areas of grassy, big sagebrush (*Artemisia tridentata*) community. The known populations occur in a small area along Troublesome Creeks in Grand County. Off-road vehicle use and oil and gas operations threaten the small population of plants. The Bureau of Land Management in concert with the Nature Conservancy has been trying to obtain the lands which is completely within the range of the Osterhout milk-vetch. WS conducts little PDM activities in Grand County and does not anticipate harming this plant. The habitat and location for this species preclude it from being disturbed by PDM activities. If beavers dam Troublesome Creek, it is possible that plants could be lost to flooding, and beaver or dam removal could have a beneficial effect. However, this has not been raised as a concern. Thus, WS concludes that PDM will have ***no effect*** on this species.

North Park Phacelia *(Endangered (47 FR 38540, Sept. 1, 1982) without critical habitat)*: This species of phacelia, a biennial or possibly a short-lived perennial, grows in sparsely vegetated areas of the Coalmont Formation in North Park of Jackson County, Colorado. It is found only in the erosive sandstone outcrops on the sides of steep ravines or sandy hills. Only 10 populations are known with most plants occurring at 2 of the sites. The plants have many stiff hairs on branching or single, upright stems that are highly divided and topped with purple flowers from July to August. Threats include off-road vehicle disturbance, livestock grazing, and coal, oil and gas exploration and the small number of populations. PDM methods have no to minimal potential to affect this species because the habitat it is found in is not conducive for PDM. Additionally, WS conducts only sporadic operational PDM in Jackson County. Thus, WS believes it will have ***no effect*** on this species.

DeBeque Phacelia *(Proposed Threatened (47 FR 38540, Sept. 1, 1982) without critical habitat)*: This rare low-growing, herbaceous annual plant with a tap root is associated with expansive clay soils in the Wasatch Formation in Mesa and Garfield Counties. This plant occurs in small patches totaling 104 acres in appropriate soils surrounded by similar soils where it does not grow. It grows on moderately steep slopes, benches, and ridge tops, but usually confined to small areas covering a few square yards. Seeds plant themselves by falling into soil cracks that close when wetted. The plant germinates in early April, flowers between late April to June, sets fruit in mid-May to July, and disintegrates shortly thereafter leaving no trace of their existence. The plant grows in an inhospitable environment with wide temperature variations, erosive saline soils, and long drought periods. It grows at about 5,000 to 6,200 feet elevation with the entire range within the southern part of the Piceance Basin, one of the largest natural gas reserves in North America. The primary threat to this species is oil and gas exploration and development, followed by other threats including small population size, off-road vehicle disturbance, and livestock grazing. PDM methods will have no potential to affect this species. WS personnel do use ATVs and horses to conduct work in some areas, but stay mostly on established trails. Unlike the recreational use of an area for off-road ATVs, WS work is conducted relatively quickly in an area with little to no damage to the environment because repeated use of an area is minimal. Thus, WS believes it will have ***no effect*** on this species.

<u>Dudley Bluffs Twinpod</u> *(Threatened (55 FR 4152, Feb. 6, 1990) without critical habitat)*: This twinpod, a small herbaceous perennial, 5-7 inches, is a member of the mustard family that adapted to living in the erosive badland soils of Piceance Basin in Rio Blanco County, Colorado. It was first documented in 1982. It was named for its distinctive heart-shaped fruits that attach to stalked at the pointed end. The leaves, stems and even fruits of this species are all covered with small, specialized branched hairs that resemble a splatter caused by a rock dropped in mud. In May and June the plant produces small, yellow flowers. This species grows on steep barren outcrops derived from calcareous sandstone and shale that are exposed in drainages from the downcutting of streams. The twinpod grows on the steep sideslopes of the outcrop. This species is vulnerable because of its limited habitat, small population sizes, and potential for oil shale mining. Most of the plants are on BLM lands, which are now protected sites. WS PDM activities will have no effect on this species due to where the species is found, on outcrops of steep slopes. WS personnel would not need to access this habitat type to conduct PDM. WS concludes it will have ***no effect*** on this species.

<u>Colorado Hookless Cactus</u> *(Threatened (44 FR 58868, October 11, 1979) without critical habitat)*: The Colorado hookless cactus, formerly Uinta Basin hookless cactus which was separated into 3 species *(74 FR 47112, Sept. 15, 2009)*, is a barrel-shaped cactus that grows normally to 5 inches in height (some to a foot) and 4 inches in diameter. The stems have 8 to 15 ribs that extend the length of the plant with aeroles or small cushioned areas with hooked spines radiating out from them. They have pink to violet blooms and small barrel-shaped fruit. They occur primarily on alluvial benches along the Colorado and Gunnison Rivers and their tributaries. Colorado hookless cactus generally occurs on gravelly or rocky surfaces on river terrace deposits and lower mesa slopes where they are mostly associated with desert shrublands up to pinyon-juniper. They have occurred at almost 100 sites, but half have not been seen in the last 20 years. Current threats include habitat loss (almost 20% of the lands have been covered by water, developed into agricultural lands, or urbanized), oil and energy development, utility corridors (power lines), invasive plant species, off-road vehicle use, water development, illegal collection, livestock and wildlife (mainly desert cottontails (*Sylvilagus audubonii*)), grazing and trampling, parasitism by the cactus-borer beetle (*Moneilema semipunctatum*), pesticides and herbicides, hybridization with other cactus, and climate change (especially drought). PDM activities will not impact this species or its habitat because little PDM is conducted in this type of habitat. WS concludes it will have ***no effect*** on this species.

<u>Mesa Verde Cactus</u> *(Threatened (44 FR 62471, Oct. 30, 1979) with no critical habitat)*: This perennial, low growing, globe-shaped cactus is mostly single-stemmed with multiple stems associated with disease or herbivory. It generally grows to just over 4 inches tall and 3 inches in diameter. The population appeared very stable until 2002 when their population died back from a lack of cactus recruitment and severe mortality, believed to be a combination of severe drought and a higher-than-typical incidence of insect predation. However, they rebounded by 2005 back to pre-2002 levels. All Mesa Verde cacti are currently on Ute Mountain Tribal lands in Colorado. They are restricted to sparsely vegetated badlands of clay loam soils derived from upper Cretaceous Mancos shale in Colorado. Populations are located in a narrow strip of land between Cortez, Colorado, and Sheep Springs, New Mexico, at elevations ranging from 4,600 - 6,600 ft. These formations erode easily, forming low, rolling hills where plants are found on hilltops and benches, but less so in basins or swales. The soils are high alkaline, have poor permeability, and have shrink-swell tendencies which make harsh sites for plant growth. However, during severe hot or cold dry periods, individual plants shrink and retract back into soils which can minimize desiccation or dehydration. They are typically associated with desert shrublands and grasslands. Current threats include habitat loss by utility corridors (power lines) and highways, oil and energy development, off-road vehicle use, illegal collection, livestock grazing and trampling, and climate change (especially drought). PDM activities will not have impacts on this species or its habitat because little PDM is conducted in this type of habitat. WS concludes it will have ***no effect*** on this species.

<u>Ute Ladies'-tresses</u> *(Threatened (*57 FR 2048, *Jan. 17, 1992) without critical habitat)*: Ute ladies'-tresses is a perennial, terrestrial orchid with 7 to 32-inch stems arising from tuberously thickened roots. The flowering stalk consists of few to many small white or ivory flowers clustered into a spiraling spike arrangement at the top of the stem. The species is characterized by whitish, stout flowers. It blooms, generally, from late July through August. The orchid occurs along riparian edges, gravel bars, old oxbows, high flow channels, and moist to wet meadows along perennial streams. It typically occurs in stable wetland and seepy areas associated with old landscape features within historical floodplains of major rivers, as well as in wetlands and seeps near freshwater lakes or springs. Ute ladies'-tresses ranges in elevation to 7,000 ft. Nearly all occupied sites have a high water table (usually within 5 to 18 inches of the surface) augmented by seasonal flooding, snowmelt, runoff, and irrigation. Threats to the Ute ladies'-tresses include groundwater pumping, water diversions, sand and gravel mining, recreation impacts, illegal collection, and invasion of their habitat by nonnative plant species such as Johnson grass (*Sorghum halepense*) and Bermuda grass (*Cynodon dactylon*).

The only aspect of PDM that potentially could affect this species is ARDM, specifically beaver dam removal. The removal of newly established beaver dams would likely be beneficial in the short term, but this species is well adapted to flooding, so it would have minimal potential to be positive. However, if the area was to remain flooded for an extended time frame and new habitat was not available above the new high water mark, then flooding by beavers would be detrimental. If flooding of Ute ladies'-tresses occurs, WS would not conduct ARDM within habitat occupied by this species without further consultation with USFWS. WS concludes that PDM will have ***no effect*** on this species because WS does not travel through the areas where the plant grows while conducting PDM.

NONESSENTIAL EXPERIMENTAL POPULATIONS IN COLORADO

USFWS, often in coordination with CPW or other State agencies, establishes T&E species NEPs. These populations require WS to Conference with USFWS about ways to conserve these species. Under ESA, NEPs are treated as threatened when they are within a National Wildlife Refuge or National Park, and are treated as a proposed species on other lands within the NEP established zone. However, if they are outside the designated recovery zone, they are treated as endangered until USFWS captures and returns the individuals to the designated zone, or expands the recovery area to include the area they are found. ESA requires federal agencies to conference with USFWS for these species. In Colorado, one species has designated NEPs (Table 7) and 2 species have been found in Colorado outside of their NEP zones.

Table 7. Federal threatened and endangered species from Non-essential, experimental populations in Colorado.

Species	*Scientific Name*	Status	Locale	Habitat	Diet*	PDM
Black-footed Ferret	*Mustela nigripes*	NEP	BLM lands in Rio Blanco and Moffat Counties	R	S	-, 0, +
Black-footed Ferret	*Mustela nigripes*	NEP	USFWS lands in Adams Counties	R	S	-, 0, +
Black-footed Ferret	*Mustela nigripes*	NEP	Private lands in Baca, Pueblo, Prowers, Larimer and Weld Counties	R	S	-, 0, +
Gray Wolf	*Canis lupus*	NEP	ID/MT/WY	FGR	Lcs	-, 0
- Mexican Gray Wolf	*Canis lupus baylei*	NEP	AZ/NM	FGR	Lcs	-, 0
California Condor	*Gymnogyps californianus*	NEP	Grand Canyon NP: AZ	FGR	C	-, 0, +

*Diet - Capitals = large proportion of diet - Lower case = small proportion of diet. ** Not listed in Colorado

STATUS	HABITAT	DIET	PDM - Impacts
NEP - Nonessential exp. pop.	**F** - Forests/riparian borders	**C**- Carrion	**(-)** - Negative
	G - Grassland/meadow	**L** - Large Vertebrates	**0** - none
	R - Range/sage/high desert	**S** - Small vertebrates (i.e. rodents, birds)	**(+)** - Positive

Black-footed Ferret: *Endangered (32 FR 4001; March 11, 1967), NEP population designated (61 FR 11320, March 20, 1996)*

Black-footed ferrets are endangered in Colorado and were discussed under that section above, but it is likely no wild population exists in Colorado with the last credible sighting in the 1940s. An NEP was established in northwestern Colorado near Wolf Creek in 2001. In 2010, fall surveys found a minimum population of 1 ferret. The population is thought to have been affected by an outbreak of plague in the area, and possibly other maladies. It was believed in 2015 that this population of ferrets no longer existed dues to collapse of the prairie dog population due to plague (J. Hughes, USFWS, personal communication, 7/19/16). Since 2014, CPW and the Colorado Black Foot Ferret Working Group has established procedures that prairie dog towns will be treated before and after introductions of ferrets with Delta Dust to ensure survival of prairie dogs and ferrets. Additionally, a new plague vaccine has been developed and an experimental use permit issued by USDA APHIS that would reduce the potential for plague outbreaks.

WS worked with CPW to provide protection for the black-footed ferrets from predators (coyotes, badgers, gray fox, and feral dogs) in the Wolf Creek NEP. WS used methods that would have no effect on the ferret such as aerial shooting and ground shooting in and around the prairie dogs, and padded-jaw foothold traps with pan-tension devices on the periphery away from the prairie dog colonies. WS in Colorado has not taken a ferret, but will continue to work with CPW to ensure that predator damage management and other projects have minimal potential to take a ferret. Additionally, WS will only conduct prairie dog damage management outside of Management Zones as part of a Safe Harbor Agreement for the NEP.

Should WS need to conduct damage management of a prairie dog population within the Conservation Zone of a Safe Harbor Agreement for NEP, WS will consult with USFWS prior to conducting the project.

WS believes that this conference opinion should be similar to the BO requested above. WS will abide by the BO and CPW's advice to avoid taking ferrets in the NEPs.

USFWS Concurrence Requested

Gray Wolf: *Endangered (32 FR 4001, March 11, 1967; 41 FR 17736, April 28, 1976; 43 FR 1912, March 9, 1978) without critical habitat, NEP designations for Yellowstone National Park in Wyoming, Idaho, and Montana and in Central Idaho and southwest Montana (59 FR 60252 and 60266, respectively, Nov. 22, 1994)*

Gray Wolf. The gray wolf was extirpated from much of the lower 48 continental United States by the 1930s with few remaining into the 1940s. The last known wolf in Colorado was killed in 1943. They were reintroduced into Idaho, Montana and Wyoming as outlined in the Wolf Recovery Plan under two NEPs in the 1990s. The 2 NEPs have been very successful and USFWS would like to remove them from the T&E list because they have surpassed recovery goals. The range for the experimental populations did not include Colorado, but wolves in Colorado will be, for the most part, from the Yellowstone NEP. Colorado has had several sightings of Gray Wolves in Colorado including one killed on I-70 in 2004, a collared female gray wolf from the Yellowstone NEP, an unknown male in Jackson County, Colorado in 2007 that was likely from the Yellowstone NEP, another collared female wolf from the Yellowstone NEP in Eagle County in 2009, an unknown wolf near Kremmling in early 2015, another collared male wolf from the Yellowstone NEP living in North and Middle Park since late spring 2015 and several reports of wolves in northwestern Colorado. If a wolf from the Yellowstone NEP, or the Central Idaho NEP, are in Colorado, north of I-70 (the dividing line in Colorado for wolves from the northern Rocky Mountain wolf and the Mexican wolf distinct population segments) they would be classified as an endangered species.

Many tools used in PDM, primarily those used for predators including foothold traps, snares, M-44s, and aerial predator damage management, have the potential for taking a wolf. In the event that WS personnel sight a wolf or find evidence that indicates their likely presence in the area, such as scat or tracks, WS will initiate mitigation measures recommended by the USFWS Wolf Recovery Team. Within the area where wolves or verified sign has been found and documented by WS personnel, M-44s and neck snares will not be used, and foothold traps and leg-snares will be checked daily. WS Colorado will implement further conservation measures by conducting no aerial predator damage management from September 1 to November 30 in areas where gray wolves are known to occur, converting to break-away body snares with stops that are checked daily, use thermal imagers or night vision when calling and shooting coyotes at night in areas where wolves are known to occur, and use sirens or calls that make prospective depredating coyotes howl or call back prior to calling and shooting coyotes in an area where wolves are known to occur. In addition, the USFWS Wolf Recovery Team will be notified. WS may assist the Wolf Recovery Team in trapping the wolf so that it can be examined. However, if it was determined to be a released hybrid, it would be euthanized.

In the event that a wolf has been found to kill livestock in Colorado, WS will verify and document the predation, obtain pertinent evidence such as photographs, and contact the USFWS Wolf Recovery Team. Should the Recovery Team determine that the offending individual(s) need to be removed, it would be likely that WS would be asked by the Recovery Team to conduct the PDM activities.

It is WS's finding that PDM activities may affect wolves. However, PDM methods are not likely to jeopardize wolf recovery, especially considering that wolves are intermittently found in Colorado and they would be from the Yellowstone NEP which is considered recovered. WS would initiate SOPs to avoid taking a wolf, if a wolf or its sign is found north of I-70 outside of its NEP range. Therefore, WS concludes that PDM ***may affect, but is not likely to jeopardize*** this species, but WS will abide by the results of the current consultation to ensure that WS will not jeopardize the Mexican wolf.

USFWS Concurrence Requested

Mexican Gray Wolf: *Endangered (32 FR 4001, March 11, 1967; 41 FR 17736, April 28, 1976; 43 FR 1912, March 9, 1978) without critical habitat, NEP designation in Southwest (63 FR 1763, January 12, 1998)*

The gray wolf, including the Mexican subspecies, was extirpated from much of the lower 48 continental United States in the first half of the twentieth century. The Mexican wolf population once inhabited areas in Arizona, New Mexico, Texas, and Mexico, but they were probably extirpated from the U.S. by 1970 with the last verified report of a wild wolf; and may altogether be extirpated now in Mexico. Fortunately, captive Mexican wolves were available for their recovery. In 1998, wolves were reintroduced in Arizona and New Mexico as an NEP under section 10(j) of the Endangered Species Act which is outlined in the Wolf Recovery Plan. WS is currently in consultation/conferencing with USFWS for the Mexican gray wolf. Many tools used in PDM for large predators such as foothold traps, snares, M-44s, and aerial predator damage management have the potential of taking a wolf. WS follows the conservation measures established in the 1998 BO and Conference Opinion issued by USFWS (1998a); this was actually two opinions - a BO for "naturally occurring wolves" and a "Conference Opinion" for the reintroduced NEP. WS in Colorado believes that we will only encounter wolves from the NEP. Any wolf seen in Colorado south of I-70, though, is considered endangered from the Mexican wolf NEP. WS will abide by the same measures given for the gray wolf above. The measures would minimize the potential for a wolf to be taken.

It is WS's finding that PDM activities may affect wolves. However, PDM methods are not likely to jeopardize wolf recovery, especially considering that wolves would most likely be from the NEP, and WS would initiate mitigation measures to avoid jeopardy should a wolf be found outside of its NEP range in Colorado. The 1998 BO and Conference Opinion provided adequate RPAs and RPMs to avoid take by WS. USFWS issued incidental take statements for the take of naturally occurring wolves in a BO and those from the NEP in the Conference Opinion, but did not anticipate that any would be taken with conservation measures in place. WS in Colorado will continue to abide by the 1998 BO/Conference Opinion should a Mexican gray wolf be found to wander north of the NEP. Therefore, WS concludes that PDM ***may affect, but is not likely to jeopardize*** this species, but WS will abide by the consultation to ensure that WS will not jeopardize the Mexican wolf.

USFWS Concurrence Requested

California Condor: *Endangered (32 FR 4001, March 11, 1967) with critical habitat in California (41 FR 187, September 24, 1976), NEP designated for Southwest reintroduction (61 FR 54044, October 16, 1996)*

The condor is the largest flying land bird in North America. They are classified as New World vultures, which, unlike Old World vultures, find food items by sight and not smell. They are a long-lived species that mature and reproduce slowly. At the end of the last ice-age, condors were found across North America, but the extinction of giant mammals during the late Pleistocene coincided with a reduction in the condor's range, remaining only along the Pacific coast. After the arrival of Europeans in North America, the condor population dwindled from a combination of shooting, the use of DDT, and other impacts associated with the settlement of the West. The California condor was extirpated over most of its range by the late 1970s and all wild condors were taken into captivity in 1980s. The propagation program was a success and they were reintroduced back into the wild in California. In addition, an NEP of California condors was established at Vermillion Cliffs in northern Arizona. Members of the NEP not occurring within the NWR or NPS System are treated as proposed species under Section 4 of the Endangered Species Act of 1973 for the purpose of Section 7. Consultation/conferencing is not required for proposed species unless a federal agency determines that its action is likely to jeopardize the continued existence of any proposed species or result in the destruction or adverse modification of proposed critical habitat. However, Colorado was not included in the NEP. Thus, they are treated as endangered while they are in Colorado.

Three condors wandered from the NEP to Grand Junction, Colorado in 1998, but did not stay and returned to the NEP (USFWS 1996). As a result of this, M-44s are not used in a 5 mile corridor around Colorado and San Juan Rivers from March 1 to October 1. Since this has not been a regular occurrence and occurred shortly after their release, it is expected that this will rarely occur, if ever again. However, if a California condor is seen in Colorado again, WS will implement the reasonable and prudent alternatives identified by USFWS in their 1992 BO to protect the condor. The BO provided by USFWS in 1992 as a result of that consultation evaluated the impacts of methods used in PDM on the California condor in its native range, including the use of the M-44, DRC-1339, rodenticides, foothold, body-gripping, and cage traps, snares, shooting, aerial predator damage management, and scare devices. WS made several "may affect" determinations and requested consultation for the condor. USFWS decided which "may affect" determinations were serious enough to escalate to jeopardy and which could be dismissed as "not likely to adversely affect." The only method of concern used in PDM in the 1992 BO was the M-44. RPAs were given for the use of the M-44 in the 1992 BO to avoid jeopardy to the California condor and a "not likely to result in jeopardy" opinion was given. In the 24 years since the BO was written and the RPAs were adopted by WS, PDM has not resulted in "take" of a California condor in its native range or the NEP in Arizona. The proposed action by WS Colorado would abide by the 1992 BO and implement all RPAs provided for PDM. WS will not use double foothold trap sets (more than one trap within 20 feet of each other) for coyotes or other large predators in any area where a condor has been sighted and will use only single M-44 sets, not closer than 300 feet from each other, which will be placed in a recess and capped so the head is not visible. WS will adhere to standard operating procedures for foothold traps and snares including no visible bait at the set site and that trap set sites (except traps used for mountain lions) will be no closer than 30 feet from a draw station. By following these RPAs, the proposed action is not likely to jeopardize the NEP should they occur in Colorado.

Since the 1992 BO was written, new evidence has found that many terrestrial raptors (including California condors), are impacted from lead toxicity as a result of ingesting lead shot and bullet fragments from carcasses and gut piles (Fisher et al. 2006). As a result of this finding, WS has been working towards the use of nontoxic shot (bismuth, steel, tungsten, nickel, and combinations thereof) nationally in aerial predator damage management, and nontoxic bullets for ground-based shooting. Research into the toxicity of nontoxic shot to birds is limited, but so far ingestion of nontoxic shot does not appear to adversely affect birds (Brewer et al. 2003, Ringelman et al. 1993). It has been standard WS operating procedure to retrieve carcasses shot with lead bullets and shot as allowable, thus minimizing the potential risk to raptors, which would be beneficial for condors too should they come back to Colorado.

On the other hand, PDM could have a positive effect on the California condor. Coyotes were responsible for the depredation of at least 3 condors in Arizona between 1996 and 2002 (Cade et al. 2004), and management targeting coyotes could be considered beneficial for them if it has been conducted in an area where they come into the State. Thus, PDM is likely to have a potential beneficial effect on the condor.

It is WS's conclusion that by following the RPAs in the 1992 BO, restricting the use of M-44s along the Colorado and San Juan Rivers, and by using only non-lead ammunition where they have been found in Colorado, PDM activities ***may affect, but are not likely to adversely affect*** this species.

USFWS Concurrence Requested

STANDARD OPERATING PROCEDURES

WS personnel will adhere to the following SOPs to protect listed T&E and sensitive species. Several are method specific with consideration for a wide variety of T&E species while others are specific to certain species. Included below are SOPs incorporated into PDM in general, for specific methods, and for specific species or groups of species. Additionally, WS abides by the RPAs, RPMs, or T/Cs for incidental take statements already in place for species that have been covered in a BO and for any newly issued BO.

General SOPs

X WS personnel are highly experienced and trained to select the most appropriate method(s) for taking problem animals with little impact to T&E species. When working in an area that has T&E species or the potential for T&E species to be exposed to PDM methods, WS personnel will know how to identify sign of the target and T&E species and use PDM methods accordingly.

X WS personnel work with research programs such as the WS-National Wildlife Research Center to continue to improve the selectivity of management devices.

X WS personnel using 4-wheel ATVs will use roads and existing trails as possible to conduct field work.

X WS personnel will retrieve the carcasses of animals shot with lead bullets or shot from the field as possible and dispose of them according to WS Policy.

Species	Scientific Name	CNHP State Rank	Where Found	Habitat	When Found	Effects of PDM
MAMMALS						
Cliff Chipmunk	*Tamias dorsalis*	S2	Moffat Co.	Pinyon-juniper	All year	0
Dwarf Shrew	*Sorex nanus*	S2	Central Foothill	Woods	All year	0
Ord's Kangaroo Rat	*Dipodomys ordii priscus*	S3	Moffat Co.	Open sandy	All year	0
Pygmy Shrew	*Sorex hoyi montanus*	S2	Jackson Co.	Wooded open	All year	0
Silky Pocket Mouse	*Perognathus flavus sanluisi*	S3	San Luis Valley	Shortgrass	All year	0
White-tailed Prairie Dog	*Cynomys leucurus*	S4	Northwest	Prairie	All year	0
Brazilian Free-tailed Bat	*Tadarida brasiliensis*	S1	Scattered sites	Caves-bldgs.	Summer	0
Swift Fox	*Vulpes velox*	S3	Eastern Colo.	Plains	All year	-, 0, +
BIRDS						
American peregrine falcon	*Falco perearinus anatum*	S3	Western Colo.	Variety	All year	0
Black swift	*Cypseloides niger*	S3	Western Colo.	Cliffs	Summer	0
Bobolink	*Dolichonyx oryzivorus*	S3	North-central	Grassland	Breed	0
Columbian sharp-tailed grouse	*Tympanuchus phasianellus columbianus*	S2	Western Colo.	Grass-shrublands	All year	0, +
Grace's warbler	*Dendroica graciae*	S3	Southwest	Pine-oak	Breed	0
Gray vireo	*Vireo vicinior*	S2	Western Colo.	Pinyon-juniper	Breed	0
Greater sandhill crane	*Grus canadensis tabida*	S2	Northwest	Marsh-grassland	Breed $	0, +
Lewis's woodpecker	*Melanerpes lewis*	S4	Western Colo.	Open woodlands	All year	0
Northern sage-grouse	*Centrocercus urophasianus*	S4	Northwest	Sage	All year	0, +
Ovenbird	*Seiurus aurocapillus*	S2	Eastern Colo.	Decid. oldgrowth	Breed	0
Prairie falcon	*Falco mexicanus*	S4	Statewide	Prairie	All year	0
Sage sparrow	*Amphispiza belli*	S2	Western Colo.	Sage	Breed	0
White-faced ibis	*Plegadis chihi*	S2	Statewide	Marsh-grassland	Breed	0, +
Black-necked stilt	*Himantopus mexicanus*	S3	Statewide	Wetlands	Breed	0, +
Boreal owl	*Aegolius funereus*	S2	North-central	Boreal forest	All year	0
Brown-capped rosy-finch	*Leucosticte australis*	S3	Western Colo.	Alpine	All year	0
Ferruginous hawk	*Buteo regalis*	S3	Statewide	Open Prairie	All year	0
Greater prairie-chicken	*Tympanuchus cupido*	S3	Northeast	Grassland	All year	0, +
McCown's longspur	*Calcarius mccownii*	S3	North-central	Grassland	Breed	0
Mountain plover	*Charadrius montanus*	S2	Eastern Colo.	Prairie	Breed	0
Northern goshawk	*Accipiter gentilis*	S3	Western Colo.	Forest	All year	0
Northern pygmy-owl	*Glaucidium gnoma*	S3	Western Colo.	Woodlands	All year	0
Veery	*Catharus fuscescens*	S3	Western Colo.	Moist woods	Breed	0
White-tailed ptarmigan	*Lagopus leucurus*	S4	Central Colo.	Alpine	All year	0, +
White-winged crossbill	*Loxia leucoptera*	S1	Western Colo.	Conifer forest	Winter	0
Willow flycatcher	*Empidonax traillii*	S4	Statewide	Riparian woods	Breed	0
Wilson's phalarope	*Phalaropus tricolor*	S4	Statewide	Wetland	Breed	0

CNHP = Colorado Natural Heritage Program — Effects of PDM: (-), negative; (+), positive; 0, no effect

State Rank (relative rarity or endangerment in the state): S1-Critically imperiled; S2-Imperiled; S3-Rare; S4-Widespread, but long-term concern

X WS projects involving habitat management where a T&E species could be affected will be discussed with USFWS prior to implementation. If WS recommends habitat management, the cooperator will be informed that they will need to consult with USFWS and obtain the necessary permits prior to receiving assistance from WS.

X Netting placed by WS personnel will be monitored frequently for ensnared birds or other wildlife.

X Pan-tension devices will be used on foothold traps and foot snare triggers to reduce the capture of nontarget wildlife including T&E species that weigh less than the target species.

X WS personnel adhere to all label requirements for toxicants. EPA labels have a section on T&E species and environmental considerations that must be followed, and WS personnel will abide by these. These restrictions invariably preclude exposure to T&E species.

Gunnison Sage Grouse SOPs

- If fencing is recommended to exclude or deter livestock predators in Gunnison sage grouse habitat then the fencing should be marked with vinyl siding undersill on the top strand at 1-meter intervals or a white rope or similar material to mark the top strand of fence within 500 meters of a lek (Stevens et al. 2012). It is preferable that no new fencing (e.g., barb wire, net wire, woven wire) be erected in Gunnison sage grouse habitat to avoid collisions and additive mortality.

Plant SOPs

- WS personnel will not collect plants while afield.

Black-footed Ferret, Mexican Gray Wolf, and California Condor

- WS personnel will abide by all RPAs, RPMs, and T/Cs outlined in the BOs, Consultations, or Conference Opinion for these species.

SUMMARY

The analysis for each listed federal threatened and endangered species is summarized for the methods that would be used to manage predation (Table 8). The table shows the methods that would be used and WS Colorado's determination of the level of effect.

LITERATURE CITED

Aldridge, C. L., D. J. Saher, T. M. Childers, K. E. Stahlnecker and Z. H. Bowen. 2012. Crucial nesting habitat for Gunnison Sage Grouse: a spatially explicit hierarchiacal approach. J. of Wildl. Manage. 76:391-406.

Brewer, L., A. Fairbrother, J. Clark, and D. Amick. 2003. Acute toxicity of lead, steel, and an iron–tungsten–nickel shot to mallard ducks (*Anas platyrhynchos*). J. Wildl. Dis. 39: 638–648.

Cade, T. J., S. A. H. Osborn, W. G. Hunt, and C. P. Woods. 2004. Commentary on released California condors *Gymnogyps californianus* in Arizona. Pp. 1–25 *in* R.D. Chancellor and B.-U. Meyburg [eds.]. Raptors worldwide. World Working Group on Birds of Prey and Owls/MME-Birdlife. Budapest, Hungary.

Coates, P. S. and D. J. Delehanty. 2010. Nest predation of greater sage grouse in relation to microhabitat factors in predators. J. of Wildl. Manage. 74:240-248.

Coates, P. S., B. E. Brussee, K. B. Howe, K. B. Gustafson, M. L. Casazza and D. J. Delehanty. 2016. Landscape characteristics and livestock presence influence common ravens: relevance to greater sage grouse conservation. Ecosphere. http://onlinelibrary.wiley.com/doi/10.1002/ecs2.1203/full

Collen, P., and R. J. Gibson. 2001. The general ecology of beavers (*Castor* spp.), as related to their influence on stream ecosystem and riparian habitats, and the subsequent effects on fish – a review. Reviews in Fish Biology and Fisheries 10: 439–461.

Davis, A. J., M. L. Phillips and P. F. Doherty, Jr. 2015. Survival of Gunnison sage grouse *Centrocercus minimus* in Colorado, USA. J. of Avian Biology 45:186-192.

Fisher, I. J., D. J. Pain, and V. G. Thomas. 2006. A review of lead poisoning from ammunition sources in terrestrial birds. Biol. Conserv. 131: 421–432.

Gregg, M. A. and J. A. Crawford. 2007. Survival of greater sage grouse chicks and broods in the northern Great Basin. J. of Wildl. Manage. 73:904-913.

Gunnison Sage Grouse Rangewide Steering Committee. 2005. Gunnison Sage Grouse Rangewide Conservation Plan. Colorado Division of Wildlife, Denver, CO, USA. 359 pp + appendices.

Harris, J. H. 1991. Effects of brood parasitism by brown-headed cowbirds on willow flycatcher nesting success along the Kern River, California. Western Birds. 22: 13–26.

Hess, J. E. and J. L. Beck. 2012. Disturbance factors influencing greater sage grouse lek abandonment in north-central Wyoming. J. of Wildl. Manage. 76:1625-1634.

Hovick, T. J., R. D. Elmore, D. K. Dahlgren, S. D. Fuhlendorf and D. M. Engle. 2014. Evidence of negative effects of anthropogenic structures on wildlife: a review of grouse survival and behaviour. J. of Applied Ecology 51:1680-1689.

Ivan, J., M. Rice, T. Shenk, D. Theobald, and E. Odell. 2011. Predictive map of Canada lynx habitat use in Colorado. Colorado Parks and Wildlife. Fort Collins, CO. 17 pp.

Manzer, D. L. and S. J. Hannon. 2005. Relating grouse nest success and corvid density to habitat: a multi-scale approach. J. of Wildl. Manage. 69:110-123.

Oyler-McCance, S. J., J. St. John, S. E. Taylor, A. D. Apa and T. W. Quinn. 2005. Population genetics of Gunnison Sage-grouse: implications for management. J. Wildl. Manage. 69:630-637.

Ringelman, J. K., M. W. Miller, and W. F. Andelt. 1993. Effects of ingested tungsten-bismuth-tin shot on captive mallards. J. Wildl. Manage. 57: 725−732.

Sager, L. 1996. A 1995 survey of Mountain Plovers, *Charadrius montanus*, in New Mexico. Endangered Species Program, New Mexico Department of Game and Fish.

Sauer, J. R., J. E. Hines, J. E. Fallon, K. L. Pardieck, D. J. Ziolkowski, Jr., and W. A. Link. 2014. *The North American Breeding Bird Survey, Results and Analysis 1966 - 2012. Version 02.19.2014 USGS Patuxent Wildlife Research Center, Laurel, MD*

Stevens, B. S., K. P. Reese, J. W. Connelly and D. D. Musil. 2012. Greater sage grouse and fences: does marking reduce collisions? Wildl. Soc. Bull. 36:297-303.

Slate, D. A., R. Owens, G. Connolly, and G. Simmons. 1992. Decision making for wildlife damage management. Transactions of the North American Wildlife and Natural Resources Conference 57:51-62.

Taylor, R. L., B. L. Walker, D. E. Naugle, and L. S. Mills. 2012. Managing multiple vital rates to maximize greater sage grouse population growth. J. of Wildl. Manage. 76:336-347.

U. S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services program. 2011. Biological Assessment for the management of wildlife damage in Colorado to protect agricultural and natural resources, property, and human health and safety: Analysis of potential impacts on threatened and endangered species. 5/12/11. USDA-APHIS-WS, 12345 West Alameda Pkwy., Suite 210, Lakewood, CO 80228. 75 pp.

_____. 2009. Letter from M. Yeary to S. Linner to reinitiate consultation for potential impacts on Canada lynx by the Colorado Wildlife Services Program. June 11, 2009. Lakewood, CO.6 pp.

U. S. Fish and Wildlife Service. 2016. New Mexico meadow jumping mouse (Zapus hudsonius luteus). Environmental Conservation Online System. U. S. Fish and Wildlife Service. Retrieved 7/28/2016.

_____. 2014. Determination of endangered status for the New Mexico meadow jumping mouse throughout its range. Fish and Wildlife Service. Federal Register 79:33119. June 10, 2014.

_____. 2011. Letter of concurrence with the USDA-APHIS-Wildlife Services Biological Assessment of impacts of wildlife damage management on T&E species in Colorado. From Susan Linner, USWFS Colorado Field Supervisor, to Mike Yeary, State Director. Nov. 22, 2011. 6 pp.

_____. 2010. Letter from S. Linner to M. Yeary for consultation for the biological assessment for the wildlife damage management program and its effects on the threatened Canada lynx. January 29, 2010. Denver, CO. 68 pp.

_____. 2002. Razorback sucker (*Xyrauchen texanus*) Recovery Goals: amendment and supplement to the Razorback Sucker Recovery Plan. U.S. Fish and Wildlife Service, Mountain-Prairie Region (6), Denver, Colorado.

_____. 2001. Local assistance sought in review of California condor experiment. USFWS Southwest Region, Albuquerque, NM. 2 pp.

_____. 1998. Biological Opinion on Mexican gray wolf. Letter to USDA-APHIS-WS from USFWS. May 27. 16 pp. + App.

_____. 1996. Establishment of a non-essential experimental population of California Condors in northern Arizona. Federal Register 61:54044.

_____. 1992. Biological opinion for USDA-APHIS-Animal Damage Control Program. Formal Consultation. U.S.D.I., Fish and Wildlife Service, Washington, D. C. 69 p.

APPENDIX D: BIOLOGICAL OPINION TO INFORMAL SECTION 7 CONSULTATION

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Colorado Ecological Services

IN REPLY REFER TO:
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ES/CO: USDA/APHIS-Wildlife Svcs, Colorado
TAILS 06E24100-2016-I-0303

November 18, 2016

Martin Lowney
State Director, Colorado
USDA, APHIS, Wildlife Services
12345 Alameda Parkway, Suite 204
Lakewood, Colorado 80228

Dear Mr. Lowney:

On August 1, 2016, we received your biological assessment (BA) and request for section 7 consultation pursuant to the Endangered Species Act (ESA) for Wildlife Services' (WS) predator damage management (PDM) program in Colorado to protect livestock, wildlife species of management concern, and human safety. You are currently preparing an environmental assessment pursuant to the National Environmental Policy Act (42 U.S.C. 4321) to examine issues, alternatives and environmental consequences of PDM to protect these resources.

The WS Colorado Program is part of the national WS program, which has been previously reviewed under a formal consultation between WS and the U.S. Fish and Wildlife Service (Service), resulting in a biological opinion (BO) from the Service in 1992 (Service 1992). Since then, changes to WS Colorado PDM activities and new threatened and endangered species listings prompted requests for updated Section 7 consultations. Since the 1992 BO, WS in Colorado and the Service have consulted on the WS aquatic rodent damage management (ARDM) program, on potential impacts to Canada lynx (*Lynx canadensis*) from the WS PDM program (WS 2009, USFWS 2010), and on a programmatic review of the WS Colorado program in 2011 (WS 2011, USFWS 2011).

You have made a determination of no effect for the following animal species:

Whooping crane	*Grus Americana*
Mexican spotted owl	*Strix occidentalis lucida*
Western yellow-billed cuckoo	*Coccyzus americanus*
New Mexico meadow jumping mouse	*Zapus hudsonius luteus*
Preble's meadow jumping mouse	*Zapus hudsonius preblei*
Grizzly bear	*Ursus arctos horribilis*
Colorado pikeminnow	*Ptychocheilus lucius*

Razorback sucker	*Xyrauchen texanus*
Humpback chub	*Gila cypha*
Bonytail	*Gila elegans*
Greenback cutthroat trout	*Oncorhynchus clarkii stomias*
Pallid sturgeon	*Scaphirhynchus albus*
Uncompahgre fritillary butterfly	*Boloria acronema*
Pawnee montane skipper	*Hesperia leonardus montana*

You have also made a no effect determination for all Federally listed plant species in Colorado. In addition, you have not requested consultation on any critical habitats. We acknowledge your determination of no effect for these species, but neither 7(a)(3) of the Act, nor implementing regulations under section 7(a)(2) of the Act require the Service to review or concur with this determination; therefore the Service will not address these species further. However, we do appreciate you informing us of your analysis for these species.

You have determined that the PDM program in Colorado may affect, but is not likely to adversely affect the following species:

Least tern	*Sternula antillarum*
Piping plover	*Charadrius melodus*
Southwestern willow flycatcher	*Empidonax traillii extimus*
California condor	*Gymnogyps californianus*
Gunnison sage-grouse	*Centrocercus minimus*
Mountain Plover	*Charadrius montanus*
Gray wolf	*Canis lupus*

We concur with your determination of may affect, but not likely to adversely affect for these species, with the exception of the mountain plover. The mountain plover was removed from consideration for listing in 2011 (76 FR 27756); therefore, consultation is not required. Details and rationale for the other species are provided below. Additionally, you have requested a consultation update for the Black-footed ferret (*Mustela nigripes*) and Canada lynx (*Lynx canadensis*). Discussion and updated information for these species is provided below as well.

Least tern, piping plover, southwestern willow flycatcher. These bird species are not targeted by WS for control. Their wetland and riparian habitat preferences limit the likelihood of their exposure to most WS actions. The use of sound devices by WS at airports may scare these birds from runways (if present, although unlikely), but this would be purely beneficial by guiding them out of harm's way (e.g., preventing a bird-airplane strike). WS limited control of gulls, corvids, and cowbirds could also provide a benefit for these species by removing potential nest predators and nest parasites. Additionally, beaver dam removal within the range of the Southwestern willow flycatcher would only take place by hand if done during the nesting season. The least tern and piping plover were included in the 1992 and 2011 consultations, and the southwestern willow flycatcher in the 2011 consultation, all with the same determination at those times and now, that they may be affected, but are not likely to be adversely affected by WS programs. We concur with your determination that WS activities may affect, but are not likely to adversely affect these species.

California condor. The California condor has only frequented the state of Colorado a few times, that we are aware of, since its near-extinction and subsequent reintroductions from captivity to California, Arizona, and Mexico. It is not a regular resident of the state and does not nest here. Nevertheless, WS takes a few precautions for the condor as outlined in the 1992 BO and 2016 BA (WS 2016a) where condors have been found (e.g., restrictions on the use of M-44s and the use of non-lead ammunition). Given this, we believe effects to the California condor are discountable and we concur with your determination that WS activities in Colorado may affect, but are not likely to adversely affect this species.

Gunnison sage-grouse. According to the BA, two routine PDM methods may disturb Gunnison sage grouse. Aerial predator damage management and calling and shooting coyotes with or without decoy dogs may disturb Gunnison sage-grouse on leks during late winter and early spring. WS Colorado conducts aerial predator damage management on Cerro Mesa, Sapinero Mesa (Gunnison Basin) and near Crawford 0-2 times per year for 15-30 minutes per location to remove coyotes that may depredate sheep. Eleven aerial predator damage management flights were conducted over 5 years with only 2 flights occurring after March 15 when lekking activity typically increases. Gunnison sage grouse were observed on leks during aerial operations over the years with about half the grouse staying on the lek and the other half dispersing into the sagebrush. Calling and shooting coyotes with or without the aid of decoy dogs has resulted in the dog or WS employee walking by or running by sage-grouse with grouse displaying various behaviors from observation, hiding, and walking away from the dog or WS employee. These interactions are infrequent and do not happen in all years. In summary, the disturbances are infrequent and of short duration, resulting in no significant effects to the Gunnison sage grouse.

The removal of coyotes to protect sheep may also have collateral benefits to Gunnison sagegrouse by removing a potential predator of sage-grouse. WS Colorado has conducted limited raven damage management to protect Gunnison sage-grouse at one satellite population as well. And, as outlined in the BA, a standard operating procedure (SOP) for Gunnison sage-grouse states that no new fencing would be constructed within occupied habitat (preferred), or if it is necessary, the top wire strand would need to be marked within 1000 meters of any lek to reduce grouse-fence collisions (WS 2016e). Given these conservation measures, we believe sagegrouse/fence collisions due to WS activities would be discountable. We concur with your determination that WS PDM activities, including coyote control and fencing, may affect, but are not likely to adversely affect this species.

Gray wolf. Since 2004, a small number of wolves (less than 10) have been sighted in 4 or 5 counties in northern Colorado; no denning or reproduction has been documented. Many tools used in PDM, primarily those used for predators including foothold traps, snares, M-44s, and aerial predator damage management, have the potential for taking a wolf. Snares, foothold traps, and M-44s are not allowed for use on public lands, but could be used on private lands. Wolves would not be purposefully targeted for capture or control.

Conservation measures to prevent taking a wolf are provided in the BA. These measures would be employed by WS within an easily defined area containing past wolf observations: Highway 13 (Moffat County) from the Wyoming border south to Craig, then east on Highway 40 to Steamboat Springs, then south on Highway 131 to Interstate 70, where the southern boundary will run east along Interstate 70 to Interstate 25 (eastern border), where the boundary will turn north to the Wyoming border; the Wyoming border between Highway 13 and Interstate 25 will be the northern boundary (WS 2016b). This area could be adjusted cooperatively by WS and the Service in the future based on updated wolf location information. Within the area potentially occupied by wolves: a) M-44s and neck snares would not be used, b) non-lethal foothold traps and leg snares could be used on private land by WS personnel, but would be checked daily, c) no aerial predator shooting would occur September 1 through November 30 (when young wolves and coyotes can be of similar size), d) body snares would have a break-away mechanism (strong enough to hold a coyote, but not a wolf), e) thermal imagers or night vision would be used when calling and shooting coyotes after dark (to more accurately identify the target species), and f) sirens or calls would be used to make coyotes howl prior to shooting coyotes (WS 2016a, 2016c). Additionally, Livestock Protection Collars would not be used and are not registered for use in Colorado (WS 2016d). Given these conservation measures, and the low likelihood of a wolf ever encountering any PDM device or WS personnel in Colorado, we concur with your determination that WS activities may affect, but are not likely to adversely affect this species.

Canada lynx. As stated in the BA, PDM implemented by WS Colorado continues to be the same as that identified in the 2009-2010 consultation (WS 2009, Service 2010), which addressed the effects of the WS Colorado program on the Canada lynx. The WS Colorado program has never taken a lynx as part of any livestock protection or other damage management programs. The only lynx that have been captured by WS were those intentionally captured for Colorado Parks and Wildlife as part of the reintroduction and monitoring effort. Given that the WS program in Colorado has not changed, including the lynx

conservation measures identified in the 2009-2010 consultation, and we have no evidence that the status of the lynx in Colorado has appreciably changed since that time, our 2010 biological opinion remains effective and valid.

Black-footed ferret. The 1992 BO on the national WS program (Service 1992) addressed effects to the fully endangered, non-reintroduced, "wild," black-footed ferret. That was prior to any black-footed ferret reintroductions into Colorado. Given that the entire state of Colorado has now been block-cleared (Service 2009, 2013a), we do not believe there are any remaining nonreintroduced ferrets. Given this, it is our opinion that the reasonable and prudent alternatives (RPAs) contained in the 1992 BO are no longer necessary in Colorado. Those 1992 RPAs were largely designed to safeguard any remaining, undetected ferrets in unsurveyed areas from WS actions, primarily prairie dog control. We now believe that there are no remaining, nonreintroduced black-footed ferrets. Since 1992, the black-footed ferret has been reintroduced into various locations in the state, however, as explained below.

Evidence indicates that the ferrets reintroduced to the Wolf Creek Management Area (within the Colorado/Utah Experimental, nonessential Population Area (NEP Area) designated under section 10(j) of the ESA (63 FR 52824)) have been exterminated by plague and no longer exist (as stated in the BA). There may be a few reintroduced ferrets just over the Colorado border that are part of the Coyote Basin and Snake John populations in Utah. These ferrets would still be in the Experimental Population Area. WS has agreed not to conduct any prairie dog damage management in the Coyote Basin or Snake John Reef areas adjacent to Rio Blanco or Moffat Counties without consulting further with the Service.

Separate consultations have been conducted for the various reintroduced ferrets on the east side of the continental divide in Colorado—a BO was issued for the ferrets reintroduced under a safe harbors agreement (Service 2013) and a BO was issued for the ferrets reintroduced to the Rocky Mountain Arsenal NWR (Service 2015). Those BOs provide incidental take coverage for any action affecting ferrets that leave the management zone identified for those reintroduced populations, which would include WS actions. The WS BA states that "WS will only conduct prairie dog damage management outside of Management Zones as part of a Safe Harbor Agreement for the NEP. Should WS need to conduct damage management of a prairie dog population within the Conservation Zone of a Safe Harbor Agreement for NEP, WS will consult with USFWS prior to conducting the project." No further section 7 consultation on the WS PDM program is necessary at this time for the black-footed ferret.

If new information becomes available, new species listed, or should there be any significant changes to the project which alter the operation of the project, or the extent of the anticipated impact, from that which is described in this memo or which may affect any endangered or threatened species in a manner or to an extent not considered in the proposed action, section 7 consultation should be reinitiated. If the Service can be of further assistance, please contact Creed Clayton at (970) 628-7187.

Sincerely,

DRUE DEBERRY

Digitally signed by DRUE DEBERRY
Date: 2016.11.18 15:49:47 -07'00'

Drue DeBerry
Acting Colorado Field Supervisor

Cc: US Fish & Wildlife, Law Enforcement Officer, Edward_Meyers@fws.gov

Literature Cited

U.S.D.A. APHIS Wildlife Services program (WS). 2009. Letter from M. Yeary to S. Linner:

Reinitiation of consultation ES/GJ-6-CO-02-F-034, Potential impacts on lynx by the USDA, APHIS, Colorado Wildlife Damage Management Program. June 11, 2009. Lakewood, CO.

U.S.D.A. APHIS Wildlife Services program (WS). 2011. Biological Assessment for wildlife damage management in Colorado to protect agricultural and natural resources, property, and human health and safety: Analysis of potential impacts on threatened and endangered species. Lakewood, CO. 72 pp.

U.S.D.A. APHIS Wildlife Services program (WS). 2016a. BIOLOGICAL ASSESSMENT FOR INFORMAL SECTION 7 CONSULTATION U. S. DEPARTMENT OF AGRICUTLURE, ANIMAL AND PLANT HEALTH INSPECTION SERVICE, WILDLIFE SERVICES – COLORADO PROGRAM, For Predator Damage Management environmental assessment. Lakewood, Colorado.

U.S.D.A. APHIS Wildlife Services program (WS). 2016b. Email, Section 7 consult follow up October 2016, sent 10/24/2016 from M. Lowney, USDA APHIS State Director, to A. Timberman, Western Slope Supervisor, and C. Clayton, Biologist, US Fish and Wildlife Service, Grand Junction, Colorado.

U.S.D.A. APHIS Wildlife Services program (WS). 2016c. Email, 2016 BA questions, sent 10/19/2016 from M. Lowney, USDA APHIS State Director, to C. Clayton, Biologist, US Fish and Wildlife Service.

U.S.D.A. APHIS Wildlife Services program (WS). 2016d. Email, 2016 BA questions, sent 10/07/2016 from M. Lowney, USDA APHIS State Director, to C. Clayton, Biologist, US Fish and Wildlife Service.

U.S.D.A. APHIS Wildlife Services program (WS). 2016e. Email, WS PDM consultation, sent 11/18/2016 from M. Lowney, USDA APHIS State Director, to C. Clayton, Biologist, US Fish and Wildlife Service.

U.S. Fish and Wildlife Service (Service). 1992. Biological opinion for USDA-APHIS-Animal Damage Control Program. July 28, 1992. Washington, D.C. 69 p.

U.S. Fish and Wildlife Service. 2009. Black-Footed Ferret Block Clearance for Black-Tailed Prairie Dog Habitat, letter to Federal, State and County Representatives stating that there are no longer any wild free ranging black-footed ferrets in Eastern Colorado. TAILS 65412-2009-TA-0577.

U.S. Fish and Wildlife Service (Service). 2010. Reinitiation of consultation and biological opinion for the wildlife damage management program and its effects on the threatened Canada lynx in Colorado. January 29, 2010. Denver, CO. 68 pp. TAILS 65412-2009-F0156.

U.S. Fish and Wildlife Service (Service). 2011. Letter of concurrence with the USDA-APHISWildlife Services Biological Assessment for impacts of wildlife damage management on T&E species in Colorado. From Susan Linner, USWFS Colorado Field Supervisor, to Mike Yeary, State Director. Nov. 22, 2011. 6 pp. TAILS 062E24100-2012-I-0028.

U.S. Fish and Wildlife Service (Service). 2013a. Black-Footed Ferret Block Clearance for whitetailed (Cynomys leucurus) and Gunnison's (Cyonmys gunnisoni) prairie dog habitats in Colorado. Letter to Colorado Parks and Wildlife, November 12, 2013. Denver, CO. TAILS: 06E24100-TA-0017.

U.S. Fish and Wildlife Service (Service). 2013b. Final Biological and Conference Opinion on the Issuance of a Section 10(a)(1)(A) Enhancement of Survival Permit to the U.S. Fish and Wildlife Service, Black-Footed Ferret Recovery Coordinator, for the Black-Footed Ferret Programmatic Safe Harbor Agreement. Ecological Services, Region 6, Denver, Colorado.

U.S. Fish and Wildlife Service (Service). 2015. Intra-Service Section 7 Consultation on the reintroduction of Black-footed Ferrets to the Refuge (Project) in Commerce City, Colorado. Ecological Services, Colorado Field Office, Denver, Colorado.

APPENDIX E. RESPONSE TO 2016 EVALUATION OF PREDATOR CONTROL STUDIES BY DR. ADRIAN TREVES, MIHA KROFEL AND JEANNINE MCMANUS

On September 1, 2016, researchers from the University of Wisconsin-Madison*, University of Ljubljana, and University of Witwatersrand released a publication entitled "Predator control should not be a shot in the dark" (Treves et al. 2016). The researchers evaluated 12 existing publications (5 non-lethal and 7 lethal methods) regarding the effectiveness of nonlethal and lethal methods for reducing predation on livestock. Their main conclusions included the following:

1. Predator control methods to prevent livestock loss have rarely been subject to rigorous tests using the "gold standard" for scientific inference (random assignment to control and treatment groups with experimental designs that avoid biases in sampling, treatment, measurement, or reporting)
2. Across the controlled experiments that they systematically examined, higher standards of evidence were generally applied in tests of non-lethal methods than in tests of lethal methods for predator control
3. Non-lethal methods were more effective than lethal methods in preventing carnivore predation on livestock generally; at least two lethal methods (government culling or regulated, public hunting) were followed by increases in predation on livestock; zero tests of non-lethal methods had counterproductive effects
4. All flawed tests came from North America; ten of 12 flawed tests were published in three journals, compared to four of 12 tests with strong inference in those same journals
5. Treves et al. (2016) recommend suspending lethal predator control methods that do not currently have rigorous evidence for functional effectiveness in preventing livestock loss until gold standard tests are completed.

Specific Points Regarding Treves' Article:

•Treves et al. (2016) recommend wildlife researchers apply the same standards used in controlled, laboratory settings to wildlife field research. Such standards (which involve randomized, controlled trials) are often not possible in field studies for a variety of reasons:

- First, it can be difficult to find comparable units for evaluation. In the case of predation management, finding multiple field study sites that not only prohibit predator control, but also allow ranching, is difficult. Almost by definition, ranchers with high predation rates usually try to control predators, and ranchers with minimal problems do not.
- Second, field studies involve a lot of variation. There are many factors from the weather to varying habitats to the movement of wildlife in and out of study areas that cannot be controlled and may impact results. This is the inherent nature of field work.
- Finally, to give sufficient statistical power, sample sizes must be large. Gathering sufficient data often involves multiple field seasons and field experts. Funding and other resources can limit the ability to conduct such studies.

•To conduct a completely randomized design as suggested by Treves et al. (2016) would result in inherently large variability among sites and would necessitate such a large sample size that it would not be possible or practical in most instances. Two alternative field designs that are commonly used in wildlife research include a switch-back and paired block approach.

- In the case of a predator control study, a switch-back design would involve at least two study areas, one (or more) with predator control and one (or more) without predator control. After at least 2 years of data collection, the sites would switch so that the one with predator control becomes the one without predator control and vice versa. An additional 2 years of data collection would occur. Wildlife Services researchers are currently involved in a controlled switch-back study like the one described above that is investigating the effectiveness of coyote control for reducing predation on deer populations in Utah.

- The paired block design, involves finding multiple sites that are similar that can be paired and compared. For each pair, one site would experience predator control and one would not.

•Treves et al.'s sloppy assessment of existing predation studies from North America and Europe causes us to question his ability to accurately critique the scientific literature. Treves et al.'s critique of a least two of the studies reviewed in their paper did not accurately interpret or represent the studies' designs and results.

- In regards to Wagner and Conover (1999), Treves et al. (2016) makes a fundamental error in interpreting the study design. When researchers make changes to the independent variable, they measure the changes in the dependent variable. The purpose of the study was to determine the impact of preventive aerial operations (independent variable) as currently practiced by the WS program on sheep losses the following summer (dependent variable) and the need for subsequent corrective predator damage management (i.e., the use of traps snares and M-44s - also a dependent variable) during the subsequent summer. Treves et al. (2016) mistakenly characterize use of traps, snares and M-44s as independent variables which indicates a fundamental inattentiveness to the details of the study. This error led the authors to erroneously claim a variation that occurred in response to the treatment was either a willful misapplication of a control variable or a gross failure in study design. Wagner and Conover (1999) purposefully allowed corrective predator damage management to be conducted during the summer following aerial operations because, as practiced, it was highly improbable that preventive aerial operations would ever be used to the exclusion of all other methods for corrective predator damage management. Furthermore, if preventive aerial operations were effective, authors predicted one of two outcomes:

1) losses on areas without aerial operations would be lower than losses in areas with aerial operations and there would be a corresponding decrease in use of traps, snares and M-44s; or,
2) increased use of corrective predation management during the summer could be sufficient to keep losses at levels similar to areas with preventive aerial operations, but the amount of summer corrective predation damage management would be higher in areas without aerial operations.

Traps, snares and M-44s pose substantially different risks to non-target species than aerial operations. Wagner and Conover (1999) felt that this information was important when making management decisions regarding the use of preventive aerial operations.

Treves et al. (2016) also states that the study is biased because "control pastures started with 40% higher sheep densities." However, Treves et al.'s calculation of sheep densities was based on incomplete information and is not a valid interpretation of the density of sheep during the study period. In the study, sheep were not permitted to disperse evenly throughout the grazing allotments, instead, herders move sheep bands through subsections of the allotments in accordance with established grazing management plans. Consequently, simply dividing the number of sheep on the allotment by the total size of the allotment, as was done, does not accurately reflect the density of sheep during the study.

Treves et al. states the study includes a reporting bias because "data was not presented" on livestock-guarding dogs. Wagner and Conover (1999) clearly states that one of the criterion used for pairing allotments was the presence or absence of livestock guarding dogs (LGD). They did not pair allotments with LGDs with allotments without LGDs. Failure to provide data showing that that number of treated allotments with LGDs matched the number of untreated allotments with LGDs does not constitute a reporting bias.

Treves et al. misrepresents another study conducted by Dr. Eric Gese (WS-NWRC) and a Utah State University collaborator on a study site in western Wyoming. Treves et al. confuses two different studies when citing Bromley and Gese (2009) on page 23. The Bromley and Gese (2001a, 2001b) study examined coyote predation on domestic sheep; in contrast, the Seidler and Gese (2012) study examined coyote predation on pronghorn antelope fawns. While citing Bromley and Gese (2009), Treves et al. (2016) is actually referring to a paper published in 2001 (Bromley and Gese 2001a). As a reason for study bias, they mention that Bromley and Gese's study includes a high overlap between coyote territories.

The statistics mentioned actually come from a completely different study (Seidler and Gese 2012) that was conducted in a different State (southeastern Colorado), 7 years later, and in a completely different system (i.e., no sheep). The Bromley and Gese (2001b) publication actually reports that coyote core areas overlapped only once (by 3%) and there was no significant difference in overlap among sterile and intact coyote packs. In fact, to eliminate a potential inaccurate assignment of the coyotes responsible for making a kill, Bromley and Gese used the actual locations of the radioed coyotes as the method of assigning which pack killed the sheep whenever there was overlap of territory boundaries between adjacent packs.

Additionally, Treves et al. incorrectly states that the estimates of weekly survival rates are not biologically significant. However, they used data from all the packs which is inappropriate as not all packs killed sheep. By only using data from sheep-killing packs and doing some simple math, they would have concluded that a weekly survival rate of 0.997 in the sterile packs equates to 94% of the lambs surviving for the next 6-months (beyond which they are no longer vulnerable to predation), versus a weekly survival rate of 0.985 in the intact packs which equates to 72% of the lambs surviving for the next 6 months. Therefore, sterilization would provide 22% higher survival of lambs which is quite biologically and economically significant to a livestock producer.

The correct references are:
Bromley, C., and E. M. Gese. 2001a. Surgical sterilization as a method of reducing coyote predation on domestic sheep. Journal of Wildlife Management 65(3):510-519.

Bromley, C., and E. M. Gese. 2001b. Effects of sterilization on territory fidelity and maintenance, pair bonds, and survival rates of free-ranging coyotes. Canadian Journal of Zoology 79(3):386-392.

Treves et al. (2016) include a paper by (Musiani et al. 2003) whereby they claim fladry (a method for controlling wolves) was experimentally tested. But in fact the experimental portion of the work was done on captive animals. The two field trials included in the paper did not meet the scientific standards outlined by Treves. This was either purposefully deceptive or sloppy.

Treves et al. (2016) selectively disregards studies from Australia. These studies are some of the more rigorous field studies on working livestock operations with free-ranging, native carnivores that evaluate the effectiveness of lethal control. Given their explicit desire to make generalization about predation control, it is odd that they would purposefully exclude this body of rigorous science.

WS understands and appreciates interest in ensuring predator damage management methods are as robust and effective as possible. WS supports the use of rigorous, scientifically-sound studies, but we realize there are many variables that cannot be controlled and assumptions that must be acknowledged when trying to answer complex ecological questions. We do not believe there is a single standard for conducting wildlife field studies and each approach or design has its own unique assumptions, drawbacks and challenges. WS does not believe that results from existing studies should be ignored. Wildlife research is inherently challenging because scientists are not working in a “closed” system. Science and the scientific method are a process. You build upon information gathered over years of study and experimentation. Results from one study lead to new questions and new studies.

WS’ policies and decisions are based on the best available science. The National Environmental Policy Act (NEPA) requires federal agencies to evaluate environmental impacts into their decision making processes and ensures that environmental information is available to public officials and citizens before decisions are made and actions are taken. To fulfill this responsibility, Wildlife Services prepares analyses of the environmental effects of program activities as part of the NEPA process. A description of and citations for various wildlife damage management actions can be found in the program’s Environmental Assessments and Environmental Impacts Statements which are available by State on the APHIS website.

Wildlife Services encourages the use of nonlethal predation damage management tools and techniques when feasible and practical, however, not all wildlife damage problems can be resolved using nonlethal techniques alone. Even with the use of single or combined nonlethal methods, livestock losses to predators often continue. When conducting lethal management activities, Wildlife Services evaluates all potential tools for humaneness, effectiveness, ability to target specific individual animals and/or species,

and the potential impact on human safety. Professional organizations such as The Wildlife Society (TWS), whose 10,000 members include scientists, managers, educators and others, have long supported the use of lethal take. TWS's Standing Position Statement on Wildlife Damage Management states, "Prevention or control of wildlife damage, which often includes removal of the animals responsible for the damage, is an essential and responsible part of wildlife management." It is important to note that Wildlife Services is tasked with reducing wildlife damage. We do not manage wildlife populations. The management of predators and other wildlife is the responsibility of the States and other federal agencies. As such, any actions undertaken to reduce wildlife damage are conducted in collaboration with State agencies and under appropriate State and federal permits and laws.