FINAL ENVIRONMENTAL ASSESSMENT

PREDATOR DAMAGE MANAGEMENT IN NEVADA

Prepared by:

United States Department of Agriculture
Animal and Plant Health Inspection Service
Wildlife Services

In Cooperation with:

United States Department of Agriculture
United States Forest Service

United States Department of Interior
Bureau of Land Management
and
United States Fish and Wildlife Service

In Consultation with:

Nevada Department of Wildlife

Nevada Department of Agriculture

July 2020

Executive Summary

Introduction

Wildlife is a valuable natural resource, long valued by the American public for aesthetic, recreational, emotional, psychological, and economic reasons. Native wildlife in overabundance, or individual animals that have learned to use resources of value to humans, can lead to conflicts. Wildlife can destroy crops and vulnerable livestock, damage property and natural resources, and pose serious risks to human and pet health and safety.

Wildlife Services (APHIS-WS), a program within the U.S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS), has a mission to provide federal professional leadership and expertise to resolve wildlife conflicts to help create a balance that allows people and wildlife to coexist. APHIS-WS in Nevada (WS-Nevada) responds to requests from the public, government agencies, tribes, private enterprise, and other entities for assistance with managing damage and threats from wildlife. This EA focuses on those species commonly referred to as predators since they prey upon other animals for some portion of time. For this EA, the following species are included as predators even though they may be statutorily defined into several types of mammals: coyote, common raven, badger, mountain lion, striped skunk, raccoon, bobcat, red fox, free-ranging/feral dogs, kit fox, black bear, free-ranging/feral cats, gray fox, spotted skunk, mink, weasels, ring-tailed cat (Section 1.3). WS-Nevada applies and recommends an integrated wildlife damage management approach (IWDM), which incorporates biological, economic, environmental, legal, and other information sources into its decision-making process. WS-Nevada's current IWDM activities include many methods for managing wildlife damage including education, advice and implementation of non-lethal and lethal options.

Proposed Action and Scope

WS-Nevada is proposing to use all appropriate PDM methods to resolve damage caused by predator species included in this EA, across those land-classes in Nevada detailed in Section 1.9.4, including wilderness areas (WAs) and wilderness study areas (WSAs), for the protection of livestock, property, human and pet health and safety, and natural resources. Currently, WS-Nevada does not conduct PDM in WAs or WSAs, but implements PDM, when requested by the land owner/manager across other portions of Nevada. Nearly 32% of all of WS-Nevada responses to damage or threats occurs on private lands (Section 1.9.4.A.).   IPDM activities are proposed on all land classes, including federal, tribal, state, county, municipal and private properties in rural, suburban, and urban areas with the exception of National Parks, USFWS lands, and Inyo National Forest.

WS-Nevada performs IPDM only when requested by those in need of wildlife damage management assistance; it does not initiate activities on its own accord. WS-Nevada coordinates, plans, and cooperates with other agencies who have jurisdiction over lands, other resources or human safety, including Nevada Department of Wildlife (NDOW) and the Nevada Department of Agriculture (NDA) and federal land and resource management agencies. All WS-Nevada actions are conducted in accordance with applicable federal, state, tribal, and local laws. Operational assistance is only provided after work plans, agreements and other appropriate documents are in place with WS-Nevada's cooperators and partner agencies.

The proposed action involves WS-Nevada continuing to recommend or use appropriate methods, either singly or in combination, to resolve damage caused by predator species. These methods include cultural practices such as shed lambing, herding, and guard animals; habitat management; animal and behavior modification such as exclusion, chemical repellents, and hazing with pyrotechnics; and lethal operational actions such as trapping and shooting (Appendix A).

National Environmental Policy Act

WS-Nevada has prepared this environmental assessment in accordance with the National Environmental Policy Act (Public Law 9-190, 42 U.S.C. 4321 et seq.), the Council on Environmental Quality regulations implementing NEPA (40 CFR 1500 et seq.) and USDA APHIS NEPA Implementing Procedures (7 CFR 372). This EA describes the need for IPDM, the potential environmental issues associated with providing IPDM, and five alternative ways and levels of providing IPDM services to those that request assistance. The EA then evaluates the environmental consequences in a comparative analysis for each environmental issue and alternative. WS-Nevada has evaluated many of the environmental issues in this EA in greater detail than the expected effects warranted because the issues have been commonly raised by the public during similar APHIS-WS NEPA processes.

WS-Nevada coordinated the preparation of this EA by cooperating and consulting with its partner agencies, including Nevada Department of Wildlife (NDOW), Nevada Department of Agriculture (NDA), U.S. Forest Service (USFS), U.S. Bureau of Land Management (BLM), and U.S. Fish and Wildlife Service (USFWS).

IPDM Objectives

WS-Nevada has established several objectives for IPDM to aid in meeting its mission to provide federal professional leadership and expertise to resolve wildlife conflicts.

- Respond in a timely and appropriate way to all requests for assistance.
- Responses, whether over the phone, remotely, or in the field, follow a formal decision process to evaluate, formulate, and implement or recommend the most effective strategy.
- The recommended strategy for each response intends to effectively reduce or eliminate damage and risks caused by the offending animal(s) to resolve conflicts with humans and their valued resources, health, and safety.
- These strategies may be both short-term and/or long-term and are often a combination of lethal and/or non-lethal methodologies to ensure effectiveness.

Needs for WS-Nevada's IPDM Actions (Section 1.11)

IPDM assistance is requested of WS-Nevada when predators cause damage to or threaten livestock, other agricultural resources, property, human/pet health and safety, and natural resources, including other wildlife species.

<u>Need for IPDM to Protect Livestock</u> (Section 1.11.2)

- Predators prey on a wide variety of livestock, including cattle, sheep, goats, swine, horses and poultry. Some problems are more seasonal, such as during lambing and calving when livestock are most vulnerable.

- Livestock predation is not evenly distributed so some producers will suffer no damage while others experience serious losses.
- Most producers have attempted non-lethal predation management strategies by the time they request assistance from WS-Nevada.
- Coyotes are responsible for the majority of livestock losses, followed by cougars, black bears, and other predators.

<u>Need for Protecting the Public and Pets from Predators</u> (Section 1.11.4)

Some predators have adapted to using human-altered habitats where they find abundant food, water and shelter inadvertently provided by humans.

- Through habituation, some individual animals lose their fear of humans and behave aggressively. While attacks on people are very rare, they appear to be increasing.
- The majority of requests for assistance in this category are from coyote conflicts with pets.
- Disease transmission risks from predators include rabies (risk to humans, and pets), distemper (risk to pets), parvovirus (risk to dogs), leptospirosis (risk to humans and pets), raccoon and skunk roundworm (risks to humans and pets), and several other pathogens.
- Predator conflicts at airports can also threaten air traffic safety, for example when a plane strikes an animal during takeoff or landing.

<u>Need for Natural Resources Protection</u> (Section 1.11.5)

Under some circumstances, predators can cause additive constraints on the ability of some sensitive or vulnerable wildlife species to reproduce and have healthy populations. When identified by NDOW as necessary, it may request that WS-Nevada assist with IPDM to protect species under their jurisdiction, such as mule deer, elk, pronghorn antelope, and bighorn sheep. In the past, the USFWS may also requested assistance in supporting populations of federally listed species.

<u>Need for Assistance with Disease Surveillance</u> (Section 1.11.6)

WS-Nevada is often requested to collect blood, tissue, or fecal samples for NDA, NDOW, the APHIS-WS National Wildlife Disease Surveillance and Emergency Response Program, and other concerned agencies and citizens. WS-Nevada can efficiently collect samples from animals around the state because it can do so in conjunction with its other routine operations so that no additional animals need to be captured or killed. The information reported by WS-Nevada can be used by other agencies and programs in disease mitigation and response decisions.

Alternatives Evaluated in Detail (Section 2.2)

The following alternatives are evaluated in detail in this WS-Nevada IPDM EA and are described below.

Alternative 1. No Action Alternative - Continue WS-Nevada PDM assistance outside of WAs and WSAs (with the exception of protecting human health and safety)**,** with inherent reasonable fluctuations of tempo, volume, and lethal and non-lethal operational and technical support.

Alternative 2. Proposed Action - Modified Current Program. A continuance of the current program modified to allow PDM in wilderness areas and wilderness study areas to protect livestock, human health and safety. Disease/parasite transmission, and federally listed threatened and endangered species, when requested and where approved by the land-managing agency.

Alternative 3: Non-lethal PDM Required Before Applying Lethal Assistance (No Preventive Lethal PDM)*.* WS-Nevada would provide both technical assistance and operational assistance, but WS-Nevada would not provide any lethal management until nonlethal methods have been tried and determined to be inadequate in each depredation situation. WS-Nevada would not conduct any preventive PDM.

Alternative 4: WS-Nevada Provides PDM Lethal Assistance Only for Cases of Human/Pet Health or Safety. WS-Nevada would provide PDM assistance, including lethal and non-lethal assistance, only when requested for protecting human/pet health or safety; all other assistance would only use non-lethal methods and/or technical assistance.

Alternative 5: No WS-Nevada PDM Activities. WS-Nevada would not conduct PDM activities in Nevada. PDM would still be implemented by Department of Agriculture, Division of Animal Industry Field Assistants (State component of WS-Nevada) and other legally authorized entities, such as NDOW, USFWS, property owners, commercial PDM companies, and certified NDOW volunteers.

All of the alternatives, except Alternative 5 (No WS-Nevada IPDM Activities), incorporate the APHIS-WS Decision Model as part of IPDM for evaluating each damage request and formulating the most appropriate strategy to address the situation, given the constraints of the alternative. The APHIS-WS Decision Model is a professional problem-solving process similar to an adaptive management strategy used by other professionals including wildlife managers. All of the alternatives, except Alternative 5, would include all protective measures included in the Proposed Action, as applicable, including APHIS-WS policies and relevant state laws and regulations.

WS-Nevada is not the only entity that can provide IWDM assistance in Nevada. Government, private entities, and others may request assistance from available local commercial wildlife control operators (WCOs) or from NDOW. Landowners and their agents may also attempt to resolve predator damage and threats as provided by state law and regulation, but they may not have the necessary effective equipment or proficiency in its humane, safe, and effective use compared to that available from WS-Nevada and commercial WCOs (Section 3.4.2).

IPDM Methods Available to WS-Nevada (Appendix A)

Implementing non-lethal methods, such as husbandry or structural barriers, are generally the responsibility of the property owners/requesters. Depending on the circumstances of a particular IPDM situation, lethal methods may be needed to address the immediate problem during the time period while non-lethal methods are implemented. The APHIS-WS Decision Model provides for the consideration of lethal and non-lethal methods, allows WS-Nevada to use and recommend the most effective and practical methods available, while accounting for the many legal, logistical, biological, ethical, and environmental variables in each unique damage situation.

- **Non-lethal methods:** Non-lethal methods can be used to disperse, prevent, restrict access, or otherwise make an area unattractive to predators causing damage, thereby reducing the risk that predators can cause damage or threats at the site and immediate area. Non-lethal methods are always given priority by WS-Nevada personnel when addressing requests for assistance, when applicable and effective (WS Directive 2.101).
- **Lethal methods:** After receiving a request for assistance and conducting a field review, trained and certified WS-Nevada personnel may determine that lethal methods are appropriate. Lethal methods are often used to reinforce non-lethal methods, to remove animals that have been identified as causing damage or posing a threat to human safety, and/or to reduce the risk of depredation reoccurring in an area where it has occurred in the past. The use of lethal methods results in temporary and small local reductions of the numbers of predators in the area where damage or threats are occurring or are expected to reoccur.

Issues Evaluated (Section 3.2) and Environmental Consequences (Chapter 3)

Effects on Populations of Predator Species Taken Intentionally (Section 3.5)

This issue drives the analysis of the direct effects of WS-Nevada's intentional lethal IPDM activities, and the cumulative effects that include all other known sources of predator mortality. WS-Nevada, its cooperating agencies, and the public are concerned with the effects of removals on the viability of predator populations. The effects on each species is evaluated using the best available information including the scientific literature and detailed take information from WS-Nevada's MIS database and reported take from NDOW and USFWS databases.

Effects on Species that May Be Taken Unintentionally

Effects on ESA-listed Threatened and Endangered Species (Section 3.6)

WS-Nevada consults with the USFWS when its activities may affect any federally-listed threatened or endangered species. This issue evaluates the potential for effects on such listed species. ESA Section 7 consultations with the USFWS are relied on for evaluating potential effects.

Unintentional Take of Other Species (Section 3.7)

Analysis of unintentional lethal and non-lethal take of predators and other species, formerly referred to as non-target take, is based on WS-Nevada take data and evaluated within the context of the species population trends.

Potential for WS-Nevada IPDM Activities to Contribute to or Cause Ecological Trophic Cascades (Section 3.8)

This issue is based on a concern that the removal of predators during IPDM may cause an indirect ecological chain of events to occur within and through different trophic levels (levels of the food chain). Complex interrelationships exist among and between trophic levels, population dynamics, habitat, biodiversity, and the species themselves. This analysis is based on an extensive review of the relevant scientific literature and impact analyses on predator and non-predator species in Nevada.

Humaneness and Ethics Related to WS-Nevada Use of IPDM methods (Section 3.9)

WS-Nevada and the public are concerned about the humane treatment of animals, and people hold differing ethical values related to IPDM. The scientific literature related to the ethics of wildlife capture and lethal take in recreational, research, and predator control activities, and the apparent humaneness of the use of mechanical, non-chemical, and chemical lethal and non-lethal take methods are summarized, discussed, and analyzed.

Potential Effects of IPDM Methods on the Environment and Their Risks to Human/Pet Health and Safety (Section 3.10)

This issue drives the analysis of the effects of WS-Nevada's use of IPDM methods (mechanical, non-chemical, and chemical methods, Appendix A) on environmental resources including soil, water, air, plants, and invertebrates. It also assesses the risks from using the IPDM methods on human and pet health and safety.

Effects on WAs and WSAs (Section 3.11)

Analyses of impacts related to IPDM actions in special management areas in Nevada focuses on understanding the types of activities allowed in special management areas with an emphasis on WSAs and congressionally-designated WAs. The evaluation includes discussion of how proposed IPDM activities in WAs and WSAs would be found to be consistent with the objectives for each special management area.

Cultural Impacts Including Impacts on Native American Cultural Uses, Hunting, Non-Consumptive Uses, and Aesthetic Impacts (Section 3.12)

Some members of the public may be concerned that WS-Nevada IPDM activities could conflict with cultural and spiritual values, recreational activities such as hunting and fishing and non-consumptive uses, such as wildlife viewing and photography. There may be some concern that the proposed action or alternatives would result in the loss of aesthetic benefits to the public, resource owners, native tribes, or neighboring residents.

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 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 IPDM activities would adversely impact aesthetic enjoyment of activities such as hiking on public lands.

Native American tribes in Nevada 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.

Meetings WS-Nevada's Stated Goal and Objectives (Section 3.14)

Section 3.14 reviews how the EA addressed WS-Nevada's goals and objectives. This section is not an environmental impact analysis. The majority of issues analyzed had little difference in impact among the alternatives because the Proposed Action, Alternative 2, had very low impacts. However, there was more variation among alternatives in meeting the objectives. Based on the information and analysis in each section, WS-Nevada's proposed IPDM activities meet the greatest number of goal and objectives.

Table of Contents

List of Tables and Figures

List of Acronyms

ACEC	Area of Critical Environmental Concern
AFWA	Association of Fish and Wildlife Agencies
APHIS	US Department of Agriculture Animal and Plant Health Inspection Service
APHIS-WS	APHIS Wildlife Services
ANAWG	APHIS Native American Working Group
AOR	Oregon Administrative Rules
ATOC	APHIS-WS Aviation Training and Operations Center in Cedar City, Utah
ATSDR	Agency for Toxic Substances and Disease Registry
AUM	Animal Unit Month
AVMA	American Veterinary Medical Association
AWP	Annual Work Plan
BA	Biological Assessment (Endangered Species Act)
BASH	Bird/Wildlife Aircraft Strike Hazard
BGEPA	Bald and Golden Eagle Protection Act
BLM	US Dept. of Interior Bureau of Land Management
BMP	Best management practice
BO	Biological Opinion
BOR	Bureau of Reclamation
CDC	Center for Disease Control
CDFW	California Department of Fish and Wildlife
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CVM	Contingent Valuation Method (economic metric)
CWTD	Columbia white-tailed deer
dB or dBA	Decibels of sound pressure (metric for sound)
DEA	United States Drug Enforcement Agency
EA	Environmental Assessment
Eco-SSL	EPA ecological soil screening levels
EIS	Environmental Impact Statement
EO	Executive Order
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FDA	United States Food and Drug Administration
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FLIR	Forward Looking Infrared night vision equipment

FLPMA	Federal Land Policy and Management Act
FONSI	Finding of No Significant Impact
FSA	Farm Services Agency
FSM	Forest Service Manual
FY	Fiscal year
GAO	US Government Accountability Office
GHG	Greenhouse gas
IARC	International Agency for Research on Cancer
IGP	Intraguild predation
IPDM	Integrated predator damage management
IRAS	EPA Integrated Risk Assessment System for lead
IRS	Internal Revenue Service
ISA	Integrated Science Assessment for lead
IWDM	Integrated wildlife damage management
LD_{50}	Lethal dose – the level at which 50% of the study animals die
LIP	Livestock Indemnity Program
LPC	Livestock protection collar
MANLTAA	May affect, not likely to adversely affect (Endangered Species Act finding)
NLTAA	Not likely to adversely affect (Endangered Species Act finding)
MBTA	Migratory Bird Treaty Act
MBI	Minimum Background Investigation
MRDG	Minimum Requirements Decision Guidelines
MIS	USDA APHIS Wildlife Service management information system database
MOU	Memorandum of Agreement
MPR	Mesopredator release
NAC	USDA APHIS WS National Aviation Coordinator
NAC	Nevada Administrative Code
NAGPRA	Native American Graves and Repatriation Act of 1990
NASAO	National Association of State Aviation Officials
NASS	National Agriculture Statistics Service
NDA	Nevada Department of Agriculture
NDA-WS	Nevada Department of Agriculture-Wildlife Services
NDOW	Nevada Department of Wildlife
NEPA	National Environmental Policy Act
NF	USDA US Forest Service national forest
NHSRT	National Historic, Scenic, and Recreation Trail
NM	National Monument
NMFS	National Marine Fisheries Service
NPS	National Park Service
NRA	National Rifle Association
NRA	National Recreation Area

NRCS	Natural Resources Conservation Service
NRDC	Natural Resources Defense Council
NRM DPS	Northern Rocky Mountain Distinct Population Segment (Endangered Species Act)
NRS	Nevada Revised Statute
NTSB	National Transportation Safety Board
NWRC	USDA APHIS-WS National Wildlife Research Center
ODFW	Oregon Department of Fish and Wildlife
OIG	USDA Office of Inspector General
OMB	Office of Management and Budget
OPM	Office of Personnel Management
OSU	Oregon State University
ORS	Oregon Revised Statutes
OSP	Oregon State Police
OSTP	Office of Science and Technology
PDM	Predator damage management
pH	Metric for degree of alkalinity or acidity
PPE	Personnel protection equipment
ppm	parts per million
RNA	Research Natural Area
TCM	Travel-Cost Method (economic metric)
TWS	The Wildlife Society
USACE	US Army Corps of Engineers
U.S.C.	U.S. Code [Statute]
USDA	US Department of Agriculture
USFS	United States Forest Service
USFWS	United State Fish and Wildlife Service
USGS	US Geological Survey
WA	Wilderness Area
WCO	Wildlife Control Operator
WID	Work Initiation Document
WDM	Wildlife Damage Management
WMU	ODFW Wildlife Management Unit
WS	USDA APHIS-Wildlife Services
WSA	Wilderness Study Area
WS-Nevada	USDA APHIS-Wildlife Services Nevada
WTP	Willingness to pay (economic metric)

1 Purpose and Need

1.1 Introduction

This chapter provides the foundation for:

- Understanding why wildlife damage occurs and the practice of wildlife and predator damage management;
- Understanding the joint federal and state framework of the U.S. Department of Agriculture's Wildlife Services Program in Nevada (WS-Nevada) and Nevada Department of Agriculture-Wildlife Services (NDA-WS) (collectively referred to as "WS-Nevada" here forward);
- Knowing the statutory authorities and roles of federal and state agencies in managing damage caused by predators in Nevada;
- Understanding how WS-Nevada cooperates with and assists private and commercial resource owners and federal, tribal, state and local government agencies in managing predator damage;
- Providing the framework for the scope of this National Environmental Policy Act (NEPA) document, the rationale for preparing an environmental assessment (EA), program goals, and decisions to be made by WS-Nevada;
- Understanding the reasons why private and commercial entities, tribes, and federal, state, and local government agencies request assistance from WS-Nevada;
- Understanding the effectiveness and cost-effectiveness associated with predator damage management in the United States; and
- The public involvement and notification processes used by WS-Nevada for this EA.

Chapter 2 identifies the issues analyzed in detail in this EA and describes the proposed action and alternatives evaluated in detail, with the rationale why some alternatives are not considered in detail, as required by the Council on Environmental Quality (CEQ) implementing regulations for NEPA at 40 CFR 1502.14(a). Details of the different wildlife damage management (WDM) methodologies are included in Appendix A. Chapter 3 provides the detailed comparative analysis of the direct, indirect, and cumulative impacts of the proposed action and alternatives on the quality of the human environment.

1.2 In Brief, What is this EA About?

Wildlife Services (APHIS-WS), an agency within the U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS), provides federal professional leadership and expertise to resolve wildlife conflicts to help create a balance that allows people and wildlife to coexist (WS Directive 1.201). WS-Nevada is a collaborative program between USDA-APHIS-Wildlife Services Program (APHIS-WS) (federal component) and the Nevada Department of Agriculture's Division of Animal Industry-Nevada Wildlife Services (NDA-WS, state component). The mission of WS-Nevada is to protect agriculture, natural resources, property, and the human health and safety of the citizens of Nevada from the threat of injury, damage, or resource loss due to wildlife. WS-Nevada has been conducting predator damage management (PDM) in Nevada for over 80 years, and has adapted PDM activities and methods over time to reflect societal values and to reduce adverse effects on people, wildlife and the environment. NDA-WS is supervised by APHIS-WS in Nevada and includes federal resources as well as state staff and resources. Because of the federal component, national APHIS-WS' mission, policies, and regulatory requirements apply to the NDA-WS component just as they apply to the federal component. For clarity throughout the document, WS-Nevada refers to the joint federal-state agency unless otherwise stated and NDA-WS refers to just the state component.

APHIS-WS recommends and/or implements a cohesive integrated wildlife damage approach, which incorporates biological, economic, environmental, legal and other information into a transparent wildlife damage management decision-making process, and includes many methods for managing wildlife damage, including non-lethal and lethal options. Although non-lethal methods should be considered first, responsible wildlife damage management sometimes requires lethal control to meet cooperators' objectives. In addressing conflicts between wildlife and people, consideration must be given not only to the needs of those directly affected by wildlife damage but also to a range of environmental, sociocultural, economic, and other relevant factors. Federal and State agency and private wildlife managers, including those working for APHIS-WS, must be experienced in evaluating the particular circumstances, determining which predator species are involved, and expertly implementing or recommending the most effective strategy using sustainable methods that balance those considerations.

Wildlife damage management for all species including predators, generally referred to as integrated wildlife damage management (IWDM), is used to describe the response to requests for assistance to manage damage caused by wildlife species. The assistance that WS-Nevada provides to requesters for managing predator damage evaluated in this EA is simply a component of the total WS-Nevada wildlife damage management activities conducted in Nevada. WS-Nevada activities that do not involve predators are evaluated in separate documents. This environmental assessment (EA) evaluates the impacts of 5 alternative approaches to managing predator damage in Nevada. The purpose of the EA is to facilitate WS-Nevada's decision-making in utilizing an integrated predator damage management (IPDM) response to requests for assistance to manage damage caused by predators.

This EA also provides sufficient analysis of impacts to determine if a Finding of No Significant Impact (FONSI) or an environmental impact statement (EIS) is appropriate. The alternatives considered in this EA vary regarding the degree of WS-Nevada involvement in predator damage management, the degree of technical assistance and operational assistance (advice, information, education, and/or demonstrations) and of operational field assistance (active management of predator damage), and the degree of lethal and non-lethal methods available for use.

The goal of the WS-Nevada IPDM program, as conducted in the current activity level in Nevada, is to manage predator damage, threats of damage, and risks to human/pet health and/or safety by responding to all requests for assistance, including technical assistance and/or direct operational assistance, regardless of the source of the request, private or public (Section 1.5.2).

WS-Nevada proposes to continue responding to requests for assistance for damage management by predatory species for the protection of livestock; property; human/pet health and safety; and natural resources; as well as collecting disease data for researchers. The EA includes an analysis of the impacts associated with continuing to assist in predator damage management on all land classes, including federal, tribal, state, county, municipal, and private properties in rural, urban and suburban areas where WS-Nevada personnel have been and may be requested to assist, based on agreements between WS-Nevada and the requesting entity. It also includes analysis of impacts of 4 other levels of predator damage management activities in Nevada both involving and not involving WS-Nevada.

The proposed action (Alternative 2; Section 2.3.2 and Appendix A) is for WS-Nevada to use all appropriate PDM methods to resolve damage caused by predator species included in this EA, across those land-classes in Nevada detailed in Section 1.9.4, including wilderness areas (WAs) and wilderness study areas (WSAs). These methods include cultural practices such as shed lambing, herding, and guard animals; habitat management; animal and behavior modification such as exclusion, chemical repellents, and hazing with pyrotechnics; and lethal operational actions such as trapping and shooting. In most situations, the requester/cooperator are responsible for implementation of non-lethal methods, such as exclusion-type barriers, and some lethal methods, consistent with state law. Resource owners that are given direct predator damage management assistance by WS-Nevada are encouraged to use reasonable and effective non-lethal management strategies and sound husbandry practices, when and where appropriate, to reduce ongoing and the potential for conflict situations.

All WS-Nevada actions are conducted in accordance with applicable federal, state, tribal, and local laws, and in accordance with current agency Memoranda of Understanding (MOUs) and interagency agreements between WS-Nevada and the various federal and state resource management agencies. WS-Nevada cooperates with Nevada Department of Wildlife (NDOW) and the Nevada Department of Agriculture (NDA), as appropriate, for actions involving predator damage management.

Predator damage management is conducted by WS-Nevada only where a property owner or manager, including government, tribal, commercial, organizational, or private entity, has requested assistance and Work Initiation Documents (WIDs), MOUs, Interagency Agreements, Cooperative Agreements, and/or work plans are in place to authorize the work.

See Sections 2.3.1 through 2.3.5, and Appendix A for details on the 5 alternatives evaluated in this EA, and Chapter 3 for their associated impacts.

1.3 What Species are Included in this EA?

Wildlife species can be scientifically or managerially (statue or rule) categorized in many different ways. The species discussed in this EA are scientifically categorized (classified) as carnivores or bird (common raven). Whereas common ravens are classified as a migratory bird by the Migratory Bird Treaty Act (16 U.S.C. 703-12), resident/non-migratory species are defined by state statutes and or administrative codes (Section 1.7) as game mammals, fur-bearing mammals, unprotected mammals, prohibited species, predatory animals, and in some cases combinations of these based upon their location being on private or public land.

For the purpose of efficiency in this EA, and not having to refer repeated to multiple categories of animals, we will refer to all these species scientifically as “predators” because of their predatory nature, at least at some time, to prey upon another animal species. This EA includes the following species (in order of proportion of take by WS-Nevada; Table 1.1). All species except for common ravens, free-ranging/feral dogs and free-ranging/feral cats are managed under state law by NDOW. Common ravens are managed under the Migratory Bird Treaty Act (MBTA) by the United States Fish and Wildlife Services (USFWS).

Table 1-1 Predator Species Included in Scope of this EA.

Common Name	Scientific Name	Managed By[1,2]
Coyote	*Canis latrans*	NDOW
Common raven	*Corvus corax*	USFWS
Badger	*Taxidea taxus*	NDOW
Mountain lion	*Felis concolor*	NDOW
Striped skunk	*Mephitis mephitis*	NDOW
Raccoon	*Procyon lotor*	NDOW
Bobcat	*Lynx rufus*	NDOW
Red fox	*Vulpes vulpes*	NDOW
Free-ranging/feral dog	*Canis familiaris*	County Sheriff/Local Officials
Kit fox	*Vulpes macrotis*	NDOW
Black bear	*Ursus americanus*	NDOW
Free ranging/feral cat	*Felis catus*	County Sheriff/Local Officials
Gray fox	*Urocyon cinereoargenteus*	NDOW
Spotted skunk	*Spilogale gracilis*	NDOW
Mink	*Mustela vison*	NDOW
Weasels	*Mustela spp.*	NDOW
Ring-tailed cat	*Bassariscus astutes*	NDOW

[1] NDOW: Nevada Department of Wildlife; [2]also managed by tribes on tribal Land

1.4 What is Wildlife Damage Management?

1.4.1 *Why Does Wildlife Damage and Risks to Human Health and Safety Occur?*

Wildlife is a valuable natural resource, long enjoyed by the American public for aesthetic, recreational, emotional, psychological, and their attendant economic benefits are important in many communities. Native wildlife in overabundance or individual animals that have learned and habituated to use resources supplied by humans, especially food, can come into conflict with humans. Introduced, feral, or invasive species may outcompete native species and cause damage to other resources. Wildlife can destroy crops and livestock, damage property and natural resources, including other species valued by humans, and pose serious risks to public and pet health and safety.

Across the United States, wildlife habitat has been substantially changed as human populations expand and land is used for human needs. These human uses and needs often compete with the needs of wildlife, which increases the potential for conflict between humans and wildlife. With this continued and more intensive use of land by humans, introduction of domestic livestock, water resource management, urbanization, and other modern agricultural, cultural, and transportation practices associated with human development have caused substantial changes in the ways that humans and wildlife, especially predators, interact.

Highly adaptable and flexible species often reach unnaturally high densities. Some animals and localized populations may adapt to change by using human infrastructure or concentrated agricultural practices for their life cycle needs, such as obtaining food and water, finding areas to breed or rest. Conflicts include threats to human health and safety.

Wildlife may serve as reservoirs for disease and parasites. Diseased animals living near areas of human activity may transmit those diseases to livestock, people, and/or pets. These diseases may transfer to people directly through physical contact or may be transmitted to people via environmental contamination by feces and even tainted food products such as fresh produce or meat products.

The wild animals themselves do not perceive the same values that humans perceive in the animals or plants they eat, the locations they choose to breed and live, or the health or safety concerns they cause to humans. They are simply using and adapting to the available habitats, including opportunities where humans provide easy food and living space. Wildlife's constant ability to adapt to changes in their environment for meeting their own needs for food, water, and shelter can create tension and conflict where human needs for social and economic security and health and safety overlap.

1.4.2 *What types of values do humans have with Wildlife?*

Schwartz et al. (2003) summarize how human attitudes towards large carnivores has evolved over time in Europe and North America from threats to life and property to utilitarian considerations, to valuing their intrinsic values. Human perceptions, attitudes, and emotions differ depending on how humans desire to "use" different wildlife species and how they interact with individual or groups of animals. For example, seeing a group of deer in a field at dusk may be seen as a positive experience, while seeing the same group of deer feeding in your garden or commercial alfalfa field is frustrating. Watching a coyote feeding on rodents in the snow may be exciting, while having the same coyote foraging for food near or on your pets or farm animals on your property may be highly undesirable and even frightening. Raccoons in the neighboring forest patch may be enjoyable to watch, while the same raccoon in your garbage, henhouse, or attic is intolerable.

We also have cultural perceptions based on our experiences, upbringing, and even childhood stories. Wolves and coyotes may be considered as "bad" because they kill and eat animals we like or because they scare us, but also "good" because they look and behave like our own canine pets, and symbolize "the ecological wild." Some people spend substantial amounts of money to travel to see wildlife in their native habitats or even in zoos, while other people may spend equally substantial amounts of money to have animals removed or harassed away from their neighborhoods, livestock, crops, airports, and even recreational areas where the animals may cause damage or people may feel or be threatened. Some people are even happy just to know that certain types of animals still exist somewhere, even if they never have the opportunity to see them; they believe that their existence shows that areas of America are still “wild.” At the same time, people will also expect to have animals that cause damage to property, economic security, or that pose a threat to people to be removed and sometimes killed, with justification.

The values that people hold regarding wild animals differ based on their past and day-to-day experiences, as well as the values held by people they trust. For example, people who live in rural areas that depend on land and natural resources tend to consider wildlife from a more utilitarian viewpoint, such as for hunting. Age and gender also influence viewpoints, with younger people and females tending to feel more emotional towards wildlife (Kellert 1994; Kellert and Smith 2000; Table 1.2).

Table 1-2. Basic Wildlife Values. (Adapted from Kellert (1994) and Kellert and Smith (2000)).

Term	Definition
Aesthetic	Focus on the physical attractiveness and appeal of wild animals
Dominionistic	Focus on the mastery and control of wild animals
Ecologistic	Focus on the interrelationships between wildlife species, natural habitats, humans, and the environment
Humanistic	Focus on emotional affection and attachment to wild animals
Moralistic	Focus on moral and spiritual importance of wild animals
Naturalistic	Focus on direct experience and contact with wild animals
Negativistic	Focus on fear and aversion of wild animals
Scientific	Focus on knowledge and study of wild animals
Utilitarian	Focus on material and practical benefits of wild animals

As summarized by Lute and Attari (2016), people have strong opinions about killing wildlife, dependent on a myriad of factors, such as social identity and experience and knowledge about different species. Determining whether an individual animal has intrinsic value (the inherent right of an entity to exist beyond its use to anyone else) is a predictor to support for conservation. Factors relevant to how people respond to wildlife can include intrinsic value attributions given to humans, some or all animals, ecosystems; considerations such as moral, economic factors, the practicality with which one views wildlife, and cost: benefit analysis; and species characteristics, such as whether an animal is considered attractive, dangerous, endangered, familiar, nuisance, important to the economy, important to one’s well-being, and important to ecosystems. The interactions of how individual people view themselves in relation to the environment, their economic security, the values associated with natural areas and property, and people’s needs and desires within the context of their relationship with specific individual animals and species and their intrinsic values and flaws create highly complex attitudes and associated behaviors, including potentially mutually exclusive ones. Also, people may go to great lengths to save an individual identifiable person, but become numb to saving nameless masses (“psychic numbing”).

Surveys conducted in 1978 and repeated in 2014 by George et al. (2016) found that attitudes towards all animals were remarkably similar in 1978 and 2014; however, the greatest differences for particularly species were for historically stigmatized species, such as bats, sharks, vultures, coyotes, and wolves, which were significantly more positive in 2014 than in 1978, with significant increases in positive attitudes towards wolves and coyotes. The authors predict that increases in positive attitudes toward predators could also signal increases in social conflicts surrounding their management, especially in areas where these species are abundant or where conflicts with predators are increasing. Conservationists also are still discussing whether nature and wildlife have intrinsic value separate from the contribution they make to human well-being (Vucetich et al. 2015), and whether and how emotions and/or a sophisticated careful accounting by disinterested trustees should enter into policy and decision making (for example, Nelson et al. 2011, Nelson et al. 2016, Treves et al. 2015).

Reflecting these tensions in our emotional and physical relationships with wild animals, national policies have changed over time. Policies towards wildlife species that are considered to be desirable because they are hunted, rare, or valued for other reasons have resulted in local, federal, and state governments using taxpayer money to manage those species for their continued existence, increased distribution, and population growth.

In the past, as settlers moved across the West, large predators such as bears, wolves, and mountain lions were perceived as inherent threats to safety and food supply. These species were feared and humans systematically extirpated or substantially reduced their population sizes in many areas through overhunting, local, state, and federal government and private predator removal programs, and/or habitat destruction. Taxpayer funds that were once used to directly reduce "undesirable" wildlife predator populations, such as wolves or grizzly bears, may now be used to protect and increase their populations and habitats, recognizing their inherent ecological and social values within the framework of potential competition over natural and human resources and values.

Manfredo et al. (2018) conducted a project administered by the Western Association of Fish and Wildlife Agencies and the Midwest Association of Fish and Wildlife Agencies to assess the social context of wildlife management in an attempt to understand the conflict between stakeholders that has increased over time. It was the first study that describes how U.S. residents think about wildlife at both the national and individual state level. Manfredo et al. (2018) identified two dimensions that are central to how people view wildlife. The first, domination, is the view that wildlife is subordinate to humans and may be used in ways that benefit humans. The second view is mutualism, or the belief that wildlife are part of a human's social network and are deserving of "rights like humans". In the study, humans' attitudes towards wildlife are not simply doministic or mutualistic, but are measured by what degree of each dimension they feel in a given circumstance. The study categorized the gradations of the value orientations into "wildlife value orientation types", defined as:

- ***Traditionalists*** *(or Utilitarians) - Score high (above the midpoint) on the domination scale and low (at or below) the midpoint on the mutualism scale; i.e., they are the most extreme in beliefs that wildlife should be used and managed for the benefit of the people.*

- ***Mutualists*** *-Score high on the mutualism scale and low on the domination scale; i.e., they are the most extreme in seeing wildlife as part of their extended social network.*
- ***Pluralists*** *-Score high on both mutualism and domination scales; i.e., different situations or contexts result in this group emphasizing one orientation over the other.*
- ***Distanced*** *- Score low on both mutualism and domination scales; i.e., they exhibit low levels of thought about and interest in wildlife.*

Manfredo et al. (2018) found that a state with a "Mutualists" majority will have a strong belief in climate change increases (and that it is caused by human activity) and favor environmental protection over economic growth, whereas a "Traditionalists" majority in a state will have a stronger belief that private property rights are a greater priority than protecting declining or endangered species. When asked if "Wolves that kill livestock should be lethally removed", 14% of Mutualists agreed, whereas 53% of Traditionalists agreed, 40% of Pluralists agreed and 24% of Distanced agreed (for Nevada, 28% of respondents agreed). When asked "If a black bear attacks a person, that bear should be lethally removed regardless of the circumstances", 53% of Traditionalists agreed, 19% of Mutualists agreed, 44% of Pluralists agreed and 31% of Distanced agreed (for Nevada, 28.3% of respondents agreed). When asked if "Coyotes that kill pets in residential areas should be lethally removed", 63% of Traditionalists agreed, 24% of Mutualists agreed, 53% of Pluralists agreed and 36% of Distanced agreed (for Nevada, 36% of respondents agreed).

The national breakdown of the respondents by Wildlife Value Orientation Types showed 35% of respondents were Mutualists, 28% were Traditionalists, 21% were Pluralists and 15% were Distanced. In Nevada, 44.3% were Mutualists, 22.3% were Traditionalists, 18.7% were Pluralists and 14.7% were Distanced. By comparing the data from the current study to Teel et al. (2005), a similar project conducted in 2004 (Wildlife Values in the West), Manfredo et al. (2018) were able to look at trends in value shift over a 12-14 year period. The pattern that they found was that the average per state changed to a 4.7% increase for Mutualists, 5.7% drop for Traditionalists, with Pluralists and Distanced rather unchanged. The value type shift in Nevada from 2004 to 2018 was considerable: Mutualists increased by 37.9%, Traditionalists decreased by 23.4%, Pluralists decreased by 25% and Distanced increased by 9.1%. This suggests that Nevada has moved toward a society that stresses the importance of environmental protection over economic growth.

Lute and Attari (2016) recognize that conflicts with wildlife have been ongoing, especially as humans have made and continue to make substantial modifications to the environment and land uses that have created such conflicts, and that lethal control may be more cost-effective than sweeping habitat protection strategies. Their study suggests that people may rely on default strategies such as habitat and ecosystem protection and moral considerations rather than also considering economic and social costs necessary for navigating difficult trade-offs and nuances inherent decision-making regarding specific situations.

Trade-offs can and do occur between different conservation objectives and human livelihoods and conservation (McShane et al. 2011). The authors argue that many options exist in managing wildlife conflict in relation to protection of individual animals, populations, ecosystems, and human physical and economic well-being, and that these choices are "hard" because every choice involves some level of loss.

1.4.3 *At What Point Do People or Entities Request Help with Managing Wildlife Damage?*

As a society, our attitudes have changed over time, and now those same species seen as conflicting with human values may be considered desirable, but even then, only under socially-acceptable circumstances. The tension regarding the use of public funds and/or lands to support a wide variety of private/individual uses or incomes (not only related to wildlife) is a federal and/or state governmental policy consideration. An example of this tension can involve individuals who believe, for example, that livestock producers should not be allowed to graze on public lands or that livestock losses to predation should be considered as a "cost of doing business."

Animals cause damage to property, agriculture, economic security, threaten the sustainability of managed or protected wildlife species, and/or threaten human and pet health and safety. When this occurs, there are many situations when people, government agencies, or commercial interests request private companies or federal or state governments to stop or reduce the damage by removing or dispersing the individual animals or local groups of animals causing the problems. When damage or losses have previously occurred and can be expected to occur again, people or agencies may request that animals or groups of animals be removed or dispersed to avoid further losses, even before the damage or losses reoccur. Often, without outside help, people or entities will try to resolve the problems themselves, sometimes by attempting to prevent the damage from re-occurring, such as by building fences and other infrastructure, or by killing animals that they perceive are, and that may or may not be causing the problem, using traps, firearms, or toxic chemicals.

The term "damage" in the case of WDM is consistently used to describe situations where the individual person or entity has determined that the losses caused by wildlife triggers their threshold for requesting assistance or attempting to take care of the problem themselves. "Damage" may be defined as economic losses to property or assets, or threats to human or pet safety. However, "damage" may also be defined as a loss in the aesthetic value of property and other situations where the behavior of wildlife is no longer tolerable to an individual person or entity.

The threshold triggering a request for assistance in dealing with a particular damage situation is often unique to the individual person, entity, or agency requesting assistance. Therefore, what constitutes damage to one person or entity and considered intolerable may not even be considered a problem by another individual or entity.

Addressing wildlife damage problems requires consideration of both the resource owners' and society's levels of acceptability and tolerance, as well as the ability of ecosystems and local wildlife populations to absorb change without long-term or short-term adverse impacts.

"Biological carrying capacity," as we use it here, is the maximum number of animals of a given species that can, in a given ecosystem, survive through the least favorable conditions occurring within a stated time interval. In other words, the biological carrying capacity is the largest number of animals that can survive until reaching limitations imposed by their habitat (e.g., food, predation, climate) (Silvy 2012). The social carrying capacity is the limit of human tolerance for wildlife population levels or the associated damage, nuisance, or threats to human safety (Silvy 2012). Just the presence of a wild animal may be considered threatening or a nuisance to people with low tolerance or inexperience with the ways of wild animals, or when the animals are viewed as cruel, aggressive, or frightening. Those phenomena are especially important because they define the sensitivity of a person or community to coexisting with a wildlife species.

This damage threshold determines the wildlife acceptance capacity. While the biological carrying capacity of the habitat may support higher populations of wildlife, in many cases the wildlife acceptance capacity of people sharing that habitat is lower. Once the wildlife acceptance capacity is met or exceeded in a particular circumstance, people take or request help for taking action to alleviate the damage or address threats.

1.4.4 *What Are the Science and Practices of Wildlife Damage Management?*

With new science and changing societal values, governmental policies have changed to the extent that native wildlife populations are no longer managed by local, state, and the federal government for population suppression, extirpation from local areas, or even entire removal over large areas or regions, unless such management meets local objectives of protecting other valued or rare wildlife populations or for reducing the threat of the spread of disease. Wildlife damage management focuses on addressing a specific situation, not broad-scale population management. The Wildlife Society (TWS), a non-profit scientific and educational association that represents wildlife professionals, recognizes that wildlife damage management is a specialized field within the wildlife management profession, and that responsible wildlife management, including IWDM, requires adherence to professional standards.

The Wildlife Society has the following standing position on Wildlife Damage Management (WDM; The Wildlife Society N.D.):

> "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.
>
> "Wildlife sometimes causes significant damage to private and public property, other wildlife, habitats, agricultural crops, livestock, forests, pastures, and urban and rural structures. Some species may threaten human health and safety or be a nuisance. Prevention of control of wildlife damage, which often includes removal of the animals responsible for the damage, is an essential and responsible part of wildlife management. Before wildlife damage management programs are undertaken, careful assessment should be made of the problem, including the impact to individuals, the community, and other wildlife species. Selected techniques should be incorporated that will be efficacious, biologically selective, and socially appropriate."
>
> "The policy of The Wildlife Society in regard to wildlife damage management and the alleviation of wildlife problems is to [in part]:…Recognize that wildlife damage management is an important part of modern wildlife management."

Adapting the definition of Integrated Pest Management from the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA; Section 1.10.3) to wildlife damage management, Integrated Wildlife Damage Management (IWDM) involves considering and applying options, tools, and techniques, either singly or in combination, for resolving the damage or threat of damage using a strategy that is sustainable and appropriate to the specific project circumstances in a way that reduces economic, health, and environmental risks. Sustainable wildlife management is defined as "the sound management of wildlife species to sustain their populations and habitat over time, taking into account the socioeconomic needs of human populations" (International Union of Forest Research Organizations and Collaborative Parnership on Sustainable Wildlife Management 2017). When managing wildlife for meeting certain objectives related to damage or threats caused by species identified as "predators," it is called integrated predator damage management (IPDM).

The APHIS-WS program uses an Integrated Wildlife Damage Management (IWDM) approach (APHIS-WS Directive 2.105) in which a combination of methods may be used or recommended to reduce wildlife damage. The challenge is to develop strategies that include the most effective combination of techniques, for example, separating the asset to be protected from the problem animals, removing the problem animals before or when they cause the problem, harassing them away, and/or educating the resource owner on how to coexist with the animals or to remove the attractant.

Per APHIS-WS Directives 2.101 and 2.105, when selecting and applying a particular method or methods, "consideration must be given to the species responsible and the frequency, extent, and magnitude of damage. In addition to damage confirmation and assessment, consideration must be given to the status of target and potential non-target species, local environmental conditions, relative costs of applying management techniques, environmental impacts, and social and legal concerns."

The APHIS-WS Directive 2.105 states:

> "The WS program applies the IWDM (commonly known as Integrated Pest Management) approach to reduce wildlife damage. As used and recommended by the WS program, IWDM encompasses the integration and application of all approved methods of prevention and management to reduce wildlife damage. The IWDM approach may incorporate cultural practices, habitat modification, animal behavior management [such as repellents, frightening devices, and physical exclusion], localized population reduction [such as removing offending animals or groups of animals] or a combination of these approaches.
>
> The selection of wildlife damage management methods and their application must consider the species causing the damage and the magnitude, geographic extent, duration, frequency, and likelihood of recurring damage. In addition, consideration is given to non-target species, environmental conditions and impacts, social and legal factors, and relative costs of management options. WS personnel shall apply and use the IWDM approach to efficiently and effectively prevent or reduce damage caused by wildlife. In applying IWDM to wildlife damage management, the WS program may offer technical assistance, direct control, or a combination of both in response to requests for help with wildlife damage problems."

1.5 What Are the Roles of Federal Agencies in Managing WDM?

Many human activities such as, but not limited to, livestock production, agriculture, electric power transmission and distribution, and garbage collection at landfills experience conflicts with wildlife predators. Both WS-Nevada and the USFWS are regularly asked to respond to these wildlife-related conflicts.

APHIS-WS provides federal professional leadership and expertise to resolve wildlife conflicts to help create a balance that allows people and wildlife to coexist. APHIS-WS applies and recommends a cohesive integrated approach, which incorporates biological, economic, environmental, legal and other information into a transparent wildlife damage management decision-making process, and includes many methods for managing wildlife damage, including nonlethal and lethal options.

The APHIS-WS mission "…to provide federal leadership in managing conflicts with wildlife" includes resolution of wildlife conflicts in rural and urban areas; conservation of natural resources (including threatened and endangered species, and managed wildlife populations), protection of public, private and commercial property and assets; and control of invasive species and wildlife disease vectors. Increasingly, APHIS-WS is responsible for minimizing wildlife threats to public health and safety, as well as to the Nation's vital agricultural base.

APHIS-WS' success is based in its combined activities of integrating fieldwork (operations) with state of the art research of applied wildlife damage management principles and techniques. APHIS-WS' National Wildlife Research Center (NWRC), is internationally recognized as a leader in wildlife damage management science. Scientists and support staff are dedicated to finding solutions to challenging wildlife damage management problems related to agriculture, natural resources, property, and human health and safety. NWRC conducts research and develops tools to address dynamic wildlife damage management challenges. APHIS-WS operations personnel and NWRC researchers work closely together. This ensures that APHIS-WS will continue to resolve wildlife conflicts effectively and as humanely as possible, using advanced science and technology.

NWRC applies scientific expertise to the development of practical methods to resolve these problems and to maintain the quality of the environments shared with wildlife. NWRC designs studies to ensure that the methods developed to alleviate animal damage are biologically sound, effective, safe, economical, and acceptable to the public. NWRC scientists produce and test the appropriate methods, technology, and materials for reducing animal damage. Through the publication of results in peer-reviewed scientific literature and the exchange of technical information by other means, the NWRC provides valuable information to the public and the scientific community, as well as to APHIS-WS' operations.

1.5.1 *What are the Federal and State Laws Authorizing WS-Nevada's Actions?*

APHIS-WS is the federal agency authorized by Congress to protect American resources from damage associated with wildlife. The Act of March 2, 1931 (46 Stat. 1468; 7 U.S.C. 426) states:

> "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 Act was amended in 1987 (Act of December 22, 1987 (101 Stat. 1329-331, 7 U.S.C. 426c)) to further provide:

> On or after December 22, 1987, the Secretary of Agriculture is authorized, except for urban rodent control, to conduct activities and to enter into agreements with State, 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 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."

Nevada Department of Agriculture (NDA) is authorized to enter into agreements with APHIS-WS (Nevada Revised Statutes (NRS) 567.080) for the control of predatory animals and property destroying birds which includes common ravens to provide "*a maximum of protection against losses of property, livestock, poultry, game birds, animals, and crops on a statewide basis…*" Under NRS Chapter 567 they are also authorized to contribute monies towards this effort. This close collaboration, between APHIS-WS and NDA-WS, forms the WS-Nevada as explained in section 1.2. NRS 567.010-090 authorizes the Nevada Department of Agriculture to cooperate with the United States Department of Agriculture (USDA) for the control of predatory animals, crop destroying birds and rodents within the State of Nevada. The mission of the WS-Nevada is to provide leadership in managing problems caused by wildlife. APHIS-WS recognizes that wildlife is an important public resource greatly valued by the people of Nevada. By its very nature, however, wildlife is a highly dynamic and mobile resource that can damage agriculture and industrial resources, pose risks to human health and safety, and affect other natural resources. The program carries out the state and federal responsibility for helping to solve problems that occur when human interests and wildlife are in conflict with one another.

1.5.2 *How does APHIS-WS Carry Out Its Mission?*

1.5.2.1 *What Are APHIS-WS' and WS-Nevada's Mission, Goals, and Objectives?*

1.5.2.1.1 APHIS-WS' Mission

APHIS-WS' mission, developed through a strategic planning process, is "to provide leadership in wildlife damage management in the protection of America's agricultural, industrial and natural resources, and to safeguard public health and safety" (WS Directive 1.201).

To facilitate long-term strategic planning, APHIS-WS identified a list of core activities in the APHIS-WS 2020-2024 Strategic Plan (APHIS-WS 2019), including these functions relevant to WS-Nevada:

- Providing Wildlife Services

- Developing Methods
- Valuing and Investing in People
- Enhancing Information and Communication

APHIS-WS Directive 3.101 states:

> "APHIS-WS is specifically authorized to enter into cooperative agreements with Government agencies, public or private institutions, organizations associations or private citizens to manage conflicts with wild animals. By coordinating Federal Government involvement in managing wildlife conflicts and/or damage, WS officials help ensure that wildlife management activities are environmentally sound and conducted in compliance with applicable federal, state, and local laws and regulations, including two significant environmental laws, the Endangered Species Act and the National Environmental Policy Act (NEPA).
>
> Wildlife Services' successes in developing and providing its expertise in IWDM methodologies, and strategies have increasingly created methodologies, strategies, and opportunities for private industry to provide similar IWDM services. WS activities are differentiated from commercial IWDM activities by among other things, adherences to the environmental protection requirements promulgated under NEPA…WS may implement methods approved exclusively for WS personnel who are the only individuals, public or private, that are trained and certified in their use. WS cooperates with private businesses by 1) providing technical training at state, regional, and national conferences; 2) developing certain IWDM methods and registering certain chemical or pesticide IWDM products for use by the industry and the public, and 3) assisting businesses by applying WS-specific management methods when requested."

The APHIS-WS program carries out its federal mission for helping to solve problems that occur when human activity and wildlife are in conflict with one another through:

- Providing training to governmental and commercial wildlife damage management professionals when requested;
- Developing and improving strategies to reduce economic losses and threats to humans from wildlife;
- Collecting, evaluating, and disseminating information on wildlife damage management techniques;

Responding to requests for assistance with wildlife damage management situations, including providing technical advice and a source for loaned, limited-use management materials and equipment such as cage traps and pyrotechnics; informing and educating the public and cooperators on how to avoid or reduce wildlife damage; and/or addressing the problem through direct action.

1.5.2.1.2 WS-Nevada Goals and Objectives

The goal of WS-Nevada in relation to IPDM activities is to meet the APHIS-WS mission of professionally supporting the coexistence of humans and wildlife. WS-Nevada staff consistently responds to all requests for assistance to meet the following components of the goal:

- Respond in a timely and appropriate way to all requests for assistance.
- Responses, whether over the phone, remotely, or in the field, follow a formal decision process (WS Decision Model; WS Directive 2.201; Section 2.5.1.2) to evaluate, formulate, and implement or recommend the most effective strategy.
- The recommended strategy for each response intends to effectively reduce or eliminate damage and risks caused by the offending animal(s) to resolve conflicts with humans and their valued resources, health, and safety.
- These strategies may be both short-term and/or long-term and are often a combination of lethal and/or non-lethal methodologies to ensure effectiveness.

WS-Nevada objectives are to:

1) Professionally and proficiently respond to all reported and verified losses or threats due to predators, using the IPDM approach using the APHIS-WS Decision Model. IPDM must be consistent with all applicable federal, state and local laws, APHIS-WS policies and directives, cooperative agreements, MOUs and other requirements as provided in any decision resulting from this EA.
2) Implement IPDM so that cumulative effects do not negatively affect the viability of any native predator populations.
3) Ensure that actions conducted within the IPDM strategy fall within the management goals and objectives of applicable wildlife damage management plans or guidance as determined by the jurisdictional state, tribal, or federal wildlife management agency.
4) Reduce target and non-target effects by using the APHIS-WS Decision Model to select the most effective, target-specific, and humane remedies available, given legal, environmental, and other constraints.
5) Incorporate the use of effective new and existing lethal and non-lethal technologies, where appropriate, into technical and direct assistance strategies.

APHIS-WS' activities are conducted in accordance with applicable federal, state, and local laws, Work Initiation Documents (WIDs), cooperative agreements, agreements for control, Memoranda of Understanding (MOU) (Section 1.8), and other applicable agreements and requirements, and the directives found in the APHIS-WS Program Policy Manual (USDA 2013). These documents establish the need for requested work, legal authorities allowing the requested work, and the respective responsibilities of APHIS-WS and its cooperators.

1.5.2.2 How Does APHIS-WS Ensure the Implementation of Professional IWDM Practices?

Each APHIS-WS state office carries out the APHIS-WS mission in accordance with the differing management goals of its state. WDM activities can include providing assistance with WDM for the purposes of managing property and asset damage and losses, protecting special status wildlife, reducing or eliminating invasive species, protecting human health or safety, managing diseases that can be passed from wildlife to people or domestic animals (zoonoses), and conducting research.

Per APHIS-WS policy and practice, APHIS-WS State Directors and District Supervisors are professional wildlife biologists. Supervisors oversee teams of highly trained and specialized wildlife biologists and other field personnel.

Employee characteristics identified in the Code of Ethics (Directive 1.301) include commitment to compliance with legal requirements; honesty; integrity; accountability; continual learning and professional development; showing high levels of respect for people, property, wildlife, and varying viewpoints regarding wildlife and wildlife management; conservation of natural resources; using the most selective and humane methods available, with preference given to non-lethal methods when practical and effective; using the APHIS-WS Decision Model to resolve WDM problems; providing expertise on managing wildlife damage to the public upon request; and working in a safe and responsible manner. They must also be experienced in working with people, and in using clear strategic skills in applying their experience, expertise, and training in applying the APHIS-WS Decision Model in effective and creative ways (Section 2.3.1.1).

All field personnel are experienced in wildlife management, competent, and are highly trained in a diversity of methods described in in detail in Appendix A, as needed and appropriate, and are trained with periodic refreshers, in:

- The safe and proficient use of firearms (WS Directive 2.615);
- The safe involvement in aerial operations (WS Directives 2.620 and 2.305);
- The safe and proficient use of explosives and pyrotechnics (WS Directive 2.625);
- The safe use and management of hazardous materials (WS Directive 2.465);
- The safe and compliant use of pesticides (WS Directive 2.401);
- The safe and proficient use of M-44s (WS Directive 2.415); and
- The safe and humane use of immobilizing and euthanizing drugs (WS Direct 2.430).

Professional and state agencies, councils, and wildlife management organizations have recognized APHIS-WS and individual employees for their work in wildlife conservation as part of WDM, including, for recent examples: the Alaska Department of Fish and Game Director's Stewardship Award; recognition for Bird/Wildlife Aircraft Strike Hazard (BASH) work at Nellis Air Force Base; USFS 2016 Eastern Region Honor Award for work managing feral swine damage on the Wayne National Forest; Michigan Aeronautics Commission Award of Excellence; Michigan Department of Natural Resources 2015 Oscar Warbeck Award for outstanding partnership in managing BASH; USFWS 2016 recognition award for efforts leading to the return of the black-footed ferret to Meeteetse, WY; National Invasive Special Council 2015 Invasive Species Leadership/Aquatic Award; The Wildlife Society 2008 Caesar Kleberg Award for Excellence in Applied Wildlife Research; and the Wolf Recovery Foundation Alpha Award for achievements and contributions benefitting wolf recovery in multiple years. In addition, APHIS-WS received the 2014 Presidential Migratory Bird Federal Stewardship Award for non-lethal localized management of conflicts between raptors and humans.

APHIS-WS biologists and employees also regularly contribute to the development of new management methodologies, publish professional articles in respected journals, and provide presentations at professional conferences.

1.5.2.3 How Does APHIS-WS Operate?

APHIS-WS personnel respond to requests for assistance with particular problems, by reviewing the circumstances to determine whether wildlife caused the problem, and, if so, identifying which species of wildlife caused the problem, and then recommending to the requester one or more courses of actions they can take to reduce the risk of further damage (APHIS-WS Directive 2.201). This first type of action is called "technical assistance" wherein APHIS-WS personnel recommend actions that can be implemented by the resource owner or manager, such as better fencing, closer husbandry of livestock, or removing the offending animal themselves compliant with applicable laws.

APHIS-WS field personnel may also take action directly in response to a request for assistance, called "direct assistance" activities. These actions can include non-lethal techniques such as harassment and/or lethal measures that remove the offending animal(s), such as capturing them with specialized equipment and conducting euthanasia when needed. The actions can occur in urban or field settings, including secured and limited use areas such as military bases and airports. Before wildlife damage management of any type is conducted, a WID must be signed by a representative of WS-Nevada and the land owner or manager, or, for work on federally managed lands, an Annual Work Plan is developed in coordination with the land management administrator or agency representative and WS-Nevada (per MOUs with the USFS and BLM, Section 1.8.2.2).

The APHIS-WS Directive 2.101 states:

> "When responding to requests for assistance, WS may provide technical assistance, direct control assistance, and/or research assistance. Technical and direct control assistance…may involve the use of either lethal or non-lethal methods, or a combination of the two. Preference is given to non-lethal methods when practical and effective."

Trained and experienced field personnel determine the appropriate PDM methodologies to recommend and/or implement using the APHIS-WS Decision Model (Slate et al. 1992, APHIS-WS Directive 2.201, Section 2.3.1.1, hereafter called the "Decision Model"). Using this Decision Model, after the field employee receives a request for assistance, s/he assesses the problem, evaluates the effectiveness of the various methods available using IPDM, recommends the strategy based on short-term and long-term effectiveness and possible restrictions, constraints, and environmental considerations and cost, discusses the options with the cooperator, and formulates the strategy, then provides the appropriate assistance, and the field and/or the cooperator monitors the effectiveness of the results. The use of the APHIS-WS Decision Model is discussed in more detail in Section 2.3.1.1.

The ultimate intent of APHIS-WS personnel responding to a request for assistance is to develop and, when appropriate, implement strategies to alleviate and/or avoid wildlife damage and threats to human/pet health or safety, using one or more of the following strategies:

- Manage the resource being damaged so it is more difficult for the wildlife to cause the damage.
- Manage the wild animals responsible for or associated with the damage in lethal and/or non-lethal ways so they cannot continue to cause damage and potentially train their young or conspecifics to cause such damage, and/or
- Create physical separation of the protected resource and the problem animals so that the damage is inherently reduced.

All APHIS-WS actions are consistent with applicable federal, state, and local laws and regulations (APHIS-WS Directive 2.201). All actions must be consistent with memoranda of understanding and agreements with federal and state agencies, such as NDOW, USFWS, UFSF, or BLM, if the actions involve those agencies. Most importantly, as a federal agency, all APHIS-WS actions must be in compliance with the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), the Migratory Bird Treaty Act (MBTA), and FIFRA, as well as the federal and state statutes discussed in this EA (Section 1.11.3 and 2.4) and in Appendix C.

When requested to assist with IPDM problems, the APHIS-WS decision is whether or not to participate based on authority, jurisdiction, funding, and a professional determination of the scientific appropriateness and effectiveness of the strategy proposed by the requester. NDOW is authorized to control the threat of predator-related damage to wildlife populations under their authority using hunting seasons and administrative removals of predators. When requested by NDOW to conduct PDM for protection or management of species under their jurisdiction, especially if the requested action involves localized population reduction, WS-Nevada evaluates the potential effectiveness and appropriateness of their involvement before making a final decision to assist. WS-Nevada considers whether such actions would be strategically planned to occur at a specific time when the managed wildlife population is vulnerable to predation, such as on the winter range or during calving, lambing, or nesting, and when population reductions are determined to be necessary on a temporary and short-term basis.

WS-Nevada activities are described in detail in Section 2.3.1 (Alternative 1) and Section 2.3.2 (Alternative 2).

1.5.3 *What are USFWS Goals and Objectives Regarding Common Raven Damage Management?*

Under the authorities of the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act, the US Fish and Wildlife Service (USFWS) regulates the take of migratory birds for hunting, rehabilitation, preventing depredation, scientific collection, religious use, and other purposes. In this role, the Service uses monitoring and assessment information to manage migratory bird populations. Overall, the Service's challenge is to balance the take of migratory birds with international, national, and regional commitments to conserve them. Permits provide a means to balance use and conservation, and allow the Service to monitor activities to determine how they affect migratory birds.

Human development in Nevada has greatly increased the amount of food, water, and nesting places for common ravens. The increase in common ravens over the past 10-20 years is causing a variety of challenges for urban and wild-land managers. The common raven, along with many other species of native birds, are protected under the Migratory Bird Treaty Act (MBTA) (USHR 2019). Wildlife Services' predator damage management program in Nevada includes the lethal control of one of these species. For bird species protected under the MBTA, these types of activities require a depredation permit issued by the USFWS pursuant to 50 C.F.R. § 21.41. In addition to evaluating the environmental impacts of Wildlife Service's predator damage management program, the purpose of this EA is to also evaluate the reasonably foreseeable environmental impacts of the USFWS decisions on issuance of depredation permits under the MBTA for these activities.

In addressing conflict with the common raven, the ultimate goals of the USFWS are to:

(1) Use an adaptive management framework to meet the changing needs of rural residents and communities across Nevada;

(2) Identify what are the best methods for limiting human-generated sources of food, water and nesting places for common ravens, as part of the task of identifying how many common ravens can or should be authorized by USFWS for direct killing;

(3) When considering methods that can affect other species (such as the use of poisons), identify actions needed to reduce the killing of non-target species, especially species of conservation or management concern.

Working within the USFWS's Species Conflict Framework, the USFWS identifies the best methods for limiting human sources of food, water and nesting places to common ravens, as part of the process for identifying how many common ravens can be authorized by USFWS for lethal removal.

This EA will also analyze potential impacts to other bird species managed by USFWS that may be impacted from activities conducted under the predator damage management program in Nevada, including impacts to non-target species of birds.

1.6 What Actions Are Outside of APHIS-WS' Authority?

APHIS-WS does not have any authority to manage wildlife other than the authority provided by Congress for assisting with wildlife-caused damage. APHIS-WS policy is to respond to requests for assistance with managing wildlife damage. Managing wildlife populations and even individual wild animals is under the legal jurisdiction of state wildlife agencies, the USFWS for ESA-listed species, the USFWS for migratory birds and eagles, and tribal governments on tribal lands, and APHIS-WS defers to the applicable laws.

APHIS-WS has no authority to determine national policy regarding use and commitment of local, state, tribal or federal resources or lands for economic use by private entities, such as livestock grazing, nor use of private land, such as for livestock feedlots, or government, commercial, or residential development.

APHIS-WS does not make public land use management decisions. Policies that determine the multiple uses of public lands are based on Congressional acts through laws such as the Taylor Grazing Act of 1934 and the Federal Land Policy and Management Act for the BLM, and the Forest Service Organic Act of 1897 and the Multiple Use-Sustained Yield Act of 1960 for the Forest Service. Congressional appropriations support the implementation of these authorities. In contrast, WS-Nevada only addresses predator damage management upon request (Section 1.5 and WS Directive 2.201).

WS-Nevada cannot use pesticides unless they are approved by the U.S. Environmental Protection Agency (EPA) per FIFRA and are registered for use in Nevada. WS-Nevada must ensure that all storage, use, and disposal by WS-Nevada personnel is consistent with FIFRA label requirements and WS Directive 2.401.

APHIS-WS does not make wildlife management decisions. The State of Nevada has full authority and jurisdiction to manage the native wildlife within its boundaries, unless authority is granted to another governmental entity, such as the US Fish and Wildlife Service per the ESA, MBTA, or the Bald and Golden Eagle Protection Act (BGEPA).

In Nevada, most native wildlife species are managed by NDOW per Nevada Revised Statute (NRS) 501.100 and 501.102. The US Fish and Wildlife Service (USFWS, Department of Interior) has authority regarding wildlife and plant species listed per the Endangered Species Act (Public Law 93-205, 15 USC 1531 as amended). The State of Nevada has its own Endangered Species Act (NRS 503.584-503.585) and a wild species management/protection classification system in Nevada Administrative Codes (NAC) 503.015-503.080 as defined per NRS 501.110 (Classification of wildlife).

Migratory birds are managed by the USFWS per the Migratory Bird Treaty Act (MBTA). The USFWS also manages waterfowl hunting and intentional take of migratory birds.

A depredation permit from the USFWS is required for all activities that would involve take of native migratory birds, which includes pursuing, hunting, wounding, capturing, or killing migratory birds, or destroying any active nest or live egg. "*CFR title 50 Part 21-Migratory Bird Permits Subpart D-Control of Depredating and Otherwise Injurious Birds*" is the authority under which the USFWS issues depredation permits.

The USFWS is also the authority for managing intentional and non-purposeful take of bald and golden eagles through the issuance of permits, as in the case of the golden eagle (Title 50 Chapter I Subchapter B Part 22-Eagle Permits) under the Bald and Golden Eagle Protection Act (BGEPA).

WS-Nevada has no authority for determining the appropriate management of wildlife populations that are under the jurisdiction of NDOW and NDA per their statutes, regulations, and species management plans and strategies, or management of species regulated in accordance with the ESA, the MBTA, or the BGEPA. Rather, WS-Nevada responds to governmental and non-governmental requesters for assistance in managing wildlife damage and threats.

For more details on the various federal and state laws regarding wildlife management and protection, see Sections 1.10.3, 2.4.4 and Appendix C.

1.7 What are the State of Nevada's Authorities and Objectives for Managing Wildlife Damage?

It is APHIS-WS policy, and therefore WS-Nevada policy, to comply with applicable state laws (APHIS-WS Directive 2.210) and APHIS-WS' practice to cooperate with states in managing wildlife damage. NDOW manages wildlife under its jurisdiction and provides state permits for aerial hunting of specific predator species, such as coyotes.

The mission of NDOW is to:

> "To protect, preserve, manage and restore wildlife and its habitat for the aesthetic, scientific, educational, recreational, and economic benefits to citizens of Nevada and the United States, and to promote the safety of persons using vessels on the waters of Nevada."
> (www.dfw.state.or.us/wildlife/license_permits_apps/docs/WCO_Training_Manual.pdf).

NDOW has commission policies for managing wildlife per State of Nevada, Nevada Board of Wildlife Commissioners that are written to inform the public and guide management. These can be reviewed in Appendix B of this EA.

In Nevada, the following species are "unprotected mammals" managed by NDOW: "coyote, spotted skunk, striped skunk, long-tailed weasel (*Mustela frenata*), short-tailed weasel (*Mustela erminea*) and black-tailed jackrabbit (*Lepus californicus*) (NAC 503.035).

Nevada law (NRS 503.470) allows fur-bearing mammals injuring any property to be taken or killed at any time in any manner by the owner or occupant of the property or with the permission of the owner or occupant. Per NAC 503.025, Fur-bearing mammals include: beaver, bobcat, gray fox, kit fox, and red fox, marten, mink, muskrat, and otter.

In Nevada, black bear and mountain lion management is the responsibility of NDOW. Generally, either NDOW or WS-Nevada receives requests directly to handle damage to livestock and/or threats to human/pets health or safety caused by black bear or mountain lion. NDOW may choose to ask WS-Nevada or private contractors to respond to the request for assistance. Upon request, however, WS-Nevada may respond independently to damage caused by mountain lions as an agent to the requester.

Free-ranging and feral dogs can be threats to human health and safety, agriculture, natural resources, and property (Bergman et al. 2009). Under Nevada state animal control law (NRS 575.020), any dogs found in the act of killing or injuring livestock may be killed immediately by any person. In Nevada, control of free-ranging dogs that threaten, damage, or kill livestock is generally the responsibility of local governmental agencies, especially the County Sherriff's department or local animal control officers. WS-Nevada policy allows WS-Nevada personnel to assist in feral and free-ranging dog control at the request of local authorities, upon approval of the WS-Nevada State Director.

APHIS-WS Directive 2.340 regarding responding to damage caused by feral, free-ranging, and hybrid dogs states that such actions will be coordinated either for each project or programmatically with state, local and tribal authorities before taking action, and that each state will develop a state-level policy [WS-Nevada Policy 001]. Per the APHIS-WS Directive, the field employee capturing any free-ranging dog that is determined to be a pet they shall inform the owner, if possible, as soon as is practical. WS-Nevada is only infrequently requested to assist with feral or free-roaming dog complaints (less than .5% of all responses of the species in this EA), as these are usually handled by local officials.

NDOW has a list of private companies providing wildlife control services on its website at:

> http://www.ndow.org/uploadedFiles/ndoworg/Content/Forms_and_Resources/Commercial-Collection-Permitees-List.pdf

To be on this list, the company must apply to NDOW and receive a permit and, once a permit is obtained, report monthly on their specific take and the complainant served

> http://www.ndow.org/uploadedFiles/ndoworg/Content/Forms_and_Resources/Commercial-Collection-Unprotected-Wildlife-Instructions.pdf.

NDOW also has developed numerous management plans for managed species in Nevada. NDOW has management and/or conservation plans for management of:

- mule deer (NDOW 2006)
- antelope (NDOW 1983)
- elk (NDOW 1997)
- mountain lion (NDOW 1995)
- bighorn sheep (NDOW 2001)
- black bear (NDOW 2012a) and
- greater sage-grouse (Copeland et al. 2014).
- predators (NDOW 2012b, 2013, 2014b, 2015 and 2016a)

Portions of these plans as appropriate are integrated into this EA as needed to support needs and analyses within the context of appropriate state policies.

1.8 How Does WS-Nevada Work with Federal/State Agencies and Grazing Boards?

1.8.1 *How Does WS-Nevada Work with NDA, NDOW and Grazing Boards?*

WS-Nevada (APHIS-WS in Nevada) and NDA-WS (Nevada Department of Agriculture, Nevada Wildlife Services) form the federal and state components of WS-Nevada collaboration. WS-Nevada refers to this joint agency, whereas NDA-WS refers to just the state component.

When WS-Nevada receives a request for assistance from NDOW for a predator damage-related problem, WS-Nevada cooperates with the state agency per applicable Nevada statute and regulations, and in accordance with guidelines, restrictions, and objectives set forth by NDOW management and conservation plans and cooperative agreements. WS-Nevada can act as an agent to NDOW, or a landowner, depending on the entity requesting assistance.

The NDA, NDOW, and Grazing Boards are authorized by NRS 502.253, 555.010, 555.021, 567.010, 567.020, 567.030, 567.040, 567.050, 567.060, 567.070, 567.080, 567.090

568.100, 568.120, 568.140, 568.150 and 568.160 to allocate funds to mutually cooperate with WS-Nevada for wildlife damage control of predatory animals. NDA State Veterinarian and Animal Disease Laboratory sometimes requests assistance with monitoring and control of livestock diseases that have a wildlife component.

WS-Nevada has Cooperative Service Agreements (CSA) with NDA, State Grazing Boards and NDOW, and a Memorandum of Understanding (MOU) with NDOW. These documents establish a cooperative relationship between WS-Nevada and NDA and NDOW, outline responsibilities and agreements for funding, and set forth objectives and goals for resolving wildlife damage conflicts in Nevada. Recognizing that the wording of these MOU and Cooperative Services Agreements may change upon renewal, it is not expected that future conditions included in the agreements would have environmental relevance not already evaluated in this EA.

A. NDA/WS-Nevada Intergovernmental Agreement

- WS-Nevada has an agreement with NDA that provides for mutual consultations and development of annual work plans, and payment of services for wildlife damage management actions taken at the request of NDA.
- The main purpose of the agreements (updated annually) are to provide Nevada State employees with GSA leased vehicles and provide funding for 1 federal District Supervisor. They also state that work by WS-Nevada will be performed in accordance with the State of Nevada's Biennial Budget 4600. WS-Nevada, as the federal agency, must determine that compliance with NEPA, ESA, and other applicable federal environmental statutes are completed before undertaking any wildlife damage management actions
- All operations have the joint concurrence of APHIS-WS and NDA. APHIS-WS must conduct the Nevada Wildlife Services Program in accordance with its established operating policies and all applicable state and federal laws and regulations.
- NDA-Wildlife Services will be supervised by WS-Nevada State Director who will also cooperate with NDA to collect wildlife disease samples for testing by NDA's Animal Disease Lab in order to protect Nevada's natural resources and to protect the State's public health.

B. NDOW/WS-Nevada Intergovernmental Agreements

- WS-Nevada has agreements with NDOW to: assist in the implementation of NDOW's Predation Management Plan in Nevada to resolve wildlife conflicts related to damage caused by predatory animals to wildlife and natural resources; and to reimburse for expenses incurred while protecting public safety as requested by NDOW.
- Development of a Memorandum of Understanding (MOU) identified NDOW and WS-Nevada as having joint responsibility for minimizing damage caused by wildlife. However NDOW retains statutory authority and responsibility for managing wildlife

in Nevada, while WS-Nevada has special expertise that benefits NDOW in carrying out the WDM program objectives.
- Again, as a federal agency, WS-Nevada must determine that compliance with NEPA, ESA, and other applicable federal environmental statutes are completed before undertaking any wildlife damage management actions.
- The agreements stipulate that work will be conducted in accordance with NDOW Predation Management Plan.

1.8.2 *How Does WS-Nevada Work with Federal Agencies?*

1.8.2.1 *How Does WS-Nevada Work with the Bureau of Land Management and the US Forest Service?*

Public lands managed by the Bureau of Land Management (BLM) comprise about 80 percent of the land area in Nevada, with USFS managing almost 10 percent of Nevada's land. Thus, working with these land management agencies is an important part of WS-Nevada's coordinated activities. The USFS and the BLM manage federally managed lands under their jurisdiction for multiple uses, including wildlife habitat, livestock grazing, timber, WAs, WSAs, cultural resources, and recreation. Both USFS and BLM recognize the importance of reducing wildlife damage on lands and resources under their jurisdictions, as integrated with their multiple use responsibilities. For these reasons, both agencies have entered into MOUs with WS nationally to facilitate a cooperative relationship. Pursuant to those MOUs, WS develops, and annually updates, Integrated Wildlife Damage Management plans that consider all applicable non-lethal and lethal methodologies to resolve wildlife damage issues. USFS and BLM cooperate with APHIS-WS in the development and annual review of IWDM plans, and they provide minimum requirements analyses (as required for non-emergency PDM work in WAs) as appropriate. WS complies with BLM and FS requirements for notification and/or approval for use of pesticides on public lands administered by those agencies (USFS MOU signed 06/02/2017, BLM MOU signed 08/29/2012).

WS-Nevada prepares Annual Work Plans for work on National Forest and BLM lands in cooperation with USFS and BLM to define actions and locations of planned work where requests for assistance have been received. WS-Nevada coordinates with the land management agencies before performing PDM activities on lands under their jurisdiction. The USFS and BLM are responsible for preparing land management plans per the National Forest Management Act (USFS) and Federal Lands Policy Management Act (BLM) to guide long-range management direction and include action constraints for protecting sensitive resources. Based on their land management and planning activities, BLM and USFS identify any potential areas of conflict for WS-Nevada to avoid.

During or prior to the last 5 years, WS-Nevada has been requested to provide PDM assistance on one National Forest (Humboldt-Toiyabe) and most BLM Districts. Current work plans involve one National Forest in Nevada and 8 BLM districts for protection of livestock, human safety and natural resources (which includes approximately 90,000 acres of the Idaho Twin Falls district which resides in Nevada). All national forests (with the exception of the Inyo National Forest) and BLM Districts may request WS-Nevada assistance with emergency work at any time.

For this EA, the USFS and BLM are cooperating agencies and have been involved with this EA to ensure consistency with their land management plans.

- Humboldt-Toiyabe NF
  - Austin Ranger District
  - Bridgeport Ranger District
  - Carson Ranger District
  - Ely Ranger District
  - Jarbidge Ranger District
  - Mountain City Ranger District
  - Ruby Mountains Ranger District
  - Santa Rosa Ranger District
  - Spring Mountains Ranger District
  - Tonopah Ranger District
- Inyo NF

BLM has 8 districts, each with a Resource Management Plan (RMP):

- Battle Mountain
- Carson City
- Elko
- Ely
- Northern California
- Southern Nevada
- Twin Falls (ID)
- Winnemucca

Over the last 5 years, 57.9% of WS-Nevada's take of target predators and 69.3% of responses to conflicts involving predator species has occurred on federal land (MIS 2017). Although a portion of the Twin Falls district resides in Nevada, it is managed by Idaho BLM Twin Falls district. WS-Nevada has not conducted work in the Twin Falls district during the analysis period. If WS-Nevada were requested to conduct work in the Twin Falls district, it would abide by the Twin Falls district RMP and WS-Idaho annual work plan restriction (no use of M-44 devices).

1.8.2.2 *What MOUs Does APHIS-WS Have with the US Forest Service and BLM?*

APHIS-WS has national memoranda of understandings (MOUs) with the USFS and the BLM for IPDM work on federally managed lands and resources under their jurisdiction.

A. MOU with the Forest Service (2017):

- Documents the cooperation between the USFS and APHIS-WS for managing indigenous and feral vertebrates causing resource damage on NFS lands, minimizing livestock losses due to predation by coyotes, mountain lions, and other predators, managing wildlife diseases, managing invasive species, and protecting other wildlife, plants, and habitat from damage as requested by the Forest Service and/or state or federal wildlife management agencies.

- Recognizes that Forest Service direction concerning WDM (wildlife damage management) within WAs is provided in Forest Service Manual (FSM) 2323.33 (Appendix I) and that both parties are committed to ensuring that WDM in WAs is provided in a manner that protects wilderness in its natural condition and preserves wilderness character for current and future generations.
- APHIS-WS shall obtain documented approval from the Regional Forester or their designee prior to conducting WDM on NFS wilderness lands consistent with FSM 2323.33c (Appendix I). Decisions will be documented on a "case-by-case basis[1]", meet with the Regional Forester or their designee to review all APHIS-WS activities on wilderness lands.
- APHIS-WS evaluates needs for IPDM in cooperation with the USFS, develops and annually updates Annual Work Plans (AWPs) in cooperation with the USFS and appropriate state and federal agencies, tribes, and others. USFS cooperates with APHIS-WS to ensure that planned PDM activities do not conflict with other land uses, including human safety zones, and to ensure that work plans are consistent with forest plans. APHIS-WS notifies the USFS before conducting activities on NFS lands and provides reporting on PDM results.
- APHIS-WS is responsible for NEPA compliance for wildlife damage, invasive, and wildlife disease management activities when requested by entities other than the USFS, and coordinates with the USFS, relevant state and federal agencies and tribes in completing NEPA compliance; the USFS complies with NEPA for all actions initiated by the USFS.
- APHIS-WS provides technical assistance and training to the USFS on WDM methodologies when requested.

B. MOU with the BLM (2012[2]):

- Documents cooperation with BLM, APHIS-WS, and state governments, provides guidelines for field operations, and identifies responsibility for NEPA compliance for PDM activities regarding predation by native and feral animals on livestock and wildlife, including federally-listed threatened and endangered species, and to other resources and human health and safety, consistent with multiple-use values.
- APHIS-WS and BLM cooperate to identify areas on BLM lands where mitigation or restrictions may apply, including human health and safety zones; the development and annual review of IPDM plans on BLM resources, consistent with the Federal Land Policy and Management Act (FLPMA), land and resource management plans, and federal laws; and evaluate needs for predator damage management in

[1] "Case-by-case" means in accordance with an agreed upon Annual Work Plan. Deviations from the Annual Work Plan will require additional approval.
[2] WS-Nevada is working under the 2012 MOU with BLM, however a new MOU has been drafted by the agencies and is expected to be finalized during the duration of the proposed PDM activities. The proposed activities are in compliance with both the 2012 MOU and the new draft MOU.

cooperation with state agencies, grazing permittees, adjacent landowners, and any other resource owner or manager, as appropriate.

- APHIS-WS is responsible for NEPA compliance for predator and invasive species damage and wildlife disease management activities conducted in response to requests on BLM lands, and will coordinate with and report to the BLM and state and local agencies and tribes during compliance.
- APHIS-WS will notify the BLM about the results of actions taken on BLM lands in an annual report.

In addition to these MOUs, the USFS, BLM, and Association of Fish and Wildlife Agencies (AFWA) entered into an agreement in June 2006 (AFWA 2006). These policies and guidelines provide the framework for cooperation for fish and wildlife management in federal WAs. This agreement addresses the restrictions on certain actions in WAs, such as use of motorized equipment and pesticide use, with specific exceptions. The Policies and Guidelines specifically address wildlife damage control in Section 13. The 3 agencies agreed to use the "Minimum Requirement Decisions Process Outline" attachment to determine if the action is necessary to manage the area as wilderness and to determine the minimum requirements for the administration of the area for the purpose of the act. The Wilderness Act (Sec. 2(a)) defines the purpose of the act "…administered for the use and enjoyment of the American people is such a manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character…" (see Section 1.10.3 for Wilderness Act and Federal Land Management Policy Act (FLPMA) for wilderness study area management and relevant land management agency policy manuals).

The BLM incorporated the Policies and Guidelines agreement into affected BLM manuals (BLM Manual 6330 (BLM 2012a) and 6340 (BLM 2012b)). The USFS incorporated the Policies and Guidelines into FSM 2323.32 and FSH 2309.19 to be implemented "in a practical, reasonable, and uniform manner in all National Forest wilderness units" (United States Forest Service 2007).

PDM actions in WAs and WSAs are discussed further in Sections 2.3 and 3.11.

1.8.2.3 *How does WS-Nevada Work with Federal Agencies to Review Proposed Work in Wilderness Areas and Wilderness Study Areas?*

For WS-Nevada activities proposed in Wilderness Areas and Wilderness Study Areas, WS-Nevada would present the proposed activities for the year to the BLM and USFS during their respective annual work plan (AWP) meetings. On USFS-managed wilderness, USFS would complete a Minimum Requirements Analysis (MRA), and the Regional Forester must approve PDM activities in accordance with USFS Wilderness policy prior to WS-Nevada conducting PDM activities in those areas. On BLM-managed wilderness, BLM would conduct an MRA for all WS activities proposed in Wilderness Areas and provide documentation of that analysis to WS prior to WS-Nevada conducting PDM in those areas.

USFS and BLM will also review all PDM activities proposed in their respective Wilderness Study Areas. The responsible land management agency will analyze the proposed activities in accordance with the Federal Lands Policy and Management Act's non-impairment standard, or one of the exceptions. The land management agencies will evaluate all PDM activities proposed in wilderness study areas for consistency with their implementing regulations, policy, and guidance, prior to WS-Nevada conducting activities in those areas.

The responsible land management agency will also review all applicable NEPA analyses for activities in wilderness areas and wilderness study areas.

Sections 1.10.3.10 and 1.10.3.11 of this EA discusses the Wilderness Act and the Federal Land Policy Management Act, as well as the agency implementing regulations for wilderness and wilderness study areas.

1.8.2.4 *How Does WS-Nevada Work with the US Fish and Wildlife Service?*

USFWS has the responsibility to manage migratory birds including the common raven, and threatened and endangered species.

1.8.2.4.1 Threatened and Endangered Species, Ecological Services Office

Under Section 7 of the ESA, Federal agencies must consult with the USFWS when any action the agency carries out, funds, or authorizes may affect a listed endangered or threatened species. WS-Nevada reviews all proposed actions for their potential to affect species listed as threatened or endangered under the federal ESA. When WDM activities may affect such species, WS-Nevada consults with the US Fish and Wildlife Service (USFWS) to ensure its program will not jeopardize the continued existence of the listed species. Effects of WS-Nevada activities on federally listed species in Nevada were evaluated by the USFWS in a Biological Opinion for impacts on listed Mojave desert tortoise (August 27, 2018) and in an informal consultation for all other species (dated August 27, 2018 and September 25, 2018). WS-Nevada closely follows operational measures outlined in its ESA consultation documents to reduce the risk of take of listed species (Sections 2.4.1.17 and 2.4.2).

WS-Nevada may also assist the USFWS in protecting ESA-listed species, when requested.

Minimization measures, reasonable and prudent measures, and terms and conditions included in the consultation documents are identified in Section 2.4 and analyses of the potential impacts of the WS-Nevada on threatened and endangered species is located in Section 3.6.

1.8.2.4.2 Migratory Bird Permit Office

The USFWS' Migratory Bird Program provides national and international leadership in the conservation and management of migratory birds by promoting science-based management of both populations and habitat. The USFWS works with a diversity of partners to assess, manage and conserve migratory bird species and their habitats.

WS-Nevada works with the USFWS Pacific Southwest Region's Migratory Bird Program under USFWS-issued common raven depredation permits that allow for the take of common ravens under specific conditions. The USFWS is also a cooperating agency in the development of this EA and has provided information, reviews and analysis on the effects of common raven damage management activities on common raven populations in Nevada and within the region (Section 3.5.4).

The purpose of a depredation permit is to provide relief to the public, businesses and public servants who are experiencing or managing damages from birds protected under the Migratory Bird Treaty Act. Authority is granted to the USFWS through CFR title 50 Part 21-Migratory Bird Permits Subpart D-Control of Depredating and Otherwise Injurious Birds. Specifically § 21.41 - Depredation permits. Permits may be issued directly to WS-Nevada, or to its cooperators with WS-Nevada acting as a designated agent (Section 1.6). WS-Nevada applies for a permit renewal each year prior to the deadline listed in block 12 (Reporting Requirements) of the permit. Both the online renewal application and a summary of common raven "take" by county covering the prior calendar year are emailed to the permit office. For the purposes of this section, "take" refers to how the bird and/or nests/eggs were affected by WS-Nevada (e.g. for birds, harassed/dispersed, killed; regarding nests and eggs, removed, destroyed/disposed of). The MB permit office then issues the permit for the acceptance of WS-Nevada. Any discrepancies or changes needed submitted to the MB permit office through a request for an amendment.

CFR title 50 Part 21-Migratory Bird Permits Subpart D-Control of Depredating and Otherwise Injurious Birds states:

"*(a) Permit requirement. Except as provided in § 21.43, 21.44, and 21.46, a depredation permit is required before any person may take, possess, or transport migratory birds for depredation control purposes. No permit is required merely to scare or herd depredating migratory birds other than endangered or threatened species or bald or golden eagles.*

(b) Application procedures. Submit application for depredation permits to the appropriate Regional Director (Attention: Migratory bird permit office). You can find addresses for the Regional Directors in 50 CFR 2.2. Each application must contain the general information and certification required in § 13.12(a) of this subchapter, and the following additional information:

> *(1) A description of the area where depredations are occurring;*
>
> *(2) The nature of the crops or other interests being injured;*
>
> *(3) The extent of such injury; and*
>
> *(4) The particular species of migratory birds committing the injury.*

(c) Additional permit conditions. In addition to the general conditions set forth in part 13 of this subchapter B, depredation permits shall be subject to requires, in this section:

> *(1) Permittees may not kill migratory birds unless specifically authorized on the permit.*
>
> *(2) Unless otherwise specifically authorized, when permittees are authorized to kill migratory birds they may do so only with a shotgun not larger than No. 10 gauge fired from the shoulder, and only on or over the threatened area or area described on the permit.*

(3) Permittees may not use blinds, pits, or other means of concealment, decoys, duck calls, or other devices to lure or entice birds within gun range.

(4) All migratory birds killed shall be retrieved by the permittee and turned over to a Bureau representative or his designee for disposition to charitable or other worthy institutions for use as food, or otherwise disposed of as provided by law.

(5) Only persons named on the permit are authorized to act as agents of the permittee under authority of the permit.

(d) Tenure of permits. The tenure of depredation permits shall be limited to the dates which appear on its face, but in no case shall be longer than one year.

[39 FR 1178, Jan. 4, 1974, as amended at 42 FR 17122, Mar. 31, 1977; 63 FR 52637, Oct. 1, 1998; 80 FR 15691, Mar. 25, 2015]". Note that there are 5 very specific additional permit conditions above under "*(c) Additional permit conditions*". These are on the cover of every issued migratory depredation permit. Of interest, "Part 13" that is referenced under "(c)" refers to "General Permit Procedures".

APHIS-WS has a national Memorandum of Understanding with the US Fish and Wildlife Service, including the following pertinent sections:

- APHIS-WS and the USFWS recognize that non-target migratory birds might incidentally be killed despite the implementation of all reasonable measures to reduce the likelihood of take during actions covered under depredation permits, depredation and control orders, and agricultural control and eradication actions.
- During NEPA compliance, APHIS-WS will evaluate the reasonable range of alternatives, assess and estimate impacts on migratory birds, monitor migratory birds with other collaborators (as funds allow), and consider impacts on target and non-target species and ways to reduce impacts.
- USFWS will provide APHIS-WS available migratory bird population data, reported take by non-APHIS-WS entities, and biological information as requested within a reasonable time frame.

1.8.2.5 *How Does WS-Nevada Work with the Federal Aviation Administration?*

WS-Nevada works with the Federal Aviation Administration (FAA), when requested, for necessary resolution of wildlife damage manage at airports to support aviation safety.

APHIS-WS MOU with the FAA and the NASAO:

- This partnership supports the organizations' common mission to collaboratively advance and encourage aviation safety within their respective areas of responsibility and to reduce wildlife hazard risks through education, research, and outreach, including promoting effective communication for ensuring critical safety, security, efficiency and natural resources/environmental compatibility.
- The end goal is to increase wildlife strike reporting and technical and operational assistance and necessary training to the aviation community to ultimately reduce the risk of wildlife hazards and ensure safer operations at airports.

1.8.3 *How Does WS-Nevada work with Native American Indian Tribes?*

WS-Nevada recognizes the rights of sovereign tribal nations, the unique legal relationship between each Tribe and the Federal government, and the importance of strong partnerships with Native American communities. Native American tribes have rights to hunt, fish and gather, graze livestock, and exercise other traditional uses and practices on unoccupied federally managed lands within ceded territories defined in Treaties between the U.S. government and the tribes. The United States and all its agencies, as fiduciaries, owe a trust duty to the Native American tribes. This duty includes a substantive duty to protect—to the fullest extent possible—the lands, assets, and resources on which the tribe's treaty-reserved rights depend and to manage habitat to support populations necessary to sustain species hunted and gathered by tribal members. WS-Nevada is committed to respecting tribal heritage and cultural values when planning and initiating wildlife damage management programs as requested by Tribal governments and/or residents or permittees. Timely and meaningful consultation and coordination with tribal governments, to the greatest extent practicable and permitted by law, are conducted consistent with Executive Order (EO) 13175 and APHIS-WS' plan implementing the executive order, including implementing the government-to-government relationship. WS-Nevada offers early opportunities for formal government-to-government consultation on its proposed program to all Tribes in Nevada, and has requested their involvement for this EA through direct invitations (October 2016) and agency draft EA review opportunities.

The APHIS Native American Working Group, created in response to EO 13175 and made up of management and support program personnel, advises APHIS-WS personnel nationwide how they can better serve Tribes, Intertribal committees, and related organizations, and helps coordinate APHIS' partnerships with Tribal governments. The APHIS-WS Tribal Liaison contact information is found at https://www.aphis.usda.gov/aphis/ourfocus/tribalrelations/sa_tribal_contact_us.

APHIS Directive 1040.3, "Consultation with Elected Leaders of Federally Recognized Indian Tribes" implements EO 13175 (Section 2.4 A16). It directs APHIS-WS agencies to provide federally recognized tribes the opportunity for government-to-government consultation and coordination in policy development and program activities that may have direct and substantial effects on their Tribe. Its purpose is to ensure that tribal perspectives on the social, cultural, economic, and ecological aspects of agriculture, as well as tribal food and natural resource priorities and goals, are heard and fully considered in the decision making processes of all parts of the Federal government. The Directive provides detailed definitions relevant to APHIS-WS and tribal government interactions and relationships, laws, and regulations, policy, and APHIS-WS management responsibilities. The Directive states regarding interpretations of agency or Tribal policies: "Unless specific judicial rulings or Acts of Congress indicate otherwise, APHIS' policy and philosophy will not be construed as validating the authority of any Native American government over lands or other resources or non-tribal members."

No WS-Nevada IPDM activities are conducted on tribal lands without a specific request from the tribal government or other authority. WS-Nevada personnel consult with tribes in Nevada before initiating PDM actions in that tribe's ceded territory. WS-Nevada has agreements (Work Initiation Documents) with 2 tribes in Nevada for PDM work: the Duck Valley and Duck Water Tribal governments for coyote damage to livestock. If a tribe requests WS-Nevada assistance, WS-Nevada will consult with the tribe regarding when, where, and how PDM actions and strategies may be conducted, and ensure that the action and strategy is approved. If PDM activities are requested on Indian Lands, the tribal government and/or the Bureau of Indian Affairs have the authority to determine the methodology used. At the tribe's request, WS-Nevada will report on any PDM activities taken on tribal lands, including lands within the reservation boundary but not currently owned by or managed by or for the tribe.

Federal agencies have trust responsibilities to federally-recognized tribes that other entities and governments do not, including government-to-government relationship, consultation, and coordination. IPDM actions taken by non-federal entities may not provide the participation in decision making regarding IPDM activities that is provided by APHIS-WS as a federal agency.

The Native American Graves and Repatriation Act of 1990 (NAGPRA), and Senate Bill 61 (signed in 1992), requires, in part, that a federal agency that makes new and inadvertent discoveries of Native American cultural items, including human remains, funerary objects, sacred objects, and other objects possessing continuing cultural, traditional, or historical importance to tribes and Native Americans during its actions on federal, state or private lands shall notify tribes and return such items to lineal descendants or Indian Tribes (disposition) associated with such items. Since WS-Nevada does not cause ground-disturbance during its IPDM activities, it is highly unlikely that any such items would be disturbed during activities. However, some items may be on or near the surface and be found by WS-Nevada field personnel, at which time work would stop in that area and NAGPRA processes would be implemented.

When WS-Nevada began the EA process in 2016, an invitation to participate in the development of the EA and the offer of consultation were sent to all federally recognized tribes in Nevada. In response, WS-Nevada received 2 phone calls from tribes, one clarifying the intent of the EA and the other expressing support for the process. In the spring of 2019, WS-Nevada sent all federally recognized tribes in Nevada a copy of the Draft EA for their review along with another invitation to engage in consultation. The Summit Lake Paiute Tribe responded with a letter and in October 2019, WS-Nevada and the Summit Lake Paiute Tribe met to discuss the EA and how the PDM activities may affect the tribe and their cultural values (Section 3.12.2).

1.8.3.1 *How does WS-Nevada work with Department of Defense (DoD)?*

WS-Nevada works with the DoD, when requested, for necessary resolution of wildlife damage manage at Naval Air Stations, Air Force Bases (AFB) and Air National Guard (ANG) facilities to support aviation safety.

APHIS-WS MOU with the DoD (signed May 15, 1990):

This partnership supports the organizations' common mission to collaboratively advance and encourage aviation safety within their respective areas of responsibility and to reduce wildlife hazard risks through education, research, and outreach, including promoting effective communication for ensuring critical safety, security, efficiency and natural resources/environmental compatibility. The main objective of these agreements is to allow WS-Nevada to conduct wildlife damage management on DOD facilities to alleviate hazards to aircraft and protect human health and safety.

1.9 How Does WS-Nevada Comply with NEPA?

1.9.1 *How Does NEPA Apply to WS-Nevada's IPDM Activities?*

WS-Nevada predator damage management activities are subject to the National Environmental Policy Act (NEPA) (Public Law 9-190, 42 U.S.C. 4321 et seq.). The APHIS-WS program follows the Council on Environmental Quality (CEQ) regulations implementing the NEPA (40 CFR 1500 et seq.) along with USDA (7 CFR 1b) and APHIS Implementing Procedures (7 CFR 372) as part of the decision-making process. NEPA sets forth the requirement that all federal actions be evaluated in terms of:

- Their potential to significantly affect the quality of the human environment for the purpose of avoiding or, where possible, mitigating and minimizing adverse impacts;
- Making informed decisions; and
- Including agencies and the public in their NEPA planning in support of informed decision-making.

Updates to WS-Nevada implementation of predator damage management in Nevada have prompted WS-Nevada to initiate this new analysis. The analyses contained in this environmental assessment (EA) are based on information and data derived from APHIS-WS' MIS database; data from the USFWS, NDA and NDOW regarding species under their jurisdiction; published and, when available, peer-reviewed scientific literature; interagency consultations; public involvement; and other relevant sources.

This EA describes the needs for resolving predator damage problems for which WS-Nevada is typically requested to assist. The EA identifies the potential issues associated with reasonable alternative ways and levels of providing that assistance. It then evaluates the environmental consequences of the alternatives for WS-Nevada's involvement in IPDM.

To assist with understanding applicable issues and reasonable alternatives to managing predator damage in Nevada and to ensure that the analysis is complete for informed decision-making, WS-Nevada has made this EA available to the public, agencies, tribes and other interested or affected entities for review and comment prior to making and publishing the decision (either preparation of a Finding of No Significant Impact (FONSI) or a Notice of Intent to prepare an Environmental Impact Statement (EIS)). Public outreach notification methods for an EA include postings on the national APHIS-WS NEPA webpage and on www.regulations.gov, a direct mailing to known local stakeholders, electronic notification to registered stakeholders on www.GovDelivery.com, and notification in the legal section of the *Nevada Appeal* newspaper. The public will be informed of the decision using the same venues, including direct mailed notices to all individuals who submit comments and provide physical addresses.

Wildlife damage management is a complex issue requiring coordination among state and federal agencies and the tribes. To facilitate planning, efficiently use agency expertise, and promote interagency coordination with meeting the needs for action (Section 1.11), WS-Nevada is coordinating the preparation of this EA with cooperating and consulting partner agencies, including NDA, NDOW, FS, BLM and USFWS. WS-Nevada also recognizes the sovereign rights of Native American tribes to manage wildlife on tribal properties, and has invited all federally recognized tribes in Nevada to cooperate or participate in the development of this EA. The WS-Nevada is committed to coordinating with all applicable land and resource management agencies including tribes when PDM activities are requested.

1.9.2 *How Will this EA Be Used to Inform WS-Nevada's Decisions?*

Although WS-Nevada only conducts predator damage management when requested by a governmental, commercial, or private entity, as a federal agency, it is required to comply with NEPA for its activities. WS-Nevada is the lead for APHIS-WS' IPDM program in Nevada. WS-Nevada has the technical expertise in management of damage caused by native predators and their activities. Cooperating agencies in the development of this EA are NDA, NDOW, BLM, USFS, and USFWS. Each of the cooperating agencies are asked to review the draft document and provide input and direction to APHIS-WS to ensure that actions are in compliance with applicable federal and state regulations and policies, federal land management plans and joint MOUs, and cooperative agreements.

WS-Nevada will use the analyses in this EA to help inform WS-Nevada decision-making, including whether to prepare an Environmental Impact Statement (EIS) or a Finding of No Significant Impact (FONSI); and whether or not to continue WS-Nevada IPDM activities and, if so, to determine how and to what degree such activities would be implemented.

1.9.3 *How Does this EA Relate to Site-Specific Analyses and Decisions, Using the APHIS-WS Decision Model?*

Many of the species addressed in this EA can be found statewide within suitable habitat, and damage or threats of damage can occur wherever those species occur and overlap with human presence, resources, or activities. Wildlife damage management falls within the category of actions in which the exact timing or location of individual requests for assistance can be difficult to predict with sufficient notice to accurately describe the locations or times in which WS-Nevada can reasonably expect to be acting. Although WS-Nevada could predict some of the possible locations or types of situations and sites where some kinds of predator-related damage could occur, the program cannot predict the specific locations or times at which affected resource owners would determine that a damage problem has become intolerable to the point that they request assistance from WS-Nevada. Therefore, WS-Nevada must be ready to provide assistance on short notice anywhere in Nevada to protect any resource or human/pet health or safety upon request where consistent with applicable federal law, land management agency policies, and MOUs with APHIS-WS.

The APHIS-WS Decision Model (Section 2.3.1.1) is the site-specific procedure for individual actions conducted by WS-Nevada personnel in the field when they respond to requests for assistance. Site-specific decisions made using the model are in accordance with NEPA decisions and include applicable WS' directives (Section 2.4.1), relevant laws and regulations, interagency agreements and memoranda of understanding, and cooperating agency policy and procedures.

The analyses in this EA are intended to apply to any action that may occur in any locale and at any time within Nevada for which WS-Nevada may be requested for assistance. Using the Decision Model (Section 2.3.1.1) for field operations, this EA meets the intent of NEPA with regard to site-specific analysis, informed decision-making, and providing the necessary timely assistance to agencies and cooperators per WS-Nevada objectives.

1.9.4 *What is the Geographic Scope of this EA and in What Areas Would WS-Nevada Actions Occur?*

The geographic scope of the actions and analyses in this EA is statewide. WS-Nevada has decided that one EA analyzing potential operational impacts for the entire state of Nevada provides a more comprehensive and less redundant analysis than multiple EAs covering smaller areas. This approach also provides a broader scope for the effective analysis of potential cumulative impacts and for using data and reports from state and federal wildlife management agencies, which are typically on a state-wide basis.

Areas in which WS-Nevada IPDM activities occur encompass rural and urban areas, including residential and commercial development; rangelands, pastures, ranches and farms; agricultural croplands; forested areas; recreation areas and trails; airports; WAs and WSAs where authorized, and other places where predators may overlap with human occurrence, activities, and land uses and create conflicts. The proportion of IPDM activities conducted on various land classes is found in Table 1.3.

Operational areas may include:

A. Private Property

Private and commercial property owners and/or managers of private property request WS-Nevada for assistance to manage predator damage and threats. An estimated 31.68% of the responses to damage or damage threats by the species in this EA occurred on private lands (Table 1.3). Private property includes areas in private ownership in urban, suburban, and rural areas, including agricultural lands, pastures, residential complexes, subdivisions, and businesses.

B. Federally Managed Lands

WS-Nevada may be requested and may conduct PDM on federally managed lands, in accordance with land management regulations, policies, and other agency agreements. This includes limited operations in areas with special designations, such as WAs and WSAs (Section 3.11). Table 3.20 includes all WAs and WSAs in the state and the likelihood of WS-Nevada working on each. The table is generally based on likelihood of conducting PDM to protect livestock, however, WS-Nevada may be requested to respond to public safety situations in any WAs or WSAs. WS-Nevada is excluding certain special designations from the scope of the EA as there is no foreseeable need to apply PDM on these lands. These lands include:

- National Park Service lands (which include Lake Mead National Recreation Area),
- USFWS refuges,
- Inyo National Forest, and
- Research Natural Areas (USFS 2015)

Grazing is not allowed on USFS and BLM lands in Clark County, therefor WS-Nevada is not proposing any PDM to protect livestock on those lands in this EA. However, PDM for protection of natural resources and human health and safety on those lands may be requested and will be analyzed in this EA.

In accordance with MOUs between USFS and BLM, WS-Nevada may respond to grazing permittee and/or land management agency requests for PDM to protect livestock on federal grazing allotments. WS-Nevada may also respond to wildlife management agency requests for PDM to protect natural resources on federally managed lands when and where consistent with applicable laws, MOUs, and APHIS-WS and land management agency policies (Sections 1.8, 1.10.3, 2.4). WS-Nevada coordinates with the applicable wildlife and land management agencies prior to the grazing/recreation seasons to identify needs, types of operations, and restrictions (documented in an Annual Work Plan), and reports annually to the agencies on PDM activities (Section 1.8). WS-Nevada may also respond to requests for assistance with human health and safety incidents on federally managed lands. An estimated 67.97% of WS-Nevada responses to predator-human conflicts occur on federally managed lands (Table 1.3).

C. State, County, and Municipal Property

Activities are conducted on properties owned and/or managed by the state, county or Nevada municipalities when requested. Such properties can include parks, forestland, historical sites, natural areas, scenic areas, conservations areas, and campgrounds. Sometimes private landowners that are being affected by predators that reside in habitat located on adjacent public lands may request assistance. The adjacent property owner/manager may agree to allow IPDM activities to occur to assist the affected landowner. WS-Nevada can also conduct PDM activities directly on state, county and city properties as agents for NDOW when requested, or independently. An estimated 0.2% of WS-Nevada responses to conflicts are conducted on state, county, or municipal lands (Table 1.3). Work on state, county, or municipal lands would be extremely limited and WS-Nevada would follow all applicable laws and policies of the appropriate land management agency. WS-Nevada IPDM activities in these areas would most likely be for the protection of health and human safety.

D. Tribal Resources

Tribal governments and resource owners can request assistance from WS-Nevada for predator damage management on lands under their authority and/or ownership. Predators play an important role in tribal culture and religious beliefs. WS-Nevada continues to work with tribes to address their needs through consultation for this EA, with policy, and in the field, as requested. Work conducted at the request of tribal governments is consistent with tribal decisions, values, and traditions as determined by the Tribal government through government-to-government consultations.

WS-Nevada respects the rights of sovereign tribal governments, provides early opportunities for all federally-recognized tribes in Nevada to participate in the IPDM planning and developing IPDM strategies for addressing their issues, provides opportunities for participating in WS-Nevada NEPA efforts through government-to-government consultation, consistent with USDA APHIS Directive 1040.3 and federal policy (Section 1.8.3).

WS-Nevada will only conduct PDM on Native American owned lands held in trust by the United States Government upon the owner(s) request and in consultation with, or authorization by, the Bureau of Indian Affairs (such as individual Indian Allotments). If PDM activities are requested on Native American owned lands WS-Nevada will consult with the tribal government and/or the Bureau of Indian Affairs to determine the methodology employed in order to efficiently resolve the problem while minimizing potential cultural resource conflicts. As a result, this EA would cover PDM operations on all Indian Lands held in trust by the United States Government throughout Nevada, where requested and implemented. See Section 1.8.2 regarding coordination and consultation for IPDM with tribes in Nevada. An estimated 0.14% of WS-Nevada responses to conflicts are conducted on tribal land (Table 1.3).

On private lands within recognized reservation boundaries and in negotiated buffer zones around tribal lands, WS-Nevada works with the resource / landowner to facilitate consultation between WS-Nevada and tribes regarding predator conflicts within those boundaries, as applicable. See Section 1.8.2 regarding coordination and consultation for IPDM with tribes in Nevada.

E. Airports and DoD Aviation Facilities

Because habitat for small mammals, and small mammals that are prey for raptors may be found within fenced active airfields, predators can become hazards to aircraft during are takeoffs and landings. WS-Nevada receives requests for assistance and training from several airport authorities to address threats of aircraft strikes at some of the airports or airbases in Nevada and may be requested for assistance at other airports in the future. WS-Nevada currently provides services and/or training to several airports/airfields in Nevada, Reno-Tahoe International Airport in Reno, Air National Guard in Reno and Sweetwater, Naval Air Station (NAS) Fallon, and Nellis Air Force Base in Clark/Nye County. Work on

DoD lands would be limited to the protection of health and human safety and protection of natural resources in rare situations. WS-Nevada would follow all applicable protective measures (Section 2.4) and DoD instructions. WS-Nevada IPDM activities in these areas would most likely be for the protection of health and human safety.

Table 1-3. WS-Nevada Responses to Conflicts by Land Class, FY 2012-FY 2016 Annual Average of 14,538.4 Responses.

Land Class	% of Conflicts Occurring by Land Class
BLM	57.94%
Private	31.68%
Forest Service	7.97%
Military	1.92%
State Land	0.14%
Tribal	0.14%
Other Public Land	0.14%
County or Municipal	<0.06%

1.9.5 *For What Period of Time is this EA Valid?*

If WS-Nevada determines that the analyses in this EA indicate that an EIS is not warranted (impacts are not significant per 40 CFR §1508.27; Section 1.10), this EA remains valid until WS-Nevada determines that new or additional needs for action, changed conditions, new issues, and/or new alternatives having different environmental impacts need to be analyzed to keep the information and analyses current. At that time, this analysis and document would be reviewed and, if appropriate, supplemented if the changes would have "environmental relevance" (40 CFR 1502.9(c)), or a new EA prepared pursuant to the NEPA.

WS-Nevada monitors IPDM activities conducted by its personnel and ensures that those activities and their impacts remain consistent with the activities and impacts analyzed in the EA and selected as part of the decision. Monitoring includes review of adopted mitigation measures and target and non-target take reported and associated impacts analyzed in the EA. Monitoring ensures that program effects are within the limits of evaluated/anticipated take in the selected alternative. Monitoring involves review of the EA for all of the issues evaluated in Chapter 3 to ensure that the activities and associated impacts have not changed substantially over time.

1.10 Why is WS-Nevada Preparing an EA Rather than an EIS?

WS-Nevada is preparing an EA to comply with APHIS NEPA Implementing Regulations. The development of this EA is the first step in the NEPA process and does not preclude the preparation of an EIS, should that be warranted based on the analysis.

APHIS NEPA Implementing Regulations in 7 CFR 372 § 372.5(b)(5) states:

(b) Actions normally requiring environmental assessments but not necessarily environmental impact statements. This class of APHIS actions may involve the agency as a whole or an entire program, but generally is related to a more discrete program component and is characterized by its limited scope (particular sites, species, or activities) and potential effect (impacting relatively few environmental values or systems). Potential environmental impacts associated with the proposed action are not considered potentially significant at the outset of the planning process. Any effects of the action on environmental resources (such as air, water, soil, plant communities, animal populations, or others) or indicators (such as dissolved oxygen content of water) can be reasonably identified, and mitigation measures are generally available and have been successfully employed. Unless the actions are categorically excluded as provided in paragraph (c) of this section, actions in this class include:
*****

(5) Programs or statewide activities to reduce damage or harm by a specific wildlife species or group of species, such as deer or birds, or to reduce a specific type of damage or harm, such as protection of agriculture from wildlife depredation and disease; for the management of rabies in wildlife; or for the protection of threatened or endangered species.

1.10.1 *What is the Purpose of an Environmental Assessment?*

The primary purpose of an EA is to determine if impacts of the proposed action or alternatives might be significant, to determine if an EIS is appropriate (40 CFR 1508.9(a)(3) and 40 CFR 1501.4). This EA is prepared so that WS-Nevada can make an informed decision on whether or not an EIS is required for the WS-Nevada IPDM activities included in this EA.

WS-Nevada prepared this statewide EA for its IPDM activities to clearly communicate the analysis of individual and cumulative impacts of its actions to the public using guidance at 40 CFR §1506.6, and to evaluate and determine if there are any potentially significant impacts that may occur from the proposed action and alternatives. This EA also facilitates planning and interagency coordination, streamlines informed decision-making, and provides for timely and effective responses to requests for IPDM assistance.

In order to make this decision, this EA conducts a thorough analysis of direct, indirect, and cumulative impacts associated with WS-Nevada assistance to requesting entities in managing predator damage and threats to resources and assets, and threats to human safety and health. WS-Nevada addresses all anticipated issues and reasonable alternatives in this EA.

This EA includes thorough and comprehensive analyses of the impacts and effectiveness of 5 alternative IPDM programs in Nevada, including no federal WS-Nevada activities at all (Section 2.3.5), in compliance with NEPA Section 102(2)(E). It also documents compliance with other environmental laws, such as the Endangered Species Act, describes the current WS-Nevada activities and alternatives in detail, and provides rationale for not considering other alternatives and issues in detail.

WS-Nevada involves the public in its EA processes by providing for public comment on pre-decisional EAs, and agency involvement through providing for cooperating and commenting agency status and the opportunity to comment on an internal interagency draft prior to public release. WS-Nevada will provide a 30-day review and comment period on the pre-decisional draft of the EA for the public and interested parties to provide comments regarding new issues, concerns, and/or alternatives. Using the guidance provided in 40 CFR §1506.6 for public involvement, WS-Nevada will clearly communicate to the public and interested parties the analyses of potential environmental impacts on the quality of the human environment. Public notification processes regarding the availability of the final NEPA document and decision will be identical to that used for the pre-decisional EA, with the addition of direct contact with commenters.

If, then WS-Nevada would publish a Notice of Intent to prepare an EIS, and this EA would be the foundation for developing the EIS, per the CEQ implementing regulations (40 CFR §1508.9(a)(3)).

1.10.2 *How will WS-Nevada Evaluate Significant Impacts?*

The process for determining if a project or program may have significant impacts is based on the CEQ regulations at 40 CFR §1508.27. WS-Nevada will review the impacts evaluated in Chapter 3 of this EA in two ways: the severity or magnitude of the impact on a resource and the context of the impact. For example, context may be considered when the resource is rare, vulnerable, not resilient, or readily changed long-term with even a short-term stressor.

Most of the factors included in 40 CFR §1508.27(b) include the phrase "the degree to which" a particular type of resource might be adversely impacted, not a determination of no adverse impact at all. Therefore, WS-Nevada evaluates the impacts to resources and documents the predicted effects in the EA. These effect analyses are used to determine if the levels of impact are indeed "significant" impacts for which a FONSI would not be appropriate. If WS-Nevada determines that the levels of impacts are not significant, then, per the CEQ regulations, the agency will document the rationale for not preparing an EIS in a publicly available FONSI.

The factors identified in 40 CFR §1508.27 are not checklists, nor do they identify thresholds of impacts; they are factors for consideration by the agency while making the decision regarding whether to prepare a FONSI based on the impact analyses in an EA or an EIS. The agency will determine how to consider those factors in its decision on whether to prepare a FONSI or an EIS. WS-Nevada will determine the *degree* to which a factor applies or does not apply to the impacts documented in the EA.

The following discussion outlines how WS-Nevada will use this EA and the criteria at 40 CFR §1508.27 to make the decision regarding whether an EA or an EIS is appropriate for the WS-Nevada IPDM program.

1.10.2.1 *Controversy Regarding Effects*

The factor at 40 CFR §1508.27(b)(4) is described as "the degree to which the effects on the quality of the human environment are likely to be highly controversial." The failure of any particular organization or person to agree with every act of a Federal agency does not create controversy regarding effects. Dissenting or oppositional public opinion, rather than concerns expressed by agencies with jurisdiction by law or expertise and/or substantial doubts raised about an agency's methodology and data, is not enough to make an action "controversial." This EA evaluates peer-reviewed and other appropriate published literature, reports, and data from agencies with jurisdiction by law to conduct the impact analyses and evaluate the potential for significant impacts. This EA also includes and evaluates differing professional opinions and recommendations expressed in publications where they exist and that are applicable to WS-Nevada informed decision-making (for example, Section 1.12).

A relatively recent comment raised in response to APHIS-WS PDM EAs in the western United States suggests that scientific controversy exists regarding APHIS-WS removal of predators considered to be at the top of the ecological food chain ("apex predators") that can cause "trophic cascades" resulting in reductions in biodiversity. This comment argues that changes at the top of the food chain (such as wolves) may result in ecological changes, including releases of populations of smaller predators (such as coyotes or foxes), in which other, often smaller predator populations may be released from suppression caused by larger predators. This ecological issue and its cumulative impact analysis are evaluated in detail in Section 3.8.

The perception of the humaneness of lethal and non-lethal operational methods used by WS-Nevada personnel are concerns that have been commonly raised by the public during similar APHIS-WS NEPA processes (USDA-APHIS-WS 2011; 2014; 2016). This issue is considered in detail using the best scientific and professional wildlife management, biology, and veterinarian information available (Section 3.9). APHIS-WS recognizes that people may readily disagree on the subjective analysis of the degree to which animals may feel pain and react to short-term and long-term stress associated with capture, immobilization, and euthanasia. This EA includes APHIS-WS Directives and other measures (Section 2.4) that are used routinely by WS-Nevada personnel for minimizing the potential for pain and stress on animals in the field.

1.10.2.2 *Unique or Unknown Risks*

Another concern commonly expressed in comments involves the potential for unknown or unavailable information (40 CFR §1502.22) to potentially result in uncertain or unique or unknown risks (40 CFR §1508.17(b)(5)), especially related to population numbers and trends and the extent and causes of mortality of target and non-target species. Throughout the analyses in Chapter 3 of this EA, WS-Nevada uses the best available data and information from wildlife agencies having jurisdiction by law (NDOW, and USFWS; 40 CFR §1508.15), as well as the scientific literature, especially peer-reviewed scientific literature, to inform its decision-making. Data provided by livestock producers, especially regarding the economic value of livestock lost to predation as reported for inclusion in the APHIS-WS MIS database, is inherently subjective to some degree, and is therefore used only as an indicator for the costs associated with livestock depredation in Section 1.11.2.

WS-Nevada recognizes that estimating wildlife populations over large areas can be extremely difficult, labor intensive, and expensive. NDOW, or, for that matter, any state wildlife management agency, has limited resources for estimating population levels and trends for predator species that are not managed as game or furbearers. Therefore these state agencies do not directly set population management objectives for these species. States may choose to monitor population health using factors such as sex ratios, age distribution of the population, indices of abundance, and/or trend data to evaluate the status of populations that do not have direct population data. This EA uses the best available information from wildlife management agencies, including NDOW when available, and peer-reviewed literature to assess potential impacts to predator and non-target wildlife species.

If population estimates are available, then the analyses in Chapter 3 use the lowest density or number estimates for wildlife species populations (where high and low population estimates are provided in the text) to arrive at the most conservative impact analysis. Coordination with NDOW and the USFWS and providing the opportunity for agency review of and involvement in this EA ensure that analyses are as robust as is possible. The analyses in Sections 3.5 provide information for WS-Nevada to determine if WS-Nevada contribution to cumulative mortality from all sources would adversely affect population levels for each predator species considered.

1.10.2.3 Threatened or Endangered Species, Unique Geographic Areas, Cultural Resources, and Compliance with Environmental Laws

This EA also provides analyses and documentation related to threatened and endangered species, areas with special designations such as WAs, cultural and historic resources, and compliance with other environmental laws, including state laws. This will be used to address the significance criteria at 40 CFR §1508.27(b)(3, 8, 9, and 10).

These issues are evaluated in the following sections:

- Impacts to threatened and endangered species and designated critical habitat (Section 3.6)
- Impacts to unique geographic areas (WAs and WSAs) (Section 3.11)
- Impacts to historic resources (Section 3.3)
- Impacts to cultural resources (Section 3.12)
- Compliance with Endangered Species Act (Section 3.6)

1.10.2.4 Cumulatively Significant Impacts

Another common comment involves the criterion for the analysis of "cumulatively significant impacts" (40 CFR §1508.27(b)(7)), which is considered in this EA in various ways.

Many of the issues evaluated in detail are inherently cumulative impact analyses including, for example (Section 3.2):

- Impacts to target species' populations, as each population has many sources of mortality, only one of which is take by WS-Nevada;

- Impacts to populations of ESA-listed species, as these species' populations are already cumulatively impacted by many sources of mortality, loss of habitat, climate change, and other stressors, causing them to be listed;
- Potential ecological impacts caused by removal of apex predators, as many ecological factors contribute to any resulting impacts;
- Potential for lead from ammunition to impact environmental and human factors, as there are many sources of lead in the environment, including lead from hunting activities and ingesting game meat shot with lead ammunition, and lead may chronically enter the environment and people over time; and
- Impacts to Cultural Uses of wildlife resources including consumptive and nonconsumptive uses and cultural values.

1.10.2.5 Public and Employee Health and Safety

The concern regarding public health and safety (significance criterion at 40 CFR §1508.27(b)(2)) is evaluated in several analyses in this EA in Chapter 3:

- The potential for humans to ingest lead sourced from ammunition through water and game meat (Section 3.10.2.6);
- The potential for hazardous chemicals being spilled or leached into surface and groundwater, and being ingested by humans (Section 3.10.2.2);
- The risk of injury to WS-Nevada employees during aerial shooting operations (Section 3.10.1.3); and
- The risk of injury to WS-Nevada employees while handling hazardous chemicals, being exposed to diseased animals, and the risk of attack by captured animals (Section 3.10.1, 3.10.3).

1.10.2.6 Impacts Can Be Both Beneficial and Adverse

Some commenters may believe that, because the protection of human and pet health and safety, livestock and other property, and wildlife is extremely beneficial, an EIS must be prepared, based on 40 CFR §1508.27(b)(1). It is important that beneficial outcomes and effects be identified as well as adverse effects as contributions to informed decision-making. However, the efficacy of meeting the need for action (e.g, reducing predator damage or risks), is not considered to be environmental impact. Environmental impacts are identified in Chapter 3 for each alternative (Sections 3.2, and 3.5 through 3.13).

1.10.3 *How Do Key Statutes, Executive Orders, and Wilderness Policies Apply to the WS-Nevada Activities?*

Please review Section 1.10.3, Section 2.4.4, and Appendix C for details on all the federal and state laws and executive orders relevant to the WS-Nevada activities. This section addresses Nevada-specific application of highly relevant laws.

1.10.3.1 *Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)*

All pesticides used or recommended for cooperator use are registered with and regulated by the US Environmental Protection Agency (USEPA) and the NDA. WS-Nevada uses or recommends for use all chemicals according to label requirements as regulated by USEPA and NDA.

1.10.3.2 *Endangered Species Act (ESA)*

WS-Nevada has consulted with the USFWS regarding its current activities. See Sections 2.4 and 3.6 for details on consultations and results.

1.10.3.3 *Migratory Bird Treaty Act*

WS-Nevada operates under migratory bird depredation permits issued by the USFWS Pacific Southwest Region permit office for take of common ravens (Section 1.8.2.3.2).

1.10.3.4 *National Historic Preservation Act*

WS-Nevada has reviewed its activities as described this EA and continues to conclude that the program is not an “undertaking” as defined by the National Historic Preservation Act (NHPA) and that consultation with the State Historic Preservation Office (SHPO) is not necessary (Government Document, April 10, 2019). WS-Nevada works closely with the USFS and BLM on public lands to ensure there are no conflicts with cultural resources. WS-Nevada has also reached out to tribes as discussed under “Consultation and Coordination with Indian Tribal Governments” in this section, and the tribes have identified cultural issues of concern to the tribes. Each of the methods described in the EA that may be used operationally and locally by WS-Nevada does not cause major ground disturbance, does not cause any physical destruction or damage to property, does not cause any alterations of property, wildlife habitat, or landscapes, and does not 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-Nevada under the proposed action are not generally the types of activities that would have the potential to affect historic properties. Although not foreseen, if WS-Nevada is requested to assist with a wildlife damage problem that could potentially cause more than minor ground disturbance on public lands, then site-specific consultation as required by Section 106 of the NHPA would be conducted as necessary.

1.10.3.5 *Executive Order 13175 – Consultation and Coordination with Indian Tribal Governments*

The United States has a unique legal relationship with Indian tribal governments as set forth in the Constitution of the United States, treaties, statutes, Executive Orders and court decisions. Executive Order 13175 directs federal agencies to establish regular and meaningful consultation and collaboration with tribal officials in the development of federal policies that have tribal implications, to strengthen the United States government-to-government relationships with Indian tribes and to reduce the imposition of unfunded mandates upon Indian tribes. Agencies shall respect Indian tribal self-government and sovereignty, honor tribal treaty and other rights and strive to meet the responsibilities that arise from the unique legal relationship between the federal government and Indian tribal governments. This Executive Order directs agencies to provide federally recognized tribes the opportunity for government-to-government consultation and coordination in policy development and program activities that may have direct and substantial effects on their tribe. Its purpose is to ensure that tribal perspectives on the social, cultural, economic and ecological aspects of agriculture, as well as tribal food and natural-resource priorities and goals, are heard and fully considered in the decision-making processes of all parts of the federal government. APHIS Directive 1040.3, Consultation with Elected Leaders of Federally Recognized Indian Tribes, provides guidance to APHIS programs on implementation of Executive Order 13175. In accordance with the provisions of Executive Order 13175 and APHIS Directive 1040.3, WS has invited all federally recognized tribes in Nevada to participate as cooperating agencies in the creation of the EA and offered to consult with them on the current and proposed PDM activities.

1.10.3.6 *Native American Graves Protection and Repatriation Act*

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-Nevada employee, the appropriate tribe would be notified. PDM activities on tribal lands would only be conducted at the request of a tribe and, therefore, the tribe would have ample opportunity to discuss cultural and archeological concerns with WS-Nevada. In addition, in consideration of Nevada’s Native American tribes, WS-Nevada has reached out to all federally-recognized tribes in Nevada to solicit their comments on this EA.

1.10.3.7 *Fish and Wildlife Act of 1956 Section 742j-1 – Airborne Hunting*

The USFWS has delegated permitting of aerial shooting to the state of Nevada (NDOW)[16. U.S. Code §742j-1 (b)(2.)]. WS-Nevada does not need to obtain a state permit from them because the APHIS-WS program is specifically exempted from this act. Other commercial, private, and lower governmental entities must obtain a permit from NDOW for use of aerial operations for predator removals (Section 1.7).

1.10.3.8 *Executive Order 12898 “Environmental Justice”*

WS-Nevada personnel use damage management methods as selectively and environmentally conscientiously as possible. All chemicals used by WS-Nevada are regulated by the EPA through FIFRA, NDA, by MOUs with Federal land managing agencies, and by APHIS-WS Directives. Based on a risk assessment conducted in Section 3.10 of this EA, APHIS-WS concluded that when APHIS-WS program chemicals are used following label directions, they are highly selective to target individuals or populations, and such use has negligible impacts on the environment. The WS-Nevada operational program properly disposes of any excess solid or hazardous waste and has been found to manage its chemicals appropriately (OIG Report 2015); Section 3.3.2, 3.10. It is not anticipated that the proposed action would result in any adverse or disproportionate environmental impacts to minority and low-income persons or populations.

1.10.3.9 *Executive Order 13045 "Protection of Children"*

Children may suffer disproportionately from environmental health and safety risks, including their developmental physical and mental status, for many reasons. APHIS-WS policy is to identify and assess environmental health and safety risks and avoid or reduce them, and WS-Nevada has considered the impacts that alternatives analyzed in this EA might have on children. All WS-Nevada 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. See Appendix A for a detailed description of all damage management methodologies included in the WS-Nevada activities and Section 3.10 for an analysis of their impacts.

1.10.3.10 *The Wilderness Act*

The Wilderness Act of 1964 established the National Wilderness Preservation System to be managed by the U.S. Forest Service, National Park Service, and U.S. Fish and Wildlife Service. In 1976, with the passage of the Federal land Policy and management Act (FLPMA), Congress made the Bureau of Land Management (BLM) the 4th agency with wilderness management authority under the Wilderness Act. The primary mandate of the Wilderness Act for the administering agencies is to preserve the wilderness character of the area. Wilderness character is composed of 4 mandatory qualities and a 5th, optional, quality:

<u>Untrammeled</u>: wilderness is essentially unhindered and free from modern human control or manipulation

<u>Natural</u>: wilderness ecological systems should be as free as possible from the effects of modern civilization

<u>Undeveloped</u>: wilderness is an area "of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation," "where man himself is a visitor who does not remain," and "with the imprint of man's work substantially unnoticeable."

<u>Solitude or Primitive and Unconfined Recreation</u>: wilderness provides opportunities for people to experience: natural sights and sounds; remote, isolated, unfrequented, or secluded places; and freedom, risk, and the physical and emotional challenges of self-discovery and self-reliance

<u>Unique, Supplemental, or Other Features</u> (optional quality): a wilderness area "may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value" that, when they are present, are part of that area's wilderness character and must be protected as such

Section 4(c) of the Wilderness Act lists uses and activities that are specifically prohibited in WAs. These include: commercial enterprise, permanent roads, temporary roads, motor vehicles, motorized equipment, motorboats, landing of aircraft, mechanical transport, structures, and installations. Special provisions under Section 4(d) of the Wilderness Act allow for very limited exceptions to the prohibitions for valid existing rights, requirements of other legislation, and actions "necessary to meet minimum requirements for the administration of the area for the purpose of the Wilderness Act."

The Wilderness Act does not affect the jurisdiction or responsibilities of the States with respect to wildlife and fish. Some portions of WAs in Nevada have historic grazing allotments, and WS-Nevada may conduct limited protection of livestock, as well as damage management and threats to human health or safety in compliance with federal and Nevada laws. WS-Nevada only provides assistance to requesting entities in designated WAs when allowed under the provisions of the specific wilderness legislation, in accordance with annual work plans, and as specified in MOUs between APHIS-WS and the land management agencies.

The Wilderness Act does not prohibit PDM within designated WAs. The Forest Service and BLM may approve wildlife damage management in designated wilderness (USFS Manual 2323 (Appendix I) and BLM Manual 6340 (BLM 2012b)). With certain exceptions, the Act prohibits using motorized equipment and motorized vehicles such as ATVs and landing of aircraft. WS-Nevada works closely with the BLM and Forest Service in cooperatively implementing their respective interagency MOUs for operations in WAs (Section 1.11.7.1).

See Section 3.11 for evaluation of impacts in WAs and WSAs.

1.10.3.11 *The Federal Land Policy Management Act (Relating to WSAs)*

The Federal Land Policy and Management Act of 1976 (FLPMA) declared that public lands be retained in federal ownership and enacted a multiple-use management mandate for the Bureau of Land Management (BLM) in its implementation of policy. Wilderness preservation is part of the BLM's multiple-use mandate, and the wilderness resource is recognized as one of the array of resource values considered in the land-use planning process. Section 603(c) of FLPMA directed the BLM to inventory all public land for roadless areas of 5,000 acres or more having wilderness characteristics and report to the President and to Congress the suitability or non-suitability of each identified area for preservation as wilderness. These areas are called Wilderness Study Areas (WSA).

Based on public lands inventory, areas meeting the criteria to be identified as WSAs were reported in 1980. In Nevada, 110 WSAs were identified, covering 5.1 million acres. From 1980 to 1991, the BLM studied these WSAs for their suitability or non-suitability for preservation as wilderness, weighing wilderness values against other potential land uses, in order to report the findings to the President and Congress. All WSAs, regardless of their suitability recommendation, possess wilderness characteristics and therefore satisfy the standards for designation as wilderness. Once the WSA suitability recommendations were reported to Congress in 1993, it became the responsibility of Congress to either designate the WSAs as WAs or to release them to other uses.

The BLM is mandated by FLPMA to manage all WSAs, regardless of the suitability recommendations, so as not to impair their suitability for preservation as wilderness. The

BLM developed a non-impairment standard to meet this mandate, including the following criteria: any new use or facility is temporary and will not create any new surface disturbance. Note that a "new" use or facility is one that is proposed or implemented at any date after the passage of FLPMA. There are 7 classes of allowable exceptions to the non-impairment standard, including emergencies, public safety, restoration of impacts from violations and emergencies, valid existing rights, grandfathered uses, actions to protect or enhance wilderness characteristics or values, and other legal requirements.

Portions of BLM WSAs were transferred to the management of the U.S. Forest Service (USFS) in 1988 by the National Forest and Public Lands Nevada Enhancement Act. WSAs in Nevada now managed by the USFS include Mount Stirling WSA in southern Nevada and Antelope Range, Fandango, and Morey Peak WSAs in central Nevada. WSA management for both the BLM and the USFS is guided by BLM Manual 6330 (BLM 2012a).

FLPMA does not prohibit PDM activities within WSAs, although some limitations relating to the BLM's non-impairment mandate may apply to certain PDM actions. See Section 3.11 for evaluation of impacts in WAs and WSAs.

1.10.3.12 *Federal Laws, BLM and USFS Policies and Processes Govern PDM in WAs and WSAs*

The Wilderness Act and FLPMA authorize the creation of WAs and WSAs. Guidance on managing these lands is provided in policy manuals specific to each wilderness administering agency. For WAs, BLM Manual 6340 and USFS Forest Service Manual (FSM) 2300 provide guidance for activities on those agencies respective WAs. With regard to WSAs, BLM Manual 6330 provides both the BLM and USFS with guidance for managing WSAs. Portions of BLM Manuals 6340, 6330, and FSM 2300 specific to PDM in WAs and WSAs are included below.

<u>Wilderness Area Guidance</u>

BLM Manual 6340, section "1.6. Wildlife Damage Control" of the states:

> *Wildlife damage control in wilderness may be necessary to conserve Federally listed threatened, endangered species, or candidate species, to prevent transmission of diseases or parasites affecting wildlife and humans, or to prevent serious losses to livestock." Refer to MOUs between the Animal and Plant Health Inspection Service (APHIS) and the Federal administering agencies regarding permissible action in wilderness. Proposals that would involve uses generally prohibited under Section 4 (c) of the Wilderness Act will be considered and may be authorized by the Federal administering agency through the MRDG[3]. The BLM should consider the following when reviewing wildlife damage control actions within wilderness areas:*

[3] The MRDG is occasionally updated by the Arthur Carhart National Wilderness, an interagency center that helps to provide consistency across the four federal agencies that manage Congressionally-designated wilderness. The most current version of the document is located on Wilderness.net, under the Management Tools menu and Minimum Requirements Analysis sub-menu.

A. Control measures should be implemented by the Animal and Plant Health Inspection Service, the BLM, the State fish and wildlife agency, or other approved State agency, pursuant to cooperative agreements or memoranda of understanding.

B. Control measures should be directed at the individual animals causing the problem.

C. Acceptable control measures include lethal and nonlethal methods. Criteria for choosing a particular method include need, location, environmental conditions, the preservation of wilderness character, and applicable federal and state laws. Only the minimum amount of control necessary to solve the problem should be used.

D. Wildlife may be killed, hunted, or otherwise controlled if necessary to protect federally listed threatened or endangered species, to prevent transmission of diseases or parasites affecting humans, or to prevent transmission of diseases or parasites affecting other wildlife.

E. Wildlife may be killed, hunted, or otherwise controlled if necessary to prevent serious losses of domestic livestock. In such cases, control must be directed only at the individual animals causing the problem.

F. Killing, hunting, or otherwise controlling nonnative species also may be necessary to reduce conflicts with native species. Killing, hunting, or otherwise controlling native species, including those reintroduced, to reduce conflicts with other native species (other than covered under sub-section viii.E, above) is not permitted, unless mutually agreed upon between the State agency and the BLM, and is consistent with preservation of wilderness character.

G. Nonnative, domestic, and feral animals maybe killed, hunted, or otherwise controlled by Federal and State agencies to protect wilderness character.

H. Poisons should be used only where other measures are not practicable, subject to additional restrictions:

I. Use only registered pesticides according to label directions and applied only by certified pesticide applicators.

II. In selecting pesticides, give preference to those that will have the least impact on non-target species and on the wilderness environment.

III. Place temporary warning signs at the entrance to the area where pesticides are being used to warn the public of any dangers to themselves or their pets. Maps that adequately indicate where the pesticides will be placed should be posted at access points, and made available to the public in the local office and through local public media outlets.

USFS FSM 2300 section "FSM 2323.33c-Predator control" states:

Predacious mammals and birds play a critical role in maintaining the integrity of natural ecosystems. Consider the benefits of a predator species in the ecosystem before approving control actions. The Regional Forester may approve predator control programs on a case-by-case basis where control is necessary to protect federally listed threatened or endangered species, to protect public health and safety, or to prevent serious losses of *domestic livestock. Focus control methods on offending individuals and under conditions that ensure minimum disturbance to the wilderness resource and visitors. Poison baits or cyanide guns are not acceptable. Poison bait collars may be approved.*

The U.S. Fish and Wildlife Service (sic[4]) *or approved State agencies shall carry out control programs. The Forest Service is responsible for determining the need for control, the methods to be used, and approving all proposed predator damage control programs in wilderness (FSM 2650).*

Only approve control projects when strong evidence exists that removing the offending individual(s) will not diminish the wilderness values of the area.

FSM 2323.33d-Other Wildlife Damage Control states: "*The Regional Forester may approve other wildlife damage control projects on a case-by-case basis if necessary to protect federally listed threatened or endangered species or for public health and safety.*".

FSM 2323.36-Disease Outbreaks states: "*The Forest Service, in cooperation with State and Federal public health authorities, may make special exceptions to policy and direction where necessary to control disease epidemics or other public health hazards in which wildlife or fish species are carriers. See FSM 2323.04 for approvals*."

Wilderness Study Area Guidance

Specific to PDM, BLM Manual 6330 (BLM 1988) (11.) Wildlife. (g.) Predator or other wildlife damage control" states:

i. Agency action---which will be coordinated with the U.S. Department of Agriculture's Animal and Plant Health Inspection Service-Wildlife Services---to control predators (or other native wildlife) in WSA should be undertaken only:

- *A. to prevent transmission of diseases or parasites affecting human health or safety;*
- *B. to prevent transmission of diseases or parasites affecting other native wildlife;*
- *C. to protect domestic livestock within the WSA; or*
- *D. to enhance recovery of federally listed threatened or endangered species.*

These actions may be taken by the U.S. Department of Agriculture's Animal and Plant Health Inspection Service-Wildlife Services, the BLM, or delegated to a State agency. See BLM Manual 6830---Animal Damage Control.

ii. Predator control activities must be directed at the specific offending animal or group of animals. Such activities should be carried out so as to minimize impacts to the wilderness characteristics of the WSA (including the natural interaction of native species).

iii. Nonnative, domestic, and feral animals maybe killed, hunted, or otherwise controlled by Federal and State agencies to protect wilderness character.

[4] Should be "APHIS-WS". Wildlife Services operated under the U.S. Fish and Wildlife Service prior to USDA-APHIS.

iv. Acceptable control measures include lethal and nonlethal methods. Criteria for choosing a particular method include need, location, environmental conditions, the preservation of wilderness characteristics, and applicable Federal and State laws. Use only the minimum amount of control necessary to solve the problem."

1.10.3.13 Congressional Grazing Guidelines (H. Rep. 96-617 and H. Rep. 101-405)

In 1980, Congressional guidance on grazing in wilderness areas was issued to address National Forest Administration policies and regulations that were discouraging or restricting grazing in wilderness. The guidelines, which have been re-issued most recently in 2002, state the following:

1. No curtailments of grazing in wilderness, where it existed prior to wilderness designation;
2. Improvements for grazing can be maintained, and where there is no other alternative, motorized equipment may be used;
3. Where it would impose unreasonable additional costs, replacement or reconstruction of improvements does not have to be done with natural materials;
4. Construction of new improvements or replacement of deteriorated facilities is permissible; and
5. The use of motorized equipment for emergency purposes, such as sick animal rescue or placement of feed in an emergency, but should not be abused.

1.10.4 *What Is the Environmental Baseline Used by WS-Nevada to Evaluate Significant Impacts?*

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 this baseline. In the context of ESA, the environmental baseline has been defined to include "the past and present impacts of all federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process" (50 CFR 402.02(d)). This definition is for the USFWS implementation of the ESA; however, the definition can serve as a useful reference for what might be considered as the environmental baseline.

The baseline appropriate for the analyses in this EA is not a "pristine" or "non-human-influenced" environment, but one that is already heavily influenced by human actions including WS-Nevada PDM which have been conducted in Nevada for decades, and PDM conducted by other federal, state, and local agencies, as well as individuals and other entities. Thus, the baseline impacts are those for Alternative 1, the No Action alternative, as described in Section 2.3.1. The analyses in Chapter 3 of this EA uses the best available information to determine the impacts of the proposed action and alternatives on the current environmental baseline.

1.11 What are the Needs for the WS-Nevada Predator Damage Management Program?

1.11.1 *What is the Need for WS-Nevada PDM Activities?*

Two independent government audits, one conducted at the request of Congress, the other based on complaints from the public and animal welfare groups to the US Department of Agriculture (Section 1.12.2), found that, despite cooperator implementation of non-lethal actions such as fencing and herding, a need exists for APHIS-WS' PDM activities. APHIS-WS management actions for predator damage was determined by these audits to be needed for protecting human safety and health; protection of crops and livestock; protection of other species, including threatened and endangered species, game and furbearer species, and recently reintroduced native species, as determined by the wildlife management agency; and protection of property and other assets.

As stated in Section 1.4.3, in some cases, cooperators likely tolerate some damage and loss until the damage reaches a threshold where the damage becomes an economic, physical, or emotional burden. The appropriate level of tolerance or threshold before using non-lethal and lethal methods differs among cooperators, their economic circumstances, and the extent, type, duration, and chronic nature of damage situations. The level of tolerance would be lower for situations in which human safety or the potential for disease transmission from wildlife to humans is at risk. For example, action must be taken immediately in the case of aircraft striking predators at an airport because it can lead to significant property damage and risks to passenger safety, or when a coyote acting aggressively in a residential area might be either habituated to humans or diseased. In cases where the affected entity is concerned with the threat of damage, the entity has often experienced damage in the past and it is reasonably foreseeable to assume that damage will occur again.

The point at which a particular entity affected by predator damage reaches their tolerance threshold and requests assistance is affected by many variable specific to the affected entity. Therefore, it is not possible to set a pre-determined threshold before a need for PDM is determined to exist.

WS-Nevada is not required to assess the economic value of a particular loss or threat of loss before taking a PDM action, and WS-Nevada responds regardless of the category of requestor. However, APHIS-WS does use a standard methodology for evaluating the value of a verified loss using national data and other factors, as well as economic values provided by the cooperator at the time of evaluation and service.

WS-Nevada recognizes that increasing numbers of people moving into rural areas or living in urban areas with increasing populations of wildlife are often unfamiliar with wildlife and may become anxious with wildlife encounters, especially encounters with predators. Therefore, WS-Nevada commonly provides technical assistance, including advice, training, and educational materials, to individuals, communities, and groups to better understand how to coexist with wildlife and reduce the potential for conflicts.

Whenever possible, WS-Nevada personnel recommend that cooperators take non-lethal action in lieu of or in addition to direct and sometimes lethal actions taken by WS-Nevada personnel. However, the appropriate strategy for a particular set of circumstances must be determined on a case-by-case basis, using the APHIS-WS Decision Model.

1.11.2 *What is the Need for IPDM to Protect Livestock in Nevada?*

Predators are responsible for preying upon a wide variety of livestock, including cattle, sheep, goats, swine, horses, and poultry. Sheep, goats, cattle (especially calves), and poultry are highly susceptible to predation throughout the year (Henne 1975, Nass 1977, Tigner and Larson 1977, Nass 1980, O'Gara et al. 1983, Bodenchuk et al. 2000). For example, cattle, calves, sheep, and goats are especially vulnerable to predation during calving, lambing, and kidding seasons in the late winter and spring (Sacks et al. 1999b, Bodenchuk et al. 2000, Shwiff and Bodenchuk 2004).

Not all producers suffer losses to predators; however, for those producers that do, those losses can be economically difficult and burdensome, and may cause small producers that are affected to experience years of negative profits (Fritts et al. 1992, Mack et al. 1992, Shelton 2004, Rashford et al. 2010). Losses are not evenly distributed among producers, and may be greater on some properties where predator territories overlap livestock occurrence and predators learn to deviate from their natural prey base to domestic livestock as an alternative food source (Shelton and Wade 1979, Shelton 2004). Therefore, predation can disproportionately affect certain properties and further increase a single producer's economic burden (Nass 1977, Howard and Shaw 1978, Nass 1980, O'Gara et al. 1983, Bodenchuk et al. 2000, Shelton 2004, Rashford et al. 2010). Shwiff and Bodenchuk (2004) state that profit margins in livestock production do not allow a 20% loss rate, and in the absence of PDM, such losses would likely result in the loss of the livestock enterprise. Without effective methods of reducing predation rates such as those used by APHIS-WS, economic losses due to predation continue to increase (Nass 1977, Howard and Shaw 1978, Nass 1980, O'Gara et al. 1983, Bodenchuk et al. 2000).

1.11.2.1 What is the Contribution of Livestock to Nevada's Economy?

Agriculture remains an important part of the Nevada economy. The states' farms combined covered nearly 40.5% of Nevada's total land area in 2012. "In 2015, 82.78% of Nevada's agriculture production was engaged in raising livestock, primarily cattle, sheep, hogs, goats and poultry. However, the economic contributions of agriculture extend well beyond the farm" (NDAa). Barbee (NDA 2017b) states:

> "*Nevada's agriculture production value is up 50 percent from $636 million in 2010 to $952 million in 2014. The top three commodities most responsible for this growth were cow/calf, milk and hay production. This is a significantly larger increase than United States agriculture production, which is up 37 percent from $344 billion in 2010 to $471 billion in 2014.*"

There are 70.7 million acres in Nevada, of which about 6 million acres (8.4%) hold 4,200 operating private farms and ranches. In 2015, ranching cattle and calves in Nevada made up almost 52% or $375.4 million of total cash receipts when compared to all other agricultural commodity sales in 2015 (NDA 2017a). In 2015, the Nevada cattle and calf inventory was 430,000 with an industry value of $748.2 million (NDA 2017a). From NDA

2017a, page 17, "*The total economic contribution of the cattle and calf industry on Nevada's economy was estimated at $642 million. This includes both direct and backward linked indirect economic activity resulting from the livestock industry. The total employment impact on the economy was 3,431 jobs with the total labor income impact of $125 million. The value added multiplier was 1.9, meaning that every dollar invested in Nevada's cattle and calf production industry production stimulates $0.90 in additional economic activity in the state. The employment multiplier was 2.2 so for every 10 jobs directly related, cattle and calf production industry supports an additional 12 jobs in the state.*"

Also for Nevada in 2015: all sheep and lamb inventory was 69,000 representing an inventory value of $18.078 million; wool production was 440,000 lbs., with a value of $924,000; hogs and pigs inventory was 1,000, representing an inventory value of $125,000 (NASS 2017). In addition, goats, poultry, rabbits, ratites and exotic livestock are produced in Nevada, but at lower levels.

Over 80 percent of the land area in Nevada is federally controlled public land. Much of this area is arid rangeland with limited potential for use. The grazing of range livestock has historically been and continues to be the most efficient means of harvesting rangeland grasses, a renewable resource. Cattle are the most common agricultural enterprise in Nevada and can be found on over half of the farms and ranches in the state. Sheep numbers have trended downward for several decades, but they remain a viable alternative on many ranges (NASS 2017).

Successful PDM includes focusing on effective methods and strategies to prevent losses from occurring by protecting the livestock at risk. It is much easier to assess the level of damage or loss once it occurs and much harder to measure the value of damage that is prevented by implementing preventive PDM. One way to assess the value of what is being protected is to measure the quantity of the resource with the direct market value of those resources. Nevada Department of Agriculture (NDA 2017a) reported estimates of livestock inventories in Nevada, including 430,000 head of cattle and calves and 69,000 head of sheep and lambs in 2015. Not all resource owners request assistance of WS-Nevada. However, WS-Nevada estimates that it in FY 2016 provided PDM activities that protected for an estimated 245,146 beef cattle and calves , worth approximately $429,650,344, and an estimated 287,732 sheep and lambs worth an approximately $34,459,726 (MIS 2017). The difference between the sheep/lamb inventory listed previously (69,000) and the MIS estimate of 287,732 is due to the NDA and the National Agricultural Statistics Service (NASS) not capturing the interstate sheep that come into Nevada from Idaho, Utah and California seasonally (M. Jensen and J. Bennett, pers. Comm. 03/22/2017).

The dollar value of damage documented by WS-Nevada that is caused by predators is often related to the number of requests for assistance received for a particular species. However, differences can be noted between predator species, primarily because larger species often cause much more damage with a higher value in one incident than species that are smaller. The monetary losses from livestock predation reflect losses that have occurred and that have been reported to or verified by WS-Nevada, but is not reflective of all livestock losses occurring in Nevada since not all livestock lost to predators are reported to WS-Nevada.

1.11.2.2 What Do Studies Say About the Numbers of Livestock Losses Due to Predators?

Livestock losses can come from a variety of sources, including disease, weather conditions, market price fluctuations, and predation. Producers routinely address disease concerns through responsive and preventive veterinary care and weather concerns through husbandry practices. Business practices address concerns with market fluctuations. These concerns must be dealt with by producers as part of their business operation. However, this EA addresses livestock losses through predation and in the context of APHIS-WS statutorily authorized activities and appropriations and, therefore, focuses on this issue.

Loss rates of different types of livestock in the presence and absence of PDM can vary widely. It is difficult to compare the findings of studies because of different study methodologies, locations, circumstances, survey methods, whether losses are reported or confirmed, varying degree of success in finding all animals depredated, and variables that cannot be controlled during the studies, such as weather and disease. However, these findings can be an indicator of levels of losses with and without PDM activities:

- Losses in the absence of direct PDM activities have been estimated to include:
  - Adult sheep ranged from 1.4% to 8.4%, lambs ranged from 6.3% to 29.3% (Shwiff and Bodenchuk 2004);
  - Adult doe goat losses were 49% and kids 64% (Guthrey and Beasom 1978);
  - Lambs ranged from 12% to 29% and ewes 1% to 8% when producers were compensated for losses in lieu of PDM (Knowlton et al. 1999);
  - Adult sheep 5.7% (range 1.4% to 8.1%), lambs 17.5% (range 6.3% to 29.3%), and calves (3%) (Bodenchuk et al. 2000);
  - Total sheep flock ranged from 3.8% in California to almost 100% of lambs in a South Texas study (Shelton and Wade 1979);
  - Adult sheep and lambs can range from 8.3% to 29.3%, respectively (Henne 1975, Munoz 1977, O'Gara et al. 1983);
  - Lambs could be as high as 22.3% (McConnell 1995).

- Losses with direct PDM activities in place:
  - Adult sheep 1.6%, lambs 6%, goats and kids 12%, and calves 0.8% (Bodenchuk et al. 2000);
  - Lambs 1% to 6% (Knowlton et al. 1999);
  - Lamb losses can be as low as 0.7% (Nass 1977, Tigner and Larson 1977, Howard and Shaw 1978, Wagner and Conover 1999, Houben et al. 2004);
  - Lamb loss proportion to coyote predation was reduced from 2.8% to less than 1% on grazing allotments in which coyotes were removed 3 to 6 months before summer sheep grazing (Wagner and Conover 1999);

- Adult sheep loss about 2%, 4.68% of the lambs, 0.05% of adult cattle, and 0.89% of the calves produced in Oregon (DeCalesta 1978).

1.11.2.3 What Are Livestock Losses to Predators Nationally?

NASS is the National Agricultural Statistics Survey section of the U.S. Department of Agriculture. It conducts the most comprehensive surveys of the status of agriculture in the United States. The results of NASS surveys used in this EA are those that are pertinent to Nevada, either nationally or statewide, and that are the most recent.

NASS conducted a survey in 2014 to determine livestock losses to predators nationally. This survey found that sheep and lamb losses due to predators represented 28% of the total loss of sheep and 36.4% for lambs from all types of mortality, accounting for 194,395 animals killed (a decrease since 2009), valued at $32.5 million. Of these losses to predators, 89.8% of them occurred from known predator species, whereas 9.2% occurred from unknown species (NAHMS 2015, (Table 1.4)). Predation on adult cattle in the 2015 survey was reported as 2.4% of all their losses and accounted for 41,700 animals, whereas predation on calves was 11.1% of the total mortality events, accounting for 238,900 calves (NAHMS 2017a).

Table 1-4. The Percentage of Total Losses Attributed to Specific Predator Species and the Associated Amount of Damage in Terms of Head of Cattle/Calves (NASS 2011) and Sheep/Lambs (NAHMS 2015) and Dollars Lost for each.

	% Total Predator Loss		Number of Head		Value ($)	
Predator Species	**Cattle/ Calves**	**Sheep/ Lambs**	**Cattle/ Calves**	**Sheep/ Lambs**	**Cattle/ Calves**	**Sheep/ Lambs**
Coyotes	53.1	60.7	116,700	118,032	48,185,000	19,581,181
Dogs	9.9	13.5	21,800	26,924	10,067,000	4,496,178
Mountain Lions/ Bobcats	8.6	7.1	18,900	13,814	9,221,000	1,205,497
Bears	1.3	3.7	2,800	7,108	1,415,000	1,205,497
Other[1]	27.1	14.7	59,700	28,517	29,587,000	4,984,893

[1] Includes livestock losses when predator species was unknown or unverified.

The losses reported above do not include the additional damage inflicted on 31,215 sheep and lambs injured but not killed, valued at $5.1 million. The combined losses occurred despite sheep operators increasing their utilization of non-lethal methods in 2014 (58% of sheep operations) as compared to 2004 (31.9%). Methods used consisted of guard animals (63.9%), fencing (54.8%), shed lambing (34.4%) and night penning (33.7%) (NAHMS 2015). Cattle injuries reported in 2015 reveal that there were 22,337 cattle, valued at $34,842,000, and 34,092 calves valued at $17,531,000 that were injured by predators but not killed (NAHMS 2017a). In 2004 (NASS 2005), sheep operators reported spending $9.8

million on non-lethal methods. Cattle operators spent $188.5 million on non-lethal methods such as guard animals (36.9%); exclusion fencing (32.8%); frequent checking (32.1%); and culling older livestock to reduce predation or other risks (28.9%) in 2010 (NASS 2011). The survey did not include information on any lethal management that might have been occurring simultaneously. Cattle operations reported in 2015 that use of non-lethal methods has increased six-fold from 3.1% in 2000 to 19% in 2015 (NAHMS 2017a).

1.11.2.4 Which Predators Prey the Most on Livestock?

Of the predators that kill livestock, coyotes are responsible for the highest percentage (Knowlton et al. 1999, Shelton 2004, NASS 2005, NASS 2006, NASS 2010, NASS 2011, NAHMS 2015). In a study of sheep predation on rangelands in Utah (Palmer et al. 2010), coyotes accounted for the majority of lamb losses at 67%, with fewer losses attributed to mountain lions (31%) and black bears (2%). Other predators that cause measurable predation on cattle, calves, sheep and lambs are black bear, mountain lion, red fox and feral or free-roaming dogs. While predation by black bears and mountain lions is not as frequent as coyote predation, the damage caused by these species can negatively impact producers (NASS 2005, 2009, 2010; ODFW 2006, NAHMS 2015, MIS 2017).

Although, in general, mountain lion predation is lower than that of coyotes, mountain lions can occasionally be responsible for large sheep and lamb loss events, sometimes called "*surplus killing*." This occurs when a single predator, for unknown reasons, only consumes selected tissues or parts of many animals or the carcasses are not fed on at all (Shaw 1987).

Mountain lions, or other predators, may also frighten an entire flock of sheep as they attack, resulting in a mass stampede, which sometimes results in many animals suffocating as they pile up on top of each other in a confined area, such as along the bottom of a drainage or in corrals. In one case in Oregon, a confirmed coyote(s) attack on a sheep flock caused a mass stampede of a flock of sheep, which broke through a fence where they then dispersed onto the adjacent railroad track. Subsequently, 117 sheep were killed and 25 injured by a train collision before the flock was corralled back into the pasture. The incident resulted in a loss of $43,450 (MIS 2009).

1.11.2.5 What are Livestock Losses to Predators in Nevada?

WS-Nevada responds to requests from resource owners that had or are experiencing some type of conflict with a predator. Damage reported to WS-Nevada, by resource owners, such as predation or injury to livestock, is recorded in the APHIS-WS MIS database as "reported" damage. If WS-Nevada employees are able to verify that the damage occurred, it is recorded in MIS as "verified" damage, defined as resource or production losses examined by a WS-Nevada employee during a site visit and determined to have been caused by a specific predator species. For more details on methods of field evaluation by WS-Nevada personnel, see Section 2.3.1.2.

Damage and the associated estimated monetary values reported to or verified by WS-Nevada personnel varies annually due to changes in the number of requests for assistance, the value of the resource being damaged, and fluctuation of both livestock and predator populations. The monetary losses from livestock predation reflect only losses have been reported to or verified by WS-Nevada. Damage figures presented do not encompass all livestock losses occurring in Nevada since not all livestock lost to predators are reported to WS-Nevada. Nevada livestock producers reported to WS-Nevada losses of 8,353 head of livestock valued at $1,310,147 during FY 2012 to 2016 (MIS 2017). According to WS-Nevada MIS data for FY 2012 to 2016 coyotes and mountain lions inflicted the most damage in value ($1,161,276), with greater than 84% of the losses attributed to coyotes, and most of the remainder attributed to mountain lions (coyotes and mountain lions comprising more than 92% of the verified and confirmed losses in value). Common raven damage was also significant, inflicting over 4% in livestock loss, with corresponding loss value of just over 8%. WS-Nevada verified approximately 55% of all the losses reported to WS-Nevada.

Using a more recent national NASS survey (2011), predators killed 500 cattle and 2,300 calves in Nevada, valued at $485,000 and $849,000, respectively. USDA (2015) reports that 2,933 sheep (5.8% of inventory) and 9,285 (19.8% of inventory) lambs were killed by predators in Nevada in 2014, with the value of $711,000 and $1,213,000, respectively. Goat and kid losses to predators in Nevada (as reported to WS-Nevada) have averaged approximately 46 per year (mostly to coyotes), an average estimated loss of $9,632 per year (MIS 2017).

A summary of the predator species responsible for loss of livestock in Nevada as reported by NASS and NAHMS is in Table 1.5 and number and value by predator and type of livestock is summarized in Table 1.6.

Table 1-5. The Proportion of Total Predator Loss and Number of Head of Cattle, Calf, Sheep and Lamb Losses in Nevada Attributed to a Particular Predator Species (NASS 2011, NAHMS 2015)[1].

Predator Species	% Cattle loss	% Calf loss	% Sheep loss	% Lamb loss
Coyotes	4.7	61.8	71.7	57.8
Mountain lions/ Bobcats	17.3[1]	2.4[1]	25.6	21.7
Bears	-	0.1	2	6.8
Dogs	-	1.7	-	.8
Common ravens	-	-	0.7	12.2
Other/Bobcats	-	3.6	-	0.7
Unknown	78	30.4	-	-
Total	500	2,300	2,933	9,286

"-"Represents 0 or less than 0.1%

[1] For cattle and calves, loss to mountain lions and bobcats was combined (NASS 2011).
[2]For cattle and calves, loss to "Other"; for sheep and lambs, loss to "Bobcats".

Table 1-6. Head of Livestock Depredated or Injured by Predators Reported to or Verified by WS-Nevada and the Estimated Combined Total Value[1] for FY 2012-FY 2016.

	Livestock Resource											
	Sheep		Cattle		Equine		Goats		Others		Total	
Species	#	Value	#	Value	#	Value	#	Value	#	Value	#	Value
Badger	0	0	0	0	0	0	0	0	0	0	0	0
Black Bear	21	$2,766	3	$2,356	0	0	0	0	0	0	24	$5,122
Bobcat	79	$9,325	0	0	0	0	17	$3,578	83	$1,423	179	$14,326
Common raven	227	$29,092	118	$77,967	0	0	17	$2,127	0	0	362	$107,336
Coyote	5,574	$755,730	352	$231,070	0	0	180	$38,164	929	$16,449	7,035	$1,037,531
Feral Cat	0	0	0	0	0	0	0	0	0	0	0	0
Feral Dog	25	$4,535	4	$2,900	8	$7,871	0	0	6	$104	43	$15,410
Gray Fox	0	0	0	0	0	0	0	0	0	0	0	0
Kit Fox	0	0	0	0	0	0	0	0	0	0	0	0
Mountain Lion	606	$97,937	20	$11,989	5	$8,814	14	$4,290	33	$715	678	$123,745
Raccoon	0	0	0	0	0	0	0	0	18	$150	18	$150
Red Fox	0	0	0	0	0	0	0	0	19	$380	19	$380
Spotted Skunk	0	0	0	0	0	0	0	0	0	0	0	0
Striped Skunk	0	0	0	0	0	0	0	0	21	$331	21	$331
Total	6,532	$899,469	497	$326,282	13	$16,685	228	$48,159	1,083	$19,552	8,353	$1,310,147

[1] Dollar values are based on nationally calculated averages or are reported by the producer (MIS 2017).

1.11.2.6 What are livestock producers doing to prevent predation?

The National Agricultural Statistics Service (1998) statewide damage survey results identified that, of those that reported, wildlife damage prevention expenses exceeded $6 million in 1997, with $1.3 million of the total costs specific to protecting all livestock species. More operations used nonlethal methods in 2014 (58%) than in 2004 (31.9%) (NAHMS 2015). Preventive measures used included fencing, hazing, guarding, and other methods (NASS 1998). Table 1.6 shows the percentage of producers surveyed that used non-lethal strategies to prevent losses of cattle, calves, (NASS 2011) and sheep (NAHMS 2015) from predators in Nevada. Culling refers to the removal of older and more vulnerable livestock from the inventory.

Additionally, livestock producers have learned that limiting their lambing/calving period to a short period of time and congregating the birthing animals into a relatively small area reduces the extent of damage that predators such as coyotes, wolves, bobcats and mountain lions will cause as compared to extended birthing time periods or spreading them over a wide geographic area. Grouping the vulnerable animals together, both in time and space, reduces the degree of exposure of each individual. Unfortunately, while this practice protects the calves from predators such as coyotes, it increases the attractiveness of the site to predators such as common ravens. Common ravens will attack young lambs, calves, and goats, and even adult ewes, nannies, and cattle in certain situations, by pecking the eyes and other vulnerable spots, such as the anal area, nose, and navel (Larsen and Dietrich 1970, Wade and Bowns, 1982). They can kill young animals by pecking out the eyes or umbilical cord which results in the animal going into shock and dying. Unfortunately, the strategy which helps to protect the young livestock from canid predation makes them vulnerable to corvid predation.

In 2015, 93% of goat ranching operations (nationally) used some kind of nonlethal method to control predators (NAHMS 2017b). Fencing and guard dogs were used the most (44.5 and 33 percent of the respondents, respectively). Operations spent an average of $1,085 on nonlethal predator control methods and $444 on lethal methods. Only 2.3% of goat ranchers requested help from state or federal government trappers for lethal control.

Table 1-7. Percentage of Nevada Livestock Operations Utilizing a Specific Non-lethal method for Protection of Cattle & Calves or Sheep[1].

Non-lethal Method	Cattle and Calves (%)	Sheep (%)
Guard animals for "Cattle and Calves"; Guard dogs for "Sheep"	58.1	29.5
Exclusion fencing	-	60
Frequent checks	36.2	14.8
Carcass removal	17.1	13.4
Culling	23.3	14.8
Night penning	-	58.7
Herding	-	29.3
Fright/harassment tactics	-	2.7
Shed lambing	-	27.1
Llamas	-	2.7
Changing bedding	-	9.8
Donkeys	-	22.3
Other	-	2.7

"-" Represents zero or less than 0.1 percent.

[1]Producers can use more than one non-lethal method simultaneously, so the columns will not total 100% (NASS 2005, 2011, NAHMS 2015).

WS-Nevada is typically contacted by landowners who have attempted several non-lethal strategies on their own. On average, producers report having tried 5 non-lethal methods before contacting WS-Nevada [J. Bennett, Pers Comm. 03/21/2017]. After receiving a request for assistance, WS-Nevada assesses the situation to determine if the non-lethal methods previously conducted by the landowner were appropriate and carried out correctly, given the circumstances. There are cases where the non-lethal methods may be more successful when applied in a different manner, saving landowner and agency resources which provides financial incentive to use the non-lethal methods. Additional non-lethal methods may be recommended and or implemented by WS-Nevada if deemed potentially effective by field personnel; often, however, resolution of the conflict requires supplemental lethal control, particularly when lambing or calving.

Appendix A provides more detail on both non-lethal and lethal PDM methods. Appendix B (Producer Implemented Nonlethal methods used in Nevada) provides more detail of non-lethal methods that livestock producers employ in Nevada.

1.11.2.7 How Many Requests for Assistance Occur in Nevada?

Requests for assistance are an indication of the level of need for PDM work to be conducted by WS-Nevada, but these requests likely represent only a portion of the actual need. For example, Connolly (1992) determined that only a fraction of the total predation attributable to coyotes was reported to or verified by APHIS-WS nationally. Connolly (1992) also stated that, based on scientific studies and livestock loss surveys generated by NASS, APHIS-WS only confirms about 19% of the total adult sheep and 23% of the lambs actually killed by predators.

WS-Nevada personnel record their responses to requests for assistance in the APHIS-WS MIS database. Each response is recorded as a Work Task, documenting the species and resource(s) that are in conflict. A work task is defined as a single visit to a property or contact by WS-Nevada personnel to provide technical assistance, to conduct a wildlife damage field evaluation/assessment/investigation, or to continue work on a PDM activity/project in progress. The number of work tasks serves as an index of the intensity of effort needed by WS-Nevada personnel to address incidents involving the species in question. Reports of these conflicts do not represent the number of individual landowner requests for service, but rather the number of responses by WS-Nevada for those types of resource/species combinations. This information can describe the frequency of responses to requests for assistance.

At the time of providing a response to an individual request for service, WS-Nevada may provide a requester with information, demonstrations, recommendations for strategies that the landowner may implement (technical assistance), and/or direct assistance in which the WS-Nevada employee takes direct action to address the predator situation. As an individual situation may involve one or more predators causing damage to more than on resource, the conflict data recorded for the field visit cannot be used to determine the number of unique requests for assistance for each predator and/or livestock animal.

The average number of work tasks WS-Nevada recorded for the species in this EA per year is 19,878 responses for FY2012 through FY 2016 (MIS 2017). Out of the total number of work tasks completed subsequent to a request for assistance with predator damage to livestock comprises 89.8% or an average of 17,851 work tasks. Of all the resources categorized as “livestock”, lambs, calves, and sheep are the resources most frequently in conflict with predators, at 40.5%, 34.9%, and 20.4% respectively. Nearly 87% of the conflicts with livestock were associated with damage or threat of damage from coyotes, with other predators contributing a smaller proportion each (Table 1.8).

Table 1-8. Total Count of Work Tasks for PDM for Livestock by Predator Species Recorded by WS-Nevada, FY 2012-FY 2016 (MIS 2017).

Species	Livestock	Proportion(%) of Work Tasks
Coyote	77,635	87
Black Bear	793	0.9
Striped Skunk	537	0.6
Raccoon	962	1.1
Lion	728	0.8
Red Fox	6312	7.1
Bobcat	256	0.3
Badger	282	0.3
Common raven	1425	1.6
Feral Cat	45	<1
Feral Dog	281	0.3
Total	89,256	100

1.11.2.8 How Does WS-Nevada Cooperate with NDOW in Managing Mountain Lion and Black Bear Damage to Livestock?

WS-Nevada cooperatively works with NDOW and/or private individuals to assist them in managing damage, threats, or complaints for mountain lions and black bears when requested. Control efforts are closely associated with individual damage complaints, and are designed to take only the animal creating the damage situation as per NDOW/APHIS-WS MOU. From NDOW/APHIS-WS MOU, Article 6,

> *"APHIS-WS agrees to notify the appropriate NDOW regional supervising biologist, supervising game warden, or NDOW dispatch within 24 hours (or as soon as practical) of taking a depredating mountain lion. APHIS-WS agrees to provide the date the complaint was received, the date the depredation event was confirmed, the date pursuit of the depredating mountain lion started, and the date pursuit ended. APHIS-WS agrees to provide the GPS coordinate of the taken depredating mountain lion. APHIS-WS agrees to report the sex, estimated age, and estimated weight of the depredating mountain lion. If APHIS-WS confirms a depredation but the remaining livestock have left the area, APHIS-WS agrees not to pursue the offending mountain lion. If foothold traps, foot snares, or cage traps are necessary to take a depredating mountain lion, APHIS-WS or their designee agrees to check the equipment at least every 96 hours or sooner as deemed*

necessary by APHIS-WS. Neck snares will be checked according to APHIS-WS policy and applicable state law.

Unless public safety is in imminent danger, APHIS-WS agrees to consult with the appropriate NDOW regional supervising biologist, supervising game warden, or their designee and obtain approval before APHIS-WS takes a depredating black bear. APHIS-WS agrees to provide the date the complaint was received, the date the depredation event was confirmed, the date pursuit of the depredating black bear started, and the date pursuit ended. APHIS-WS agrees to provide the GPS coordinate of the taken depredating black bear. APHIS-WS agrees to report the sex, estimated age, and estimated weight of the depredating black bear. If APHIS-WS confirms a depredation but the remaining livestock have left the area, APHIS-WS agrees not to pursue the offending black bear. If culvert traps, cage traps, foot or neck snares are necessary to take a depredating black bear, APHIS- WS or their designee agrees to check all equipment set for black bears every 24 hours.

All mountain lions, bobcats, and black bears taken pursuant to this MOU are the property of the State of Nevada. The head and complete hide (including the feet, claws and skull) will be salvaged and submitted to NDOW within 96 hours, (or as soon as possible), properly labeled with the location of take, sex, date taken, and the name of the person taking the animal. If the animal is not salvageable or retrievable, a GPS coordinate and a written report will suffice. APHIS-WS agrees to record and submit other pertinent biological data regarding these species as requested on forms provided by NDOW.

When public safety is in imminent danger, mountain lion, coyote, bobcat, and black bear may be killed when warranted. APHIS-WS shall notify NDOW immediately of any incident of a wildlife attack on a human and preserve the scene and offending animal if taken for NDOW to investigate as per NDOW Wildlife Attack Policy.

APHIS-WS agrees to make every reasonable effort to take the specific animal that is depredating or about to depredate. APHIS-WS agrees not to arbitrarily take wildlife in an area or "pre-cull" non- depredating big game carnivores, unless requested by NDOW.

APHIS-WS agrees to make every reasonable effort to reduce non-target take of wildlife and that all non-target wildlife taken, other than unprotected wildlife, shall be reported to NDOW within 10 working days or as soon as practical. Non-target wildlife will be disposed of as directed by APHIS- WS policy or as requested by NDOW. Upon notification,NDOW may request APHIS-WS modify the method of take to prevent further loss of non-target wildlife.

APHIS-WS agrees to not use any wildlife taken for personal or commercial *purposes.*

APHIS-WS agrees to use M-44 devices in accordance with APHIS-WS policy and US-EPA guidelines. Upon request by NDOW, APHIS-WS agrees to provide information describing the locations where M-44 devices are presently deployed or are scheduled to be deployed provided this information does not violate The Privacy Act, FIFRA, or other regulations, as appropriate.

APHIS-WS agrees to clearly label all traps, snares, and/or other equipment set to capture wildlife as APHIS-WS property. APHIS-WS agrees not to set equipment within 30 feet of exposed bait (except when trapping depredating mountain lions) as per APHIS-WS policy. APHIS-WS agrees not to use game animals as bait, use traps with improper trap jaw spacing, or set foothold traps within 200 feet of a road as specified in State statute, unless trapping on fenced private property under agreement with APHIS-WS, or requested by NDOW.

APHIS-WS agrees to submit quarterly reports of the number of each species of wildlife killed, by county, to the NDOW Game Chief. Quarterly reports are due no later than the 10th day of the month following the end of each quarter. The fourth quarter report shall include an annual summary, and is due no later than January 10 of the following year."

As the mountain lion population has increased in Nevada and the human population expanded into rural and suburban areas, the potential for mountain lion-livestock conflicts has increased. Dispersing sub-adult mountain lions compete with mature and established adults and are frequently forced into areas occupied by people with livestock. The NDOW objective in areas where mountain lion-livestock conflicts occur is to "*reduce the economic impact of predation from mountain lion on domestic livestock, but it is recognized that some livestock loss will occur, particularly on public lands within the State*" (NDOW 1995).

NDOW receives numerous complaints from concerned citizens regarding mountain lion-livestock conflicts and sometimes bear-livestock conflicts (almost exclusively in Washoe, Lyon, Douglas and Carson City counties); these complaints are recorded in a log maintained by NDOW. Mountain lions rarely cause damage to land or crops; most public damage complaints occur when mountain lions take or attempt to take livestock. Many complaints are initially handled by NDOW using non-lethal technical assistance, and NDOW may handle the problem itself (mainly concerning bear complaints) or forward the complaint to WS-Nevada for direct action or to other NDOW agents. WS-Nevada can also receive requests for assistance directly from resource owners and directly provide services.

A complaint filed with NDOW or WS-Nevada can be for one or multiple mountain lions or bears that may be responsible for the damage of a particular resource or property. Therefore, the number of complaints recorded by either agency does not necessarily indicate how many predators were involved, but rather the frequency of damage occurrences in Nevada during a calendar year. Additionally, the number of complaints filed with NDOW differs from the number of work tasks recorded by WS-Nevada in the MIS database because the WS-Nevada data include both the initial and subsequent responses for those conflicts. Depredating animals may also be taken by property owners (operating under a depredation permit issued by NDOW), who must report and provide the take to NDOW. Therefore, it is not possible to know with certainty the total number of animals involved.

Table 1.9 displays the level of complaints reported to NDOW for mountain lions and black bears (P. Jackson, NDOW, Pers Comm., 09/06/2017 email). Note the difference in the number of reported black bear complaints by agency, indicating how little interaction WS-Nevada has with black bears. Black bear damage to livestock almost exclusively occurs in Carson City County and Lyon County and is minimal, over the last 5 FY's, bears have only caused $5,122 worth of damage (reported/verified), all to livestock (3 calves, 15 sheep, 6 lambs), averaging one black bear removed/year.

Table 1-9. Number of Mountain Lion and Black Bear Complaints Received by NDOW and WS-Nevada During CY 2012-2016. (Includes all Resources).

Calendar Year	# of Bear Complaints		# of Mountain Lion Complaints	
	NDOW	**WS-Nevada**	**NDOW**	**WS-Nevada**
2012	83	40	N/A	691
2013	97	1	N/A	680
2014	143	13	N/A	690
2015	122	1	3[1,2]	367
2016	N/A	1	42[2]	426

[1]Data recording began in November 2015 and covers November and December 2015 (P. Jackson NDOW 10/16/17 email).

[2]Data is as reported to NDOW Reno Office (NDOW Western Region) and Las Vegas Office (Southern Region) (P. Jackson NDOW 10/16/17 email).

1.11.2.9 What Proportion of WS-Nevada Livestock Conflict Work Occurs on Public and Private Lands?

Nevada comprises an estimated 70.7 million acres, with approximately 84% under the jurisdiction of federal agencies (BLM 63%, USFS 12.5%, other 8.5%). Private lands comprise approximately 12%, state lands approximately 0.4%, Tribal lands approximately 1.6%, and local and other lands approximately 2% (BLM, FS). In Nevada, predator conflicts specific to livestock occur mostly on BLM lands (52%), followed by private land (38.6%), USFS lands (9.3%), state lands (0.07%), and county or city lands (0.00%) (MIS 2017, Table 1.9). The primary livestock grazing use of these lands is for cow-calf production and production of range bands of sheep. Table 1.10 summarizes livestock losses by land classification.

Table 1-10. Average Number of Livestock Reported or Verified Lost due to Predators by Land Class in Nevada where WS-Nevada Conducts PDM (FY 2012-2016).

Land Class	Cattle	Sheep	Goats	Horses	Total
Private	65	451	37	2	555
USFS	0	133	0	0	133
BLM	28	719	>1	0	748
State	1	0	0	0	1
County/City	0	0	0	0	0
Total	94	1,303	37	2	1,437

The primary predators of concern on USFS and BLM land are coyotes and mountain lion (MIS 2017).

BLM lands in Nevada border private land, and work on one land class may actually benefit livestock on another land class, especially near the property lines. Because of the mobility and large home ranges of coyotes, mountain lions, and common ravens, it is often necessary to conduct PDM on private lands and on adjacent BLM and FS grazing allotments in order to provide adequate livestock protection.

The need to conduct PDM on public lands depends upon the type of livestock, time of year, and location where they are grazed. Public lands in Nevada are used extensively for grazing sheep, lambs, cows, and calves, and, therefore livestock losses are highest on those land classes as shown in Tables 1.11 and 1.12. All BLM Districts, except Carson City, and USFS lands showed substantial losses of sheep and lambs to coyote predation. Most BLM Districts showed losses of calves, though the USFS NFs did not. Losses of all livestock classes caused by predators were valued on average at $120,677 per year on BLM lands and at $21,247 per year on USFS lands during FY 2012-16 (Table 1.13 MIS 2017).

Table 1-11. Average Livestock Losses to Predators on Public Lands-BLM Districts FY 2012-2016 (Reported and Verified).

Livestock	Predator	Battle-Mountain	Carson-City	Eagle-Lake	Elko	Ely	Sur-prise	Winne-mucca
Sheep	Coyote	21	<1	0	23	64	1	31
	Mtn. lion	5	0	1	1	9	0	1
	Feral dog	0	0	0	0	2	0	0
	Bobcat	0	0	0	0	<1	0	0
	Common raven	0	0	0	0	<1	0	0
	Total	26	<1	1	24	76	1	32
	Value ($)	$4,749	$80	$153	$5,784	$17,372	$589	$5,187
Lambs	Coyote	91	2	74	49	91	71	133
	Mtn. lion	3	0	13	17	6	1	2
	Common raven	0	0	0	3	21	0	13
	Bobcat	0	0	0	<1	1	0	12
	Total	94	2	87	69	119	72	160
	Value ($)	$11,253	$190	$9,087	$11,173	$19,416	$7,773	$16,234
Calves	Coyote	1	<1	0	2	6	0	9
	Common raven	<1	<1	0	<1	4	1	0
	Mtn. lion	1	0	0	0	1	0	0
	B. bear	0	<1	0	0	0	0	0
	Total	2	<1	0	2	11	1	9
	Value ($)	$1,365	$471	$0	$1,542	$7,833	$471	$6,164
Goats, Kid	Coyote	0	0	0	0	<1	0	2
	Value ($)	$0	$0	$0	$0	$219	$0	$452
		0	0	0	0	0	0	0
Total Average Number Livestock Lost		122	3	88	95	206	74	203
Average Value of Livestock Lost ($)		$17,367	$741	$9,240	$18,499	$44,840	$8,833	$28,037

Table 1-12. Average Livestock Losses to Predators on Public Lands-National Forest Ranger Districts FY 2012-2016.

Livestock	Predator	Austin	Bridgeport	Ely	Mountain City	Ruby Mountains
Sheep	Coyote	<1	0	<1	1	1
	Mtn. lion	0	0	5	0	<1
	Total	<1	0	5	1	1
	Value ($)	$80	$0	$801	$340	$237
Lambs	Coyote	5	1	69	6	19
	Mtn. lion	<1	4	18	0	1
	Bobcat	0	0	1	0	0
	Total	5	5	88	6	20
	Value ($)	$654	$515	$13,545	$1,160	$3,916
Total Average Number of Livestock Lost		85	5	93	7	21
Total Average Value of Livestock Lost ($)		$734	$515	$14,346	$1,500	$4,153

Private lands are used much more as lambing and calving grounds and raising other types of livestock. Losses on private lands within and outside the BLM Lands reflect this and a wider variety of livestock losses (Tables 1.12 and 1.13). Total losses of all livestock classes caused by predators on private lands within Nevada BLM lands averaged 347 animals/year valued at $66,653/year, during FY 2012-2016 (MIS 2017). Total losses of all livestock classes caused by predators on all private lands in Nevada averaged 555 animals/year, which was valued at $108,215/year, during FY 2012-2016 (Table 1.14).

Table 1-13. Average Livestock Losses to Predators on Public Lands-BLM Districts FY 2012-2016 (Reported and Verified).

Livestock	Predator	Battle Mountain	Carson-City	Eagle-Lake	Elko	Ely	Sur-prise	Winne-mucca
Sheep	Coyote	21	<1	0	23	64	1	31
	Mtn. lion	5	0	1	1	9	0	1
	Feral Dog	0	0	0	0	2	0	0
	Bobcat	0	0	0	0	<1	0	0
	Common raven	0	0	0	0	<1	0	0
	Total	26	<1	1	24	76	1	32
	Value ($)	$4,749	$80	$153	$5,784	$17,372	$589	$5,187
Lambs	Coyote	91	2	74	49	91	71	133
	Mtn. lion	3	0	13	17	6	1	2
	Common raven	0	0	0	3	21	0	13
	Bobcat	0	0	0	<1	1	0	12
	Total	94	2	87	69	119	72	160
	Value ($)	$11,253	$190	$9,087	$11,173	$19,416	$7,773	$16,234
Calves	Coyote	1	<1	0	2	6	0	9
	Common raven	<1	<1	0	<1	4	1	0
	Mtn. lion	1	0	0	0	1	0	0
	B. bear	0	<1	0	0	0	0	0
	Total	2	<1	0	2	11	1	9
	Value ($)	$1,365	$471	$0	$1,542	$7,833	$471	$6,164
Goats, Kid	Coyote	0	0	0	0	<1	0	2
	Value ($)	$0	$0	$0	$0	$219	$0	$452
		0	0	0	0	0	0	0
Total Average Number Livestock Lost		122	3	88	95	206	74	203
Average Value of Livestock Lost ($)		$17,367	$741	$9,240	$18,499	$44,840	$8,833	$28,037

Private lands account for about 12% of the lands in Nevada, but averaged 43% of the total value of losses (Table 1.14). Conversely, non-private lands account for approximately 88% of the lands in Nevada and averaged 57% of total value of losses (Table 1.14). Losses for public and private lands are compared in Table 1.14. Production on private lands is higher per acre than on public lands primarily because private lands are generally of better quality for agricultural uses and have better access to water (ie. along river bottoms). Additionally, the available animal unit months (AUMs) on BLM and USFS allotments were reduced by 342,600 (about 20%) from 1980-1998 (Pearce et al. 1999) which has reduced the percentage of non-private lands needing PDM. Therefore, the percentage of losses is expected to be higher on private than non-private lands. Indeed, average value of losses averaged 6 times higher per acre under agreement on private lands than on non-private during FY 2012– FY 2016 (MIS 2017). Consequently, WS-Nevada spends more effort per acre on private lands than on non-private lands.

Table 1-14. Comparison of Livestock Losses on Public and Private Lands FY 2012-2016 (Reported and Verified).

Livestock	Predation	BLM Public Land	Forest Service Land	State Lands	Non Private Land Total	Private Land Total
Sheep	Total	153	8	0	**161**	**45**
	Value ($)	$32,048	$1,457	$0	**$33,505**	**$9,945**
Lambs	Total	566	125	0	**691**	**406**
	Value ($)	$69,883	$19,790	$0	**$89,673**	**$46,132**
Cattle	Total	0	0	0	**0**	**<1**
	Value ($)	$0	$0	$0	**$0**	**$500**
Calves	Total	29	0	<1	**29**	**65**
	Value ($)	$18,527	$0	$81	**$18,608**	**$42,914**
Goats, All	Total	<1	0	0	**<1**	**37**
	Value ($)	$219	$0	$0	**$219**	**$7,566**
Horses, All	Total	0	0	0	**0**	**2**
	Value ($)	$0	$0	$0	**$0**	**$1,158**
Average Loss Totaled		748	133	<1	**881**	**555**
Average Loss Value Totaled ($)		$120,677	$21,247	$81	**$142,005**	**$108,215**

1.11.2.10 What Diseases Do Predators Transmit to Livestock in Nevada?

In addition to direct livestock losses to predators through predation and injury, livestock can also be impacted by a number of diseases transmissible from predators. Not all of these pathogens have documented detections in Nevada predator populations. However, since these pathogens are known to circulate in predator populations outside of Nevada, it is possible that some pathogens may be undetected in Nevada predator populations or may be introduced to those populations in the future. Predator management can have an indirect effect by reducing the risk of livestock contracting a disease by minimizing the potential for livestock-predator interactions. Transmittable diseases include the rabies virus (raccoons, skunks, foxes, coyotes); leptospirosis (canines, raccoons); *Neospora caninum* (feral dogs, coyotes, and fox); and *Toxoplasma gondii* (domestic cats) (Adler et al. 2010, CDC 2011, McAllister 2014). WS-Nevada has not been requested to conduct PDM specifically for livestock disease control, but PDM activities for other reasons can indirectly assist disease control efforts.

1.11.3 *What is the Need for IPDM in Nevada for Protecting Agriculture Resources and Property Other Than Livestock?*

1.11.3.1 Background

As discussed previously, predators, as defined for this EA (Section 3.1), cause conflicts with livestock, comprising 80.6% of WS-Nevada's responses to conflicts (based on Work Tasks recorded). The remaining 19.4% of responses were for conflicts between predators and other agricultural resources (1.0% of total responses), human health and safety (5.8%), natural resource protection (9.6%) and property damage (3%). Direct or indirect damage to other agricultural commodities include aquaculture, fruit and nut crops, field crops, range and pasture, and commercial game animals. Field crops are damaged by coyotes, badgers, common ravens, skunks, and raccoons. Fruits and nut crops have been damaged by common ravens and raccoons. Aquaculture has also been damaged by raccoons. Commercial game animals have been damaged by coyotes, raccoons and feral dogs.

Predators such as foxes and badgers can burrow in improved or planted pasture, restricting the use of planting and mowing equipment or potentially damaging the equipment. Predators also damage buildings and structures (including homes, sheds, barns, coops, etc.), trying to gain access for food or other resources, and undermining the structure's foundation. Bears, coyotes, skunks, and badgers damage irrigation pipe systems by chewing on them. Skunks, raccoons, coyotes, and badgers destroy gardens, lawns, or turf farms. They live under homes, destroying insulation and other components and creating health concerns with feces. Common ravens cause damage to property in Nevada such as landfills and utilities (Sections 1.11.3.2 and 1.11.3.3).

Although damage to other agricultural resources and property has occurred and could continue to occur, damage or the threat of damage to those resources occurs less frequently in Nevada compared to damage to livestock. These types of damages comprise approximately 3.9% of WS-Nevada responses to damage or threats from the species discussed in this EA. Reported and verified damage recorded by WS-Nevada for other types of agricultural resources and property totaled $1,036,026 for FY 2012 through FY 2016, averaging $212,605 per year (MIS 2017).

1.11.3.2 How Do Common Ravens Cause Damage at Landfills?

Common ravens are a problem at landfills where they either obtain trash materials from uncovered garbage, or they have access to trash that has been uncovered by the activities of other species (e.g. dogs and coyotes digging up garbage). They can carry trash materials out of the landfill, resulting in risks to human health and safety in the area surrounding the landfill and fines regarding vector control. During FY 2012 – FY 2016, Nevada landfills averaged $7,800 in reported and verified losses to common ravens (machinery, abatement and fines) to WS-Nevada. Congregation of common ravens at landfills can result in accumulations of fecal matter on equipment and buildings, which is a health and safety risk to landfill personnel. Landfill operators fence their landfills to keep out coyotes and free-roaming dogs and make a continual effort to keep the trash covered by dirt. Covering the garbage with too little dirt does not sufficiently deter birds, however placing too much dirt reduces the life expectancy of the landfill. Although landfill operators make an attempt to keep the garbage covered, the continual delivery of garbage results in some access for the common ravens throughout the day. Additionally, common ravens loaf at landfills, swarming over the garbage as it is dumped. Harassment of the birds at this time can cause the common ravens to fly away from the landfill with the garbage to cache or feed on elsewhere (scattering the waste).

1.11.3.3 How Do Common Ravens Damage Utilities?

Common ravens increasingly cause damage to power distribution lines and equipment, causing outages and fires from nesting on power pole cross members and insulators despite installation of perch deterrents being added. Much of the affected power distribution systems deliver power to rural areas which includes hospitals. Although backup generators are in place, loss of power can lead to loss of life. The corresponding fires from common raven nesting also cause wildfires that threaten greater sage-grouse and other wildlife habitat, property and range, often in remote locations that take time to detect resulting in increased damage from delay in fire suppression responses. As an example of common raven damage for just one rural cooperative power company (covering Wendover, Carlin, and Wells, NV) in CY 2015, 560 hours were expended and 10,560 miles were driven by company personnel in inspecting and removing 294 nests from power structures to prevent arcing and corresponding fires/outages. This additional cost incurred from the common ravens resulted in $22,349 worth of extra human resource hours, $11,765 in replacement/repair to distribution transformers and one voltage regulator, cost of mileage @ $1.90/mile was $20,066, for a combined cost of $56,556 (M. Cromie pers. Comm. 2016).

1.11.4 *What is the Need in Nevada for Protection of Public Safety, Health, and Pets from Predators?*

1.11.4.1 What is the Potential for Risk to Human and Pet Health and Safety from Predators?

Human encroachment into wildlife habitat and wildlife encroaching into human residential and other human-altered areas, often in response to available food, including pets, increase the likelihood of human-wildlife interactions. Those species that people are likely to encounter are those most likely to adapt to and thrive in human-altered habitats due to the ready availability of food, water, and shelter inadvertently provided by residents. These habitat alterations may include landscaping vegetation, artificial pools, pet food, presence of pets (leashed or unleashed), garbage, piles of waste debris, and woodpiles, for example. Many people enjoy wildlife to the point of purchasing food specifically for feeding wildlife despite laws prohibiting this in Nevada.

NRS 501.382 makes it illegal to intentionally feed any big game animal (antelope, black bear, mule deer, mountain goat, mountain lion, Rocky Mountain Elk and certain subspecies of bighorn sheep) without the written authorization of the Nevada Department of Wildlife. The constant presence of human-created refuse, readily-available water supplies, and abundant prey populations found in areas of human development often increase the survival rates and biological carrying capacity of wildlife species that are adaptable to those habitats. Often the only limiting factor of some wildlife populations living near human development is disease, which readily spreads among concentrated populations of wildlife congregated into small areas capitalizing on the unlimited amount of food, water, and shelter found within those human-altered habitats (Section 1.11.4.8), and mortality due to collisions with vehicles on roadways.

As wildlife adapts to using human-altered habitats and societal views have led humans to ignore and in some ways encourage wildlife to live within our midst, many animals have lost their fear of people and become habituated to people, vehicles, and developed areas. With their natural fear of humans gone, some individual animals may exhibit bold and even dominant behavior toward humans. If people respond by backing away, the animal becomes further emboldened. Animal behavior may then either appear to be or actually become aggressive, with aggressive posturing, a general lack of caution toward people, and/or other abnormal behavior. In addition to habituation, disease may also cause these behaviors, resulting in calls for assistance. Overall, attacks by wildlife on people are very rare in Nevada and nationwide.

1.11.4.2 What is the Extent of Human-Coyote Interactions in Nevada?

Although wildlife attacking people occurs rarely, the number of attacks appears to be on the increase, especially near human residential areas. Timm and Baker (2007) defined a single “attack” as an incident in which physical contact between one or more humans occurred at a single location at a point in time. Their database found 111 incidents in California, occurring since 1961, resulting in injuries to 136 individuals (87 adults and 49 children). An additional 62 incidents involved coyotes aggressively approaching or stalking adults or children, in which no physical contact occurred.

Human-coyote conflict in urban environments with overly bold and aggressive behavior toward people and pets is on the increase in the U.S. (Breck et. al. 2017). Breck et al. (2017) conducted a study in urban Colorado focusing on reactive coyote management and found that alone, reactive nonlethal hazing as conducted in their study was ineffective in reducing human-coyote activity overlap, although reactive lethal removal of problem individuals was effective. When bold and aggressive behavior toward people manifests in social groups, attempts at returning the behavior back through reactive hazing, such as in the study, is most likely ineffective as the problem typically evolves over time through learned experiences with people. If the reactive corrective stimuli doesn't cause pain, then it is not likely perceived as a threat, successful resolution in that case would be reactive lethal removal of the problem coyote(s). Breck et al. (2017) concluded that a successful urban community human-coyote conflict management plan would include primarily a proactive non-lethal component with a lethal component for problem individuals. Bonnell and Breck (2017) found in their Colorado urban environ hazing study that coyotes were less likely to respond to hazing if the hazer was accompanied with a dog, but that a community-level hazing program can be an effective short-term tool. They also state that "We emphasize that there is no reliable evidence (i.e., peer-reviewed research) showing community-level hazing or other forms of hazing will train a problem coyote out of severe conflict behavior." Which is, again, the reason that lethal removal must always be reserved as a response in an effective urban coyote management plan.

Poessel et. al (2016) surveyed 105 urban areas in the U.S. regarding coyotes and conflicts and found: larger urban areas were more likely to have coyotes and conflicts; from a regional perspective, western region urban areas were more likely to have conflicts than other regions; cities with less forest and more development were more likely to have conflicts than other urban habitat groups; and landscape design and citizen education may reduce human-coyote conflicts.

Timm et al. (2004) reported that coyotes attacking people have increased in California, and further study by Timm and Baker (2007) found the problem possibly increasing in other states, including at least 76 attack incidents from 18 states outside of California and 17 attacks in four Canadian provinces. The study found that urban sprawl of residential developments has reduced the amount of buffer habitat between wildlands and suburban communities. Recent reductions in coyote control efforts due to public concern may have led to increased attacks on people by allowing for a larger coyote population size near suburban areas and by lessening coyotes' fear of humans which is normally reinforced by lethal control methods (Timm et al. 2004). In addition, coyote attacks on pets are apparently beginning or are occurring in increasing numbers of suburban areas throughout North America (Timm and Baker 2007).

Timm and Baker (2007) find that conflicts with coyotes occur when the animal has become habituated to the residential area, learning to tolerate at a distance, then becoming more "tame" through positive reinforcement such as availability of food, including through intentional feeding. Most often, habituation and subsequent problems arise because people attracted the coyote to the area by giving it access to food. After emboldened coyotes have become accustomed to a being provided with food, the abrupt remove of the food source may result in increased aggression or attacks on pets, children, and adults (Timm et al. 2004). While coyote attacks on humans are very rare in Nevada (e.g. NDOW confirmed that a lady was bitten on her side in Henderson while trying to protect her puppy from a group of 3 coyotes in July, 2017), NDOW receives many complaints from the public related to urban coyotes, many of which are due to misconceptions and fear of coyotes and not necessarily because of evidence of damage or attack (NDOW 2016b; Table 1.15).

Coyote attacks, including a fatal attack on a 19-year old woman in Nova Scotia (Canadian Broadcast Company 2009), have only heightened people's awareness of the potential threat of such encounters. In the Chicago metropolitan area, newspaper articles related to human-coyote conflicts have increased over twenty-fold since the 1990's (White and Gehrt 2009). In July 2015, 4 coyote attacks on children were reported in Irvine, California within a month (Heck 2015, CDFW 2015a). While bites or deaths caused by coyotes are generally reported by the media as 'attacks', White and Gehrt (2009) found that some reports of coyote scratches or neighborhood sightings have been reported as 'attacks.'

There are many preventive, non-lethal measures that the public can take to reduce the likelihood of conflicts with coyotes, including feeding pets inside, removing brush and wood piles, installing motion-activated lights, and keeping a close eye on children and pets (NDOW, undated). Additionally, NDOW recommends that dogs be kept on a leash and dog-walkers be cautious of coyote dens in the spring, when coyote mothers are territorial and protective of their young (NDOW, undated). Should a threatening encounter occur, making loud noises, stomping feet, waving arms, and throwing rocks at the animal are advised in order to scare away the coyote and reinforce a negative association with humans (NDOW, undated).

When non-lethal methods are not effective or human health and safety is at imminent risk, lethal methods may be needed. Coyotes are classified in the state of Nevada as unprotected mammals and therefore can be taken on private property by the landowner or landowner's agent (NAC 503.035, NAC 503.090 and NRS 502.010). However, methods for lethal take may be limited in urban areas pursuant to NAC 503.165, NRS 503.580 and county/local ordinances. NDOW, NSP, and WS-Nevada have authority to lethally remove coyotes within county and city limits (NRS 501.375 and exemptions provided in NRS 268.0035).

Timm et al. (2004) conducted a study on the best and most sustainable method to resolve issues with urban coyotes after several human-coyote conflicts were documented. The study concluded that the use of foothold traps to capture and euthanize a few coyotes is most effective (Timm et al. 2004). Prior to this study, traps were shown to be effective at removing coyotes from Glendale, California, shortly after a child was killed in his yard. Glendale city and Los Angeles county officials trapped 55 coyotes in an 80-day period from within one-half mile of the site of the attack, an unusually high number for such a small area (Howell 1982).

WS-Nevada assists residents (mostly urban) concerned about a predator's apparent loss of fear for humans, damage threats, or attacks on their pets or themselves or others. During CY 2012-2016, WS-Nevada responded to 643 conflicts (work tasks) with pets, 72.2% of which were related to coyotes, 12.1% to skunks, 7.6% to raccoons, 5.3% to lions, 1.2% to badgers, and 1.6% to bobcats, feral cats and red fox (MIS 2017).

Table 1-15. Coyote Complaints Recorded by NDOW and WS-Nevada CY 2012-2016.

	2012	2013	2014	2015	2016
Complaints Received by NDOW (Southern and Western Region) [1,2]					
Pets	N/A	N/A	N/A	3	61
Human Health/ Safety	N/A	N/A	N/A	8	71
Responses to Conflicts Received by WS-Nevada					
Pets	95	68	91	84	126
Human Health/ Safety	157	275	370	47	163

[1]Data recording began in November 2015 and covers November and December 2015 (P. Jackson NDOW 10/16/17 email).

[2]Data is as reported to NDOW Reno Office (NDOW Western Region) and Las Vegas Office (Southern Region) (P. Jackson NDOW 10/16/17 email).

1.11.4.3 *What is the Extent of Human-Black Bear Interactions in Nevada?*

At least 63 people have been killed by non-captive black bears between 1900 and 2009, mostly in Alaska and Canada (49 fatal encounters), with 14 fatal encounters in the lower 48 states. In 38% of the incidents, the presence of food or garbage probably influenced the black bear being in the location. Most fatal predatory incidents involved adults or subadult male black bears, indicating the female bears with young are not the most dangerous black bears (Herrero et al. 2011).

The following information is from the NDOW Black Bear Management Plan (NDOW 2012a).

> *"NDOW will use the most appropriate control measures to manage bear-human conflicts, utilizing non-lethal techniques and aversion conditioning, combined with on-site releases when possible. Translocation of nuisance bears will remain a management option when deemed appropriate (not a public safety threat).*

> *Black bears are omnivorous and often seek out the most readily available food resources, including human trash, pet food and fruit trees. This behavior frequently brings them into close proximity to humans. Efforts will be made through public education to reduce the availability of human caused attractants. Public education about the black bear in Nevada will be emphasized. The Department of Wildlife will assume a leadership role in furthering the public's understanding of this species.*
>
> *Black bears are also opportunistic predators and many occasionally kill domestic livestock, primarily sheep and goats. The Department of Wildlife will attempt to control or prevent damage to livestock and other personal property caused by black bears wherever possible. Although efforts will be made to reduce the economic impact of this predation, it is recognized that some loss will occur."*

Black bear damage to livestock is described in Section 1.11.2.5 and 1.11.2.8.

> *"Black bears are intelligent, curious and very powerful animals. They are also very tolerant of humans, and can adapt to human presence more so than many other species. Yet, at times, black bears can pose a legitimate threat to human safety. When considered by NDOW to pose a legitimate threat to human health and safety, they will be humanely killed. The Department will facilitate the necessary control measures in the most expedient manner."*

Black bears may easily adapt to living in close proximity to humans, especially with the presence of subsidized food, and may lose their fear of humans. The most effective method to eliminate conflicts with black bears is to remove the anthropomorphic attractants (Lackey et al. 2018). In Figure 1 (The Bear Behavioral Ladder of Progression (from Masterson (2016)) of Lackey et al. (2018) the authors explain how bears follow a predictable escalation of behavior that if unchanged may lead to anthropogenic mortality. Following the steps of the ladder: first rung-first food reward with no negative consequences; second rung-repeated food rewards with no negative consequences, bears tolerance of people increases; third rung-bear becomes bolder while searching for food; fourth rung-human habituation with human-food conditioning behavior increasing; final rung-bear enters homes and vehicles (cause for anthropogenic mortality). Most threatening conflicts with black bears in Nevada occur in rural and urban residential areas and recreational areas such as campgrounds involving the presence of easy human-provided food, typically garbage cans, bird feeders, feed storage sheds, or food kept in automobiles (Herrero and Fleck 1990). As of 2015, laws have been enacted to prevent human feeding of black bears. Specifically, Nevada (NRS 501.382) established a prohibition on knowingly placing food, garbage, or other attractants for black bears (and certain other wildlife species), with few exceptions. Additionally, the main counties and cities in black bear habitat have ordinances requiring residents to keep wildlife from accessing garbage and laws to prohibit the feeding of wildlife (Washoe, Douglas, Carson City County, Carson City, Incline Village and City of Reno).

No cases of human-bear interactions in which a human received injuries have been documented in Nevada; there are no documented human mortalities. Since 1986, California Counties that border Nevada's black bear population have experienced 23 black bear attacks on people, some causing serious injury (P.Jackson, NDOW, 09/06/17 and California Department of Fish and Wildlife website https.//www.wildlife.ca.gov/news/Bear/Bear-Incidents downloaded 09.28.17).

NDOW is responsible for responding to situations where black bear and mountain lions are considered dangerous to people, however, they have entered into a Cooperative Service Agreement and Work Financial Plan with WS-Nevada for WS-Nevada to provide assistance where necessary (Section 1.8), although in regard to black bear public safety issues, NDOW typically resolves on their own. WS-Nevada provided 10 responses (combined technical assistance and direct control) for conflicts regarding potentially dangerous interactions with black bears and threats to pets for the years CY2012 to 2016 (MIS 2017).

1.11.4.4 What are NDOW's Objectives and Strategies Related to Black Bear-Human and Pet Health and Safety Management?

NDOW, the agency with jurisdiction for black bear management in Nevada, has determined that a black bear exhibiting the following behavior patterns may be considered a human safety hazard:

- Exhibits little or no fear of people;
- Displays aggressive behavior when in contact with people, such as false charges, growling; or teeth popping;
- Repetitive daylight activity around people;
- Hazing in nuisance situations is ineffective;
- Attempting to break into residences or buildings, such indicating no fear of people;
- Repeated feedings in garbage, pet-bird feeders or stock feeders; and/or
- Animal in poor condition due to injury or malnutrition.

The NDOW objectives for managing black bears that are a threat to human/pet health or safety involve working to reduce the number of human-bear conflicts that may result in the lethal or non-lethal removal of the black bear, particularly in situations where bears may become habituated to humans, as well as maintaining healthy and optimum bear populations (NDOW 2012a). NDOW strategies related to human-bear conflict can be found in Lackey (2012) "Bear Conflict Management Manual" and Lackey et al. (2018).

Characteristics of residential areas often limit the ability to capture and remove bears that are a safety threat, nuisance, or causing damage. The presence of pets, children, and private properties make some methods used to capture or haze bears impractical. Discharging a firearm or other weapon is usually prohibited by law within city limits or by ordinance within residential areas. As a result, most conflicts in residential areas are resolved through advice from NDOW and actions taken by affected homeowners and NDOW. For example, NDOW employs an adverse conditioning program when releasing problem bears using Karelian bear dogs. In situations related to human safety or considerable damage within residential areas, dart guns or culvert traps may be used by NDOW in an attempt to capture the bear causing problems. Culvert traps or box-type traps are safe for use in areas where pets and people may frequent. However, the capture efficiency of culvert traps can be limited, especially if food is readily available, so, in some circumstances, problem black bears cannot be removed and residents must become educated on how to reduce or prevent the problems.

To reduce losses through damage by black bears, damage management may include lethal methods in areas where this is possible. Under NRS 501.376 exemption, the killing of black bear and mountain lion is legal if killing the animal is necessary to protect the life or property of any person in imminent danger of being attacked by the animal. As listed in Section 1.7, a landowner or landowner's agent is allowed to use lethal control to address damage issues related to black bears after obtaining a permit from the department under NRS 503.595. Such takes must be reported to NDOW with carcass/ head/hide (as applicable) surrendered to NDOW.

The vast majority of human-bear conflicts that result in black bears being killed occur in western Nevada. From CY 2010-2015, of the 601 black bears handled for causing damage or for human-safety issues, all occurred in western Nevada, mostly for damaging property or public safety (Section 1.11.2.5 and 1.11.2.8 and P. Jackson Nevada Department of Wildlife, personal communication email 9/06/17). A relatively low number of black bears are killed for reasons related to human safety or nuisance (48 of the 601 (< 8%) handled between CY 2010 and 2015 (P. Jackson Nevada Department of Wildlife, personal communication email 9/06/17)). The department provides advice to citizens about non-lethal control techniques, especially to reduce conflicts with these particular issues. Table 1.16 summarizes complaints received by NDOW and WS-Nevada between 2012 and 2016.

Table 1-16. Black Bear Public Safety Responses to Complaints Recorded by NDOW and WS-Nevada CY 2012-2016 (excludes livestock depredation).

	2012	2013	2014	2015	2016
Responses to Conflicts Received by NDOW					
Pets	0	0	0	0	N/A
Human Health/ Safety	81	95	141	122	N/A
Responses to Conflicts Received by WS-Nevada					
Pets	0	0	0	0	0
Human Health/ Safety	0	5	3	0	2

1.11.4.5 What is the Extent of Human-Mountain Lion Interactions in Nevada?

Potential dangerous mountain lion behaviors include aggressive actions such as charging or snarling, or loss of wariness of humans as displayed by reported sightings during the day in areas with permanent structures used by humans. Mountain lion attacks on people in the western United States and Canada have increased in the last two decades, primarily due to increasing lion populations, human use of lion habitats, and habituation to people (Beier 1991, Beier 1992). Although rare, mountain lion attacks on humans in the western United States and British Columbia have increased in the last 2 decades (Beier 1992; Cougar Management Guidelines Working Group 2005; ODFW 2006), primarily due to increased mountain lion populations, reduced hunting, and increased human use of mountain lion habitats (Beier 1992; ODFW 2006). Fitzhugh et al. (2003) report there were 16 fatal and 92 non-fatal attacks on humans since 1890 in the United States and Canada but of those, seven fatal and 38 non-fatal attacks occurred since 1991. For example, since California's Wildlife Protection Act of 1990 gave mountain lions special status in the state resulting in a prohibition on regulated hunting, there have been 3 fatal and 10 nonfatal attacks verified by California Department of Fish and Wildlife (2014).

There have been 3 fatal attacks and 12 non-fatal attacks in California between 1986 and 2014 (CDFG 2014). Most recently, a fatal attack occurred in New Mexico in 2008 (NMGF 2008). Recent attacks in 2016 on small children in Colorado and Idaho were thwarted by family members.

No mountain lion-caused human fatalities have been documented in Nevada and inquiries from the public regarding potential concerns with apparently aggressive mountain lions remain stable (P. Jackson, Nevada Department of Wildlife, personal communication 2017 email).

In western Nevada (2007-2016), mountain lions killed as a result of livestock depredation or human safety was the leading cause of non-hunting mortality, with mountain lions killed in response to protecting other natural resources second. For the same time frame in eastern Nevada, roughly the same trend held; for southern Nevada, same time frame, leading cause of non-hunting mountain lion mortality was also depredation but mainly human health and safety concerns (NDOW 2016a). From 2012 through 2016, NDOW received an average of 21 complaints per year related to damage (livestock and pets) or human safety (P. Jackson, Nevada Department of Wildlife, personal communication 09/06/2017 email).

1.11.4.6 What are NDOW and WS-Nevada Responses to Mountain Lion Threats?

NDOW responds to mountain lion complaints if public safety is a concern (P.Jackson, Nevada Department of Wildlife, personal communication 09/06/2017 email).

NDOW cannot verify all mountain lion complaints due to the large volume of complaints compared with available staffing and because mountain lions do not always leave detectable sign or evidence or evidence deteriorates due to weather or disturbance. However, NDOW believes using all reported complaints, even if not verified, does measure the level of public concern that exists over mountain lion occurrence in populated areas. Table 1.17 summarizes the complaints received by NDOW and WS-Nevada for reported mountain lion safety concerns between 2012 and 2016 for threats to human safety and pets. The majority of mountain lion-human safety concerns are not verified and do not result in removal efforts. WS-Nevada personnel may provide advice on precautionary measures that reduce risk and information on legal removal actions that the landowner may take. The few situations where mountain lions have been killed because of human safety concerns generally involve verified complaints where threats to human safety were considered high.

Table 1-17. Mountain Lion Complaints Recorded by NDOW and WS-Nevada CY 2012-2016[1,2]

	2012	2013	2014	2015	2016
Complaints Received by NDOW					
Pets	N/A	N/A	N/A	0	9
Human Health/ Safety	10	10	10	3	16
Responses to Conflicts Received by WS-Nevada					
Pets	3	3	17	10	1
Human Health/ Safety	25	24	40	31	3

[1]Data recording began in November 2015 and covers November and December 2015 (P. Jackson, Nevada Department of Wildlife, personal communication 10/16/17 email).

[2]Data is as reported to NDOW Reno Office (NDOW Western Region) and Las Vegas Office (Southern Region) (P. Jackson, Nevada Department of Wildlife, personal communication 10/16/17 email).

NDOW objectives related to human safety and pet concerns with mountain lions involve removing mountain lions for public safety on a case by case basis (P. Jackson, Nevada Department of Wildlife, personal communication 09/06/17 email).

1.11.4.7 What is NDOW's Policy Regarding Relocation/Translocation of Depredating Black Bears and Mountain Lions?

When technical assistance does not resolve the problem or an eminent threat is likely, NDOW may attempt to live-trap and relocate the offending bear or request WS-Nevada to live-trap for them. Generally, NDOW addresses translocation of black bears on a case by case basis, whereas mountain lions are not translocated (P. Jackson, Nevada Department of Wildlife, personal communication 09/06/2017 email). NDOW also has the authority to lengthen hunting seasons and increase the lawful take in areas experiencing black bear and mountain lion problems. However, most human-bear conflicts in Nevada are resolved using advice or non-lethal solutions.

NDOW personnel are allowed by NRS 501.3525 and policy to make a decision to kill an animal in a human safety situation in which no damage has yet occurred, using discretion in making the professional decision as to when a black bear is or is not in a human safety situation (based on NDOW authority to manage and regulate wildlife populations and the Commission-approved guidance in NDOW's Black Bear Management Plan (NDOW 2012a)). Also, agents of NDOW, and employees or agents of county, state, or federal agencies, including WS-Nevada and law enforcement agencies acting as NDOW's agent or while acting in their official capacity also have authority to kill black bear posing a threat to human safety. A private citizen may also kill a threatening black bear if in immediate danger (NRS 501.376). All take must be reported to NDOW.

1.11.4.8 What is the Potential for Disease Transmission to Humans and Pets?

Diseases of wildlife, livestock, pets, and humans can be caused by viral, bacterial, or parasitic pathogen species. Zoonoses (i.e., diseases transmissible to people from other animal species) are a major concern for wildlife managers and other officials. Pathogen transmission occurs through direct contact between infected and uninfected hosts, including host contact with a pathogen-contaminated environment or food product. Additionally, indirect transmission of pathogens through an intermediate host or vector species, such as biting insects transmitting West Nile Virus, is another possible transmission pathway. Disease transmission can occur between wildlife species or be confined to one species. Pets and livestock often encounter and interact with wild mammals, which can increase the opportunity for transmission of pathogens to humans. Additionally, illness in wildlife can alter host behavior patterns, which can lead to encounters with humans and can result in pathogen exposure and transmission.

WS-Nevada employs technical assistance and educational materials to inform the public about the risks associated with pathogen transmission from wildlife to humans, livestock, and pets. Planning of wildlife disease surveillance activities by WS-Nevada is guided by the WS-National Wildlife Disease Program (NWDP) with input from and cooperation with state agencies, including NDOW and NDA, and cooperating private resource owners. Additionally, disease observations from field personnel and the general public are used by the NWDP in future disease surveillance projects. WS-Nevada conducts limited opportunistic sampling for pathogens in predatory species and remains ready to assist NDOW, NDA, and public health departments with active or passive sampling, as requested and funding allows.

Determining which pathogens are circulating, which species are affected, and when and where the pathogens are occurring are important factors when conducting disease surveillance. However, these factors can be difficult to determine due to increasing global connectivity, changing climate, human transport of wildlife and pathogens, cultural practices regarding wildlife and wildlife parts, environmental management strategies, host and pathogen population dynamics, unknown pathogens, host suitability, species' shifting habitat and range, and other ecosystem pressures. WS-Nevada is currently contributing to surveillance of the following mammalian pathogens.

Leptospirosis is a disease of wildlife, pets, livestock, and humans caused by multiple bacterial species in the genus *Leptospira.* Infectious bacteria is shed by acutely and chronically infected hosts in the urine. Ingestion of untreated water or contaminated food is the primary route of infection. With the exception of pinnipeds, reports of clinically affected wildlife are rare. Maintenance hosts include canine species, domestic pigs, horses, cattle, elk, and multiple rodent species, including rats. It is suspected that feral swine, raccoons, and skunks may be reservoir species. Clinically infected species include domestic dogs, cattle, sheep, goats, horses, pigs, captive cervids, California sea lions, northern fur seals, and humans (Spickler and Ledom Larson 2013). As a contributor to the National Wildlife Research Center's nationwide leptospirosis research, WS-Nevada collects opportunistic samples from canine species, feral swine, and raccoons taken in the course of IWDM activities.

Plague (*Yersinia pestis*) and tularemia (*Franciscella tularensis*) are bacterial diseases that regularly affect wildlife populations in the United States. WS-Nevada contributes to the National Wildlife Research Center's nationwide plague and tularemia surveillance program (APHIS-WS 2016) by submitting opportunistic samples from any mammal species taken as part of regular damage management projects.

1.11.4.9 What Work is Needed to Protect Air Operations from Predators at Nevada Airports and DoD Aviation Facilities?

Airports provide ideal conditions for many wildlife species due to the large open grassy areas adjacent to brushy, forested habitat used as noise barriers and often being adjacent to water. Access to most airport properties is restricted, so predators living within airport boundaries are not harvestable during hunting and trapping seasons and are insulated from many other human disturbances. Common ravens have no natural or un-natural control mechanisms of consequence outside of removal under a federal migratory bird depredation permit (Section 1.8.2.3.2), as such, they receive protection inside and outside airport boundaries.

The civil and military aviation communities have acknowledged that the threat to human health and safety from aircraft collisions with wildlife is increasing (Dolbeer 2000; MacKinnon et al. 2001; Dolbeer 2009). Collisions between aircraft and wildlife are a concern throughout the world because wildlife strikes threaten passenger safety (Thorpe 1996), result in lost revenue, and repairs to aircraft can be costly (Linnell et al. 1996; Robinson 1996; Thorpe 1997; Keirn et al. 2010). Aircraft collisions with wildlife can also erode public confidence in the air transport industry as a whole (Conover et al. 1995).

Between 1990 and 2015, there were 3,572 reported aircraft strikes involving 43 species of terrestrial mammals in the United States (Dolbeer et al. 2016). The number of mammal strikes actually occurring is likely to be greater even though strike reporting at General Aviation airports has increased 40% from 2011 to 2015. Species of terrestrial mammals struck by aircraft in the United States from 1990 through 2015, including raccoons, fox, cats, coyotes, artiodactyls (i.e. deer), opossums, dogs, and skunks. Of the reports of terrestrial mammals struck by aircraft, 37% were carnivores (primarily coyotes), causing over $4.3 million in damages from 1990-2015 (Dolbeer et al. 2016). Aircraft striking coyotes have resulted in 14,209 hours of aircraft downtime and nearly $3.8 million in damages to aircraft in the United States since 1990 (Dolbeer et al. 2016). Aircraft strikes involving dogs have caused over $400,700 in damage in the United States since 1990 (Dolbeer et al. 2016).

In addition to direct damage, an aircraft striking a mammal can pose serious threats to human safety if the damage from the strike causes a catastrophic failure of the aircraft leading to a crash. For example, damage to the landing gear during the landing roll and/or takeoff run can cause a loss of control of the aircraft, causing additional damage to the aircraft and increasing the threat to human safety. Nearly 64% of the reported mammal strikes from 1990 through 2014 occurred at night, with 89% occurring during the landing roll or the takeoff run (Dolbeer et al. 2014).

From 2011 to 2016, civil aircraft in Nevada have been reported striking one kit fox, one coyote and one common raven to the Federal Aviation Administration (FAA) Wildlife Strike Database (FAA database 2016) and have requested assistance with managing threats to human safety and damage to property associated with predators present inside the area of operations of airports and receiving training in addressing their problems. The infrequency of aircraft strikes does not lessen the need to prevent threats to human safety and the prevention of damage to property. Preventing damage and reducing threats to human safety is the goal of those cooperators requesting assistance at airports in Nevada given that a potential strike could lead to the loss of human life and considerable damage to property.

Wildlife populations of terrestrial mammals near or found confined within perimeter fences at airports can be a threat to human safety and cause damage to property when struck by aircraft. Those wildlife confined inside an airport perimeter fence would not be considered distinct populations nor separate from those populations found outside the perimeter fence. Wildlife found within the boundaries of perimeter fences originate from populations outside the fence. Those individuals of a species inside the fence neither exhibit nor have unique characteristics from those individuals of the same species that occur outside the fence; therefore, those individuals of a species confined inside an airport perimeter fence do not warrant consideration as a unique population under this analysis.

WS-Nevada provides full time and part-time assistance to airports/air stations/air bases in Nevada. For predator species considered in this EA during CY 2012 through CY 2016, WS-Nevada provided responses to conflicts at 4 airports/joint-use facilities, approximately 44% of which were related to coyotes, 15% common ravens and 12% to feral/free ranging dogs (MIS 2017).

1.11.5 *What Is the Need for WS-Nevada Assistance to NDOW for Natural Resources Protection?*

1.11.5.1 Background

Predation is one of many mortality factors that influences wildlife populations. Predators often play critical roles in the composition, distribution, and function of wildlife populations in ecosystems (Section 3.8). Normally, predation by native predators on native prey species is part of the function of a healthy ecosystem, and the health of a predator population is integrally linked to health of its prey base. High predation rates on prey populations with few individuals relative to the capacity of the landscape to support prey populations can affect the viability of prey populations. The relationships of predators and prey are discussed in detail in Section 3.8.

Revenue derived from recreation and hunting, especially recreation related to wildlife and the outdoors, is increasingly important to the economy of Nevada. According to a 2016-2017 report by the Outdoor Industry Association (OIA 2017), on a national level, over $166.8 billion is spent on camping, over $30.2 billion on wildlife watching and $27.3 billion is spent on hunting. Based on surveys conducted in 2010 and 2011 for the Outdoor Industry Association, outdoor recreation generates $14.9 billion in consumer spending, $4.8 billion in wages and salaries, $1 billion in state and local tax revenue and 148,000 direct Nevada jobs (OIA 2012). In 2011, a USFWS Survey found that 734,000 Nevadans and nonresidents (16 yrs old and older) fished, hunted, or wildlife watched in Nevada. Of that total, 147,000 fished, 43,000 hunted and 643,000 participated in wildlife watching activities (including those that also fished and/or hunted). Expenditures for each category are as follows: Nevadans who only fished - $139 million; Nevadans who only hunted- $204 million; Nevadans who fished and hunted - $682 million (including those that also fished and hunted) (USDI, USFWS and USDC, USCB 2011). The report can be viewed in its entirety at https://www.census.gov/prod/2013pubs/fhw11-nv.pdf.

NDOW is charged with managing resident wildlife and is responsible for the maintenance of game populations for the benefit of the people of the State of Nevada (Nevada Revised Statute (NRS) 501.337). NDOW has identified that, under some circumstances, predators can cause additive constraints on the ability of some sensitive or vulnerable game species to reproduce and have healthy populations. When identified by the agency as necessary and appropriate, NDOW may request assistance from WS-Nevada, as well as commercial and volunteer agents, to protect species under their jurisdiction, with WS-Nevada assisting NDOW with technical and operational support.

In the past, NDOW has requested PDM services from WS-Nevada to reduce predation to local populations of mule deer (*Odocoileus hemionus*), pronghorn antelope (*Antilocapra americana*), bighorn sheep (*Ovis canadensis, O. c. sierrae,* and *O. c. nelsoni*), and greater sage-grouse (*Centrocercus urophasianus*) especially on winter ranges for deer (predation on weakened individuals), spring ranges for pronghorn antelope and deer (predation on fawns), and, where needed, for vulnerable bighorn sheep populations, especially related to new transplants into poorly occupied or unoccupied habitat.

NDOW is fully responsible for determining if and when PDM actions are appropriate for protection of species under its jurisdiction, considering management objectives, reproduction rates and survival, sources of mortality, habitat quality and diversity, genetic limitations, and invasive species impacts.

NDOW has developed management plans for game species to guide their management actions (Section 1.7). These plans provide goals and management actions for ensuring sustainable populations in Nevada. Habitat management is under the jurisdiction of the appropriate state and federal land management agencies such as the USFS or BLM, often in coordination with NDOW, as well as private landowners. Therefore, PDM has been identified by NDOW as a component of game management plans and/or objectives, and NDOW may request WS-Nevada to assist with this management component (Sections 1.11.5.2 through 1.11.5.8).

1.11.5.2 What are Predator-Prey Relationships

Predator-prey studies assess 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 is complex. Monteith et al. (2014) summarized that evidence of mortality is often used to justify predator management to increase ungulate (hoofed mammal, e.g., deer, elk, etc.) populations which underscores the need to correctly interpret the causes and consequences of mortality. Factors limiting growth of ungulate populations are numerous, interacting, and subject to variability (Bishop et al. 2009). 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 ungulate population dynamics (Sinclair and Krebs 2002). Further, the interactions between nutrition and predation are likely mediated by weather, habitat, and other forms of mortality (Vucetich et al. 2005, White and Garrott 2005, Wright et al. 2006, Hopcraft et al. 2010, Brodie et al. 2013, Middleton et al. 2013). That being said, predation can affect a prey population only if predation mortality is at least partially additive to mortality from other causes (Fryxell et al. 2014). Multiple studies have identified 3 conditions that must be met to determine that predators are effecting an ungulate population: 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 (Theberge and Gauthier 1985, Hurley et al. 2011, Forrester and Wittmer 2013).

Determining 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. 2011). 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. Additive mortality is that which increases the overall mortality, but does not cause a reduction in other forms of mortality. Compensatory mortality is that which causes a reduction in other forms of mortality, such that overall mortality is not increased (Bartmann et al. 1992).

Predation mortality and malnutrition/disease mortality are often the largest causes of death in ungulate populations, especially mule deer (Bishop et al. 2009, Hurley et al. 2011, Forrester and Wittmer 2013). Predation was the largest proximate cause of mortality in both adult female and fawn mule deer in all studies reviewed by (Forrester and Wittmer 2013). However, 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 even more complicated in multiple predator, multiple prey systems (Lathem et al. 2013, Leblond et al. 2016). Montieth 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; in other words, whether predation mortality was additive or compensatory. Bishop et al. (2009) reached a similar conclusion about determining if mortality was additive or compensatory. But interactions are complex, and thus data are difficult to interpret. Hurley et al. (2011) found evidence of compensatory mortality from coyotes, and inconsistent effects of predator management on mule population metrics. They also 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 overwhelmed the effects of predator-caused mortality. They found that the greatest potential for population growth was likely from improving habitat to improve nutrition for mule deer. Hurley et al. (2011) postulated that coyote removal may increase deer populations, but this was contingent on lagomorph and small mammal population levels measured in April (as an alternate food source for coyotes).

Managing ungulate populations requires wildlife agencies to examine many factors to understand why a population may have declined and to guide management efforts to increase a population. Populations can be affected by climate variation, predation, habitat (nutrition), and/or the relationship to carrying capacity (Bishop et al. 2009). Whereas 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.

1.11.5.3 What are NDOW Management Objectives Related to Predation of Big Game Species?

Under certain conditions, predators considered in this EA, primarily coyotes and mountain lions, can have an adverse impact on deer, elk, bighorn sheep, and pronghorn antelope populations, and this predation is of concern during periods when the population is vulnerable, such as fawning, calving, and lambing for the young or winter for adults (Pimlott 1970, Bartush 1978, Shaw 1977, USFWS 1978, Trainer et al. 1983, Hamlin et al. 1984, Neff et al. 1985, Bishop et al. 2009, Knopff et al. 2010, Clark et al. 2014).

Because of increasing evidence that mountain lion and coyote predation can limit some ungulate populations (Rominger et al. 2004; Rominger 2007 and section 1.11.5.2), local short-term management of predators under proper conditions can be an important tool in meeting specific big game management objectives. Factors such as predator densities, alternate prey densities, weather conditions, ungulate densities and vulnerability can influence survival and maintenance of young in a population. Based on research and experience, NDOW has determined that, on a case-by-case basis, PDM may be an important tool for meeting their species management objectives. The decision to manage wildlife populations using PDM is solely a decision that is made by NDOW as the jurisdictional wildlife management agency in Nevada. NDOW may request PDM assistance from WS-Nevada, and WS-Nevada considers all requests for providing assistance to NDOW in meeting their wildlife management.

The structure of NDOW's management objectives relative to predation of big game species is provided in their Predator Management Plan, which is updated annually to respond to prior year results or new problems. This detailed plan provides objectives and goals with both broad and focused projects depending upon what is required to resolve a problem or answer a question. It consists of concepts, types of projects and monitoring.

From the 2016 Plan:

> *The goal of the Nevada Department of Wildlife's (NDOW's) Predator Management Program is to conduct projects consistent with the terrestrial portion of NDOW's Mission "to preserve, protect, manage, and restore wildlife and its habitat for the aesthetic, scientific, educational, recreational, and economic benefits to citizens of Nevada and the United States." Provisions outlined in NRS 502.253 authorize the collection of a $3 fee for each big game tag application, deposition of the revenue from such a fee collection into the Wildlife Fund Account, and use by NDOW to 1) develop and implement an annual program for the management and control of predatory wildlife, 2) conduct wildlife management activities relating to the protection of non-predatory game animals and sensitive wildlife species, and 3) conduct research necessary to determine successful techniques for managing and controlling predatory wildlife. This statute also allows for: the expenditure of a portion of the money collected to enable the State Department of Agriculture and other contractors and grantees to develop and carry out programs designed as*

described above; developing and conducting predator management activities under the guidance of the Nevada Board of Wildlife Commissioners; and provide that unspent monies remain in the Wildlife Fund Account and do not revert to State General Funds at the end of any fiscal year.

NDOW maintains a philosophy that predator management is a tool to be applied deliberately and strategically. Predator management may include lethal removal of predators or corvids, nonlethal management of predator or corvid populations, habitat management to promote more robust prey populations which are better able to sustain predation, monitoring and modeling select predator populations, managing for healthy predator populations, and public education; however not all of these aspects are currently eligible for funding through predator fee dollars. NDOW intends to use predator management on a case-by-case basis, with clear goals, and based on an objective scientific analysis of available data. To be effective, predator management should be applied with proper intensity and at a focused scale. Equally important, when possible projects should be monitored to determine whether desired results are achieved. This approach is supported by the scientific literature on predation management. NDOW is committed to using all available tools and the most up-to-date science, including strategic use of predator management, to preserve our wildlife heritage for the long term.

NDOW is a state agency that must balance the biological needs of wildlife, statutory mandates, and social desires of the public. In the 2015 legislative session, Assembly Bill 78 was adopted which in part amended NRS 502.253 (4) (b) to read:

> *[The Department] "Shall not adopt any program for the management and control of predatory wildlife developed pursuant to this section that provides for the expenditure of less than 80 percent of the amount of money collected pursuant to subsection 1 in the most recent fiscal year for which the Department has complete information for the purposes of lethal management and control of predatory wildlife." NDOW intends to comply with statute and apply the tools of scientific predation management in biologically sound, socially responsible means."*

NDOW has 3 categories of projects in the predator management plan (NDOW 2017c), which are listed throughout the plan:

> *"1.* ***Implementation****: The primary objective is to implement management of predators through lethal or non-lethal means. NDOW will collaborate with USDA Wildlife Services and private contractors to conduct lethal and non-lethal management of predators. Identifying and monitoring a response variable is not a primary objective for implementation.*
>
> ***2. Experimental Management****: The primary objectives are management of predators through lethal or non-lethal means and to learn the effects of a novel management technique. NDOW will collaborate with USDA Wildlife Services, private contractors, and other wildlife professionals to conduct lethal*

or non-lethal management of predators and will put forethought into project design. Response variables will be identified and data will be collected to determine project effectiveness. Expected outcomes will include project effectiveness, agency reports, and possible peer-reviewed publications.

3. Experimentation*: The primary objective is for increasing knowledge of predators in Nevada. NDOW may collaborate with other wildlife professionals to study and learn about predators of Nevada. Expected outcomes will include agency reports, peer-reviewed publications, and information on how to better manage Nevada's predators."*

NDOW also has 3 levels of monitoring to assess effectiveness and direction of projects (NDOW 2017c):

*"**1. Standard Monitoring**: The primary objective of standard monitoring is to use existing survey protocols to evaluate the response of game species or sensitive wildlife to lethal or non-lethal management of predators. NDOW conducts annual and biannual surveys to evaluate trend and composition of game species or sensitive wildlife and to inform the season and quota-setting process. Composition surveys will yield response variables such as recruitment of juveniles into the adult population and will be compared to published benchmarks of productivity in the management area of interest, to neighboring areas not receiving predator management, or in the same area before treatment began. Standard monitoring represents no change to existing monitoring efforts. Expected outcomes include an indication of project effectiveness and agency reports.*

2. Intermediate Monitoring*: The primary objective of intermediate monitoring is to apply a specific monitoring plan designed to evaluate the response of game species or sensitive wildlife to lethal or non-lethal management of predators. NDOW may collaborate with other wildlife professionals to identify reference and treatment areas or evaluate productivity of game species or sensitive wildlife before, during, and after implementation to determine effectiveness of predator management. Composition surveys may be modified to thoroughly evaluate productivity in the reference and treatment areas and to better accommodate annual variation in survey conditions. Expected outcomes will include an indication of project effectiveness, agency reports, and possible peer-reviewed publications.*

3. Rigorous Monitoring*: The primary objective of rigorous monitoring is to evaluate several response variables known to affect productivity of game species or sensitive wildlife and to determine the relative influence of those variables when measuring the response to lethal or non-lethal management of predators. NDOW may collaborate with other wildlife professionals to identify the requirements of rigorous monitoring and to further evaluate factors influencing productivity of game species or sensitive wildlife such as survival of juveniles, body condition of adults, or habitat productivity. Rigorous monitoring efforts will help to disentangle biotic and abiotic conditions that* *may influence productivity of game species or sensitive wildlife from the effects of lethal or non-lethal management of predators. Expected outcomes will include agency reports, peer-reviewed publications, and information on how to better manage Nevada's wildlife".*

As the management agency, NDOW would determine when and where PDM would be conducted. WS-Nevada may be asked by NDOW to protect big game species from predation. WS-Nevada would provide assistance with PDM in these situations whenever NDOW determined it to be warranted and effective.

1.11.5.4 *What is the Potential Impact of Predation on Ungulate Populations in Nevada?*

The determination of the effect of predation on deer, elk, or other wildlife is challenging and complex, with some studies in the western United States concluding that predators can have a major effect on ungulate populations (Knowlton 1964, White 1967, Beasom 1974, Bartush 1978, Garner et al. 1976, Connolly 1978, Hamlin et al. 1984, Neal 1990, Teer et al. 1991, Pojar and Bowden 2004), while other studies have found that predators have little effect. Differences in ungulate and predator densities, species of predator, weather, disease, human harvest, and whether the prey population is at habitat carrying capacity all influence the viability of wildlife populations. Management agencies need to look at the factors related to the ungulate population dynamics and carefully determine if predation is having a negative impact on the population, and if management actions are warranted.

Connolly (1978) reviewed 68 studies of predation on wild ungulate populations and concluded that in 31 cases, predation by coyotes had an influence on white-tailed deer, mule deer, pronghorn antelope, and bighorn sheep populations. Hamlin et al. (1984) observed that a minimum of 90% summer mortality of deer fawns was a result of coyote predation. Pojar and Bowden (2004) found, for mule deer fawns in Colorado in areas with habitat similar to that in Nevada, that 75% of predation mortality occurred by July 31. Other authors also observed that coyotes were responsible for the majority of deer fawn mortality during the first few weeks of life (Knowlton 1964, White 1967). One study in the central Sierra Nevada in California found that predation was the largest cause of deer fawn loss, resulting in the death of 50% of all fawns during the first 12 months of life. In this instance, cougars were the main predator, with coyotes accounting for 27% of predation (Neal 1990). Teer et al. (1991) concluded from work conducted at the Welder Wildlife Refuge, Texas, that coyotes take a large portion of the fawns each year during the first few weeks of life. Another Texas study (Beasom 1974) found that predators were responsible for 74% and 61% of the fawn mortality for 2 consecutive years. Garner (1976), Garner et al. (1976), and Bartush (1978) found annual losses of deer fawns in Oklahoma to be about 88%, with coyotes responsible for about 88% to 97% of the mortality. Trainer et al. (1981) reported that heavy mortality of mule deer fawns during early summer and late fall and winter in the Steens Mountains in Oregon, primarily from coyote predation, was limiting the ability of the population to maintain or increase population levels.

Predation was found to be the leading cause of pronghorn antelope fawn loss, accounting for 91% of the mortalities that occurred during a 1981-82 study in southeastern Oregon (Trainer et al. 1983), with coyotes comprising 60% of that mortality. In addition, a coyote reduction study in southeastern Oregon documented that, in 1985, 1986 and 1987, an estimated reduction of 24%, 48%, and 58% of the spring coyote population in the study area resulted in an increase in fawns from 4 fawns/100 does in 1984 to 34, 71, and 84 fawns/100 does in 1985, 1986, and 1987, respectively (Willis et al. 1993). Other authors observed that coyotes were responsible for the majority of fawn mortality during the first few weeks of life (Knowlton 1964, White 1967). Reductions of individual and localized groups of coyotes and other predators have been shown to result in increasing fawn survival of white-tailed deer (Guthery and Beasom 1977, Stout 1982, Knowlton and Stoddart 1992) and pronghorn antelope (Arrington and Edwards 1951, Smith et al. 1986).

Brown and Conover (2011) conducted a large-scale removal of coyotes on twelve large areas in Utah and Wyoming to study effects on pronghorn antelope and mule deer populations. Their data suggest that coyote removal conducted during the winter and spring provided greater benefit than removals conducted during the prior fall or summer, increasing pronghorn survival and abundance, but removal did not affect mule deer populations. Hurley et al. (2011) could not detect a strong effect of mountain lion or coyote removal on mule deer population trends in southeastern Idaho. A low correlation was found with the previous year's mountain lion removal and severity of the winter, with winter precipitation apparently the primary factor for mule deer population growth. Coyote removal increased neonate fawn survival may occur only under particular conditions of prey densities and weather conditions, and increased survival did not contribute to population growth. Even with increased mule deer survival and fawn ratios, the authors were unable to demonstrate significant changes in population trend with mountain lion removal.

Sections 1.11.5.3 through 1.11.5.8 are summarized from the following NDOW species management plans: Mountain Lion Management Plan (1995), Nevada's Bighorn Sheep Management Plan (2001), Nevada's Pronghorn Antelope Management Plan (1983), Nevada's Elk Management Plan (1997), and Nevada's Mule Deer Management Plan (2006) and Nevada's Greater Sage-Grouse Conservation Plan (Copeland et al. 2014). NDOW has the singular authority to manage game ungulate populations in Nevada and, therefore, the authority to set its management goals objectives, and actions. The information contained in NDOW's management plans is the most useful available for meeting their goals and objectives. WS-Nevada may assist in meeting the agency's goals and objectives only when requested by NDOW.

1.11.5.5 What is the Potential Impact of Mountain Lion Predation on Nevada Deer and Elk Populations?

The health of a mountain lion population is integrally directly linked to ungulate prey availability, distribution, and abundance (Pierce et al. 2000a, Logan and Sweanor 2001, Cougar Management Guidelines Working Group 2005). High mountain lion predation rates, especially on stressed prey populations, can reduce the size and sustainability of prey populations. Likewise, when severe winter conditions or large-scale habitat loss severely reduces local prey populations, mountain lions dependent on vulnerable prey may further depress or prevent prey population recovery (Neal et al. 1987), often resulting in mountain lion population declines or use of alternate prey, including other ungulates or domestic livestock (Kamler et al. 2002).

Throughout the western United States, deer and elk are the staple food of mountain lions. Numerous studies have found deer to be the primary food item of mountain lions even when other ungulate species such as elk, bighorn sheep, or pronghorn were present (Robinette et al. 1959, Anderson 1983, Ackerman et al. 1984, Cashman et al. 1992, Beier and Barrett 1993, Logan et al. 1996). However, in many of these studies, ungulates other than deer were not available in significant numbers. Although a variety of other species, including small mammals and birds, may be eaten, mountain lions do not persist in areas without ungulate prey.

Mountain lions in northeastern Oregon consumed (in order of decreasing frequency): mule deer, Rocky Mountain elk, porcupine, snowshoe hare, and deer mice (Maser and Rohweder 1983). Winter foods for mountain lions in Oregon's Cascade Range were principally black-tailed deer and porcupine (Toweill and Maser 1985). Another Oregon study indicated deer, elk, and porcupine were the most common winter food items (Toweill and Meslow 1977). In some cases there is a difference in prey selection based on sex, age, and reproductive status of mountain lions (Anderson and Lindzey 2003). Nowak (1999) found adult females killed more mule deer (65%) than elk (35%) and tended to select mule deer fawns, older adult mule deer females, and calf elk over other sex and age classes of available prey. Pierce et al. (2000b) also concluded that age and sex of prey were more important in mountain lion prey selection process than was body condition of the prey. The number of prey consumed by an individual mountain lion varies with a number of factors, such as the mountain lion’s sex, age, size, and reproductive status, as well as weather conditions (kills spoil more rapidly in warm temperatures), competition with other predators such as black bear, and scavenging by other species such as birds and coyotes (Iriarte et al. 1990).

From the Nevada 1995 Mountain Lion Species Management Plan (NDOW 1995):

> *“Mountain lions are at the top of the food chain, and consequently, eat a variety of prey species ranging in size from woodrats (Neotoma spp) to elk (Cervus elaphus) (Robinette, et al. 1959). Where abundant, mule deer are the primary prey species of mountain lions. In some areas feral horses are often preyed upon. Bighorn sheep (Ovis canadensis), can be an important prey species where deer are sparse or do not occur. Other prey species include beaver (Castor canadensis), cottontail (Sylvilagus spp.), jackrabbit (Lepus spp.), domestic livestock, other carnivores, and blue grouse (Dendragapus obscurus) (Ashman et al. 1983).”*

Elk

Mountain lion predation has been implicated in low elk calf survival and resultant elk population declines. In southeast Washington, mountain lion predation accounted for more than half the known elk calf mortality (Myers et al. 1999) and end-of-winter (ODFW 2010) cow ratios averaged 21:100. Mountain lions were found to impact calf survival in 2 Idaho study areas with low ratios of calf: 100 cows, responsible for 38% of known calf mortalities in the Lochsa River study area and 36% in the Clearwater River study area (P. Zager, Idaho Department of Fish and Game, pers. comm. as cited by WS-Oregon); black bears were also heavy predators on elk calves.

In contrast, the Nevada Rocky Mountain elk populations increased and expanded since augmentations in 1979 (NDOW 1997). In 2016, Nevada's elk population was estimated at 16,000 (NDOW 2016a). As NDOW elk management goals have been met, there has been no need for protection of adult elk or calves from mountain lions. Although unlikely, the need for protection could arise after additive environmental stressors aligned (such as temporary loss of habitat to wildfire followed by a hard winter).

Mule Deer

Mountain lion predation impact mule deer populations, although the degree of impact can be difficult to determine, due to the numerous factors that can affect mule deer herds, such as differences in deer and predator densities, species of predators, weather, disease, human harvest, and whether the prey population is at habitat carrying capacity. In California, mountain lion predation was found to be the primary cause of a significant decline in mule deer in the Sierra Nevada Mountains (Harrison 1989). A three-year Oregon study found mountain lion predation of adult mule deer as the leading cause of mortality, accounting for 33% of all known mortality (Mathews and Coggins 1997). A study of a wintering mule deer herd in Hells Canyon, Idaho showed a 25% annual mortality rate for adult does from 1999-2001 (Edelmann 2003), primarily due to mountain lion predation. A review of published studies addressing deer-predator relationships by Ballard et al. (2001) indicated determining the impacts of predation were confounded by numerous factors; however predation may be a significant contributor in some areas under certain conditions.

1.11.5.6 How Does Mountain Lion Predation Impact Bighorn Sheep Populations in the West?

Wehausen (1996) reported several instances where mountain lion predation on bighorn sheep populations reduced population growth rates, resulting in the cessation of the bighorn sheep restoration program into new habitat. Mountain lions in California were reported to be a threat to the native Sierra Nevada bighorn sheep population directly through predation and indirectly with their presence by keeping bighorn sheep out of critical winter range. These in part were factors that lead to a 1999 emergency listing under the ESA (64 FR 19300, followed in 2000 by a final listing (65 FR 20)) because the small bighorn sheep population was in danger of extinction. The state determined that the combination of selective mountain lion control on bighorn sheep winter ranges may have contributed to increased use of formerly-restricted winter range (USFWS 2008). McKinney et al. (2006) found that lethal removal of mountain lions in the Mazatzal Mountains of Arizona led to: lower mountain lion abundance; less predation of desert bighorn sheep; greater growth, production, and productivity of the desert bighorn sheep population despite years of continual drought. Rominger et al. (2004) reported that mountain lions limited expansion of a transplanted population of bighorn sheep in New Mexico. Hayes et al. (2000) proposed that mountain lion predation on bighorn sheep may be impeding recovery of a federally-listed endangered bighorn sheep population in the Peninsular Ranges of California.

1.11.5.7 How Does Mountain Lion Predation Impact Nevada's Bighorn Sheep Populations?

Nevada has 3 subspecies of bighorn sheep: Rocky Mountain bighorn sheep (not native to Nevada), California bighorn sheep and desert (Nelson) bighorn sheep. There appears to be some disagreement about bighorn sheep abundance in Nevada prior to the 1900's. According to historic accounts researched by Great Basin Consulting, bighorn sheep were not abundant in Nevada in the early 1800's. The only written accounts found that: the John Work party in 1831 found tracks, but no bighorns until they reached Oregon (they saw 4 sheep near the Owhyee River); Cartographer Charles Preuss saw "mountain sheep" somewhere in what would be Humboldt or Washoe County when he was taking the Fremont party from Fort Vancouver (Washington) to Pyramid Lake in 1843; and lastly an account in 1849 where Elisha D. Perkins likely mistook antelope for being bighorn sheep. So, during a 78 year period from 1824-1900, only 2 instances occurred and were recorded where bighorn sheep were seen, despite the thousands of miles traveled by mountain men, explorers, and emigrants. From the NDOW 2001 Bighorn Sheep Management Plan (NDOW 2001), Smith (1909) is cited of an account that John C. Fremont wrote on January 11, 1834; "On our road down, the next day, we saw herds of mountain sheep while traveling through Nevada's Lake Range." Based on historic accounts, archeological evidence and biological judgement of areas that had adequate bighorn habitat, the bighorn sheep management team estimated the Nevada bighorn sheep population at over 30,000 bighorn sheep during 1860 (NDOW 2001). NDOW estimates that in 1960 Nevada's bighorn sheep population was estimated between 2,000 and 3,000 (NDOW 2001). By the 1980's intensive management/restoration efforts were underway leading to a 2001 herd estimate of 6,500 bighorns in 74 mountain ranges. In 2016, NDOW estimated the bighorn sheep (BHS) populations at: Desert BHS=9,700, California BHS=1,800, Rocky Mountain BHS=210 (NDOW 2016a).

Controlled ram hunting for bighorn sheep began again in 1952. Ram harvest of any subspecies has never exceeded 10% of the total estimated ram population and has never exceeded 3% of the total population. Ram hunting alone does not limit bighorn sheep populations in Nevada primarily because limited ram removal has no effect on ewe pregnancy rates, although limited controlled ewe hunting for bighorn sheep began in 2014. The greatest threat to Nevada's wild sheep is currently pneumonia (*Mycoplasma ovipneumoniae*): such as the outbreak in Hunt Unit 031 (California bighorn sheep) in 2015, where NDOW made the decision to lethally remove 27 sheep in an attempt to protect surrounding herds; and the outbreak of 2014 where the population of the Badlands/Contact herd of Rocky Mountain bighorn sheep went from ~50 animals to ~15. According to NDOW (2016b), predation is also suspected of playing a role in the Badlands/Contact herd decline.

Desert bighorn sheep survey data indicate that as a whole, the statewide population has not changed since the previous year (2015). It is stable to the point of issuing ewe tags to reduce the population in areas where local populations are above sustainable management levels (SML) as an example 140 ewe tags were issued in 4 separate units, resulting in a harvest of 99 ewes in 2015 to protect the herd from stress that could weaken them and make them vulnerable to wild sheep pneumonia complex (*Mycoplasma ovipneumoniae*). Due to potential of introducing novel strains of *M. ovipneumoniae* into a herd that is below SML, herd augmentation may not be a viable option, hence issuing ewe tags (NDOW 2016a).

California bighorn sheep survey data in NDOW (2016b) indicate that as a whole, the statewide population dropped ~5% from 2015, which is mainly attributed to the Unit 031 die off mentioned previously (~1.4% of the population).

Rocky Mountain bighorn sheep survey data in NDOW (2016b) indicate that only one population seems to be doing well. The Mount Moriah herd is estimated at 90 animals, while the remaining five herds average 24 adults. As mentioned previously, disease and predation appear to be suppressing this subspecies.

NDOW (2014a) indicates that Desert Bighorn Sheep are preyed heavily upon by mountain lions in Hunt Units 205 and 207. From NDOW (2016), 2 bighorn sheep protection projects were initiated/continued that protect California bighorn sheep and Rocky Mountain bighorn sheep from lion predation. The intensity of the removal efforts are dependent upon clearly specified herd size/health objectives and also abide by the Board of Wildlife Commissioners Commission Policy Number 22 which requires predator control prior to and after translocation or establishment of game species to increase success of herd augmentation.

1.11.5.8 *What is the Potential Impact of Predation on Greater Sage-grouse Populations in Nevada?*

Greater sage-grouse populations have declined throughout the western U.S. over the last several decades due to a variety of environmental factors (Connelly and Braun 1997). Greater 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, Conover and Roberts 2016, Dinkins et al. 2016a, 2016b, Peebles et al. 2017). Populations of some of the most important greater sage-grouse predators have increased dramatically over the last 100 years, 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, an IPDM 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 IPDM 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 IPDM for the protection of bird populations.

Batterson and Morse (1948) documented heavy predation on greater sage-grouse nests in northeastern Oregon, and while the greatest limiting factor was common raven (*Corvus corax*) predation, coyotes and badgers also contributed to nest predation. Common ravens have been documented to be the most common predator of greater sage-grouse nests (Coates et al. 2008, Lockyer et al. 2013). Common raven removal has been shown to increase greater sage-grouse numbers (Peebles et al. 2017) and increase nesting success (Dinkins et al. 2016a). Predation by common ravens could be one of the greatest limiting factors for Gunnison sage-grouse as well.

(Keister and Willis 1986) suggested that the major factor in determining greater 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 common ravens were suspected as the primary nest predators. A coyote removal project was implemented on their study area, and greater 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 greater sage-grouse and predator populations, weather, and habitat from an area of Oregon that had some of the best greater sage-grouse habitat in the state. The only meaningful relationship they found was a significant negative correlation between coyote abundance and the number of greater sage-grouse chicks produced per hen. They concluded that fluctuation in predator abundance was probably the single most important factor affecting annual productivity of greater sage-grouse in their study area. Presnal and Wood (1953) documented an example illustrating the potential of coyotes as predators on greater 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 3 adult greater 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 greater sage-grouse hen plus six whole newly-hatched greater sage-grouse chicks. The area around the den was littered with greater 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 greater 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 greater sage-grouse in their study area in Utah, and recently revised greater sage-grouse management guidelines, suggesting that red fox populations should be discouraged in greater 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 greater 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 common raven and coyote removal in relation to temporal variation in climate on greater sage-grouse nest success was undertaken (Dinkins et al. 2016b). Depredation of greater sage-grouse nests can limit productivity. Common ravens have become more abundant in sage habitat due to increases in anthropogenic structures and supplemental food sources. Dinkins et al. (2016a) showed removal of common ravens can increase nest success and may have a place in greater 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 greater sage-grouse nest success during wet years was postulated but the cause of lower nest success was outside the scope of the study.

Habitat loss remains the greatest cause of greater sage-grouse population declines (Connelly et 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 greater sage-grouse (Beck and Mitchell 2000). Large expanses of sagebrush were burned or chemically treated after World War II for forage production for livestock. Influences of livestock grazing on sagebrush habitats were evaluated by Beck and Mitchell (2000). Livestock impacts on greater sage-grouse can be positive, negative or neutral (Gutherey 1996). Impacts of livestock grazing on sagebrush is highly variable and related to stocking densities and forage management practices (*e.g.*, fire, herbicides)(Gutherey 1996). Whereas 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 years 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 smaller sage 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 forbs. Greater sage-grouse use sagebrush, grasses and forbs at different times of the year for foraging, raising young and wintering. Livestock grazing can be compatible with greater sage-grouse when stocking rates are low or moderate since grasses, forbs and sagebrush remain for nesting (Beck and Mitchell 2000). Some higher stocking rates of livestock following a drought can reduce available habitat for nesting greater sage-grouse. In summary, livestock grazing affects are highly variable with the effects most reduced by stocking rates.

Common raven and corvid populations have increased significantly over the last 40 years as humans have introduced anthropogenic structures into sagebrush habitat (Manzer and Hannon 2005, Coates and Delehanty 2010, Coates et al. 2016). Common ravens are one of the predators depredating greater 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.

Greater Sage-grouse in Nevada

Greater sage-grouse is a species of concern in Nevada. Because of a decline in greater sage-grouse populations and habitat losses range-wide, Nevada, like most western states, has engaged in a conservation planning process to maintain, enhance, and restore greater sage-grouse and balance greater sage-grouse habitats and populations with local economic considerations (NDOW 2004b and Copeland et al. 2014). The Greater Sage-grouse Conservation Plan for Nevada and Eastern California (NDOW 2004b), and 2014 Nevada Greater Sage-grouse Conservation Plan (Copeland et al. 2014), lists predation among many factors affecting greater sage-grouse, and identifies habitat quantity and quality, and wildfire as having affected Nevada greater sage-grouse populations the most. The greater sage-grouse plan details specific projects that have been completed or are in progress to remedy the identified limitation.

Predation can impact all stages of this species life cycle, from nest raiding (egg eating) by common ravens, badgers, coyotes, fox and weasels, to chick predation by common ravens and weasels, to juvenile and adult predation by raptors (hawks, eagles, owls), coyotes, and badgers (Connelly et al. 2004, Coates et al. 2008, Lockyer et al. 2013, Copeland et al. 2014),   Nest predation and early brood (chick) mortality by predators has been well documented in the literature (Schroeder et al. 1999, Connelly et al. 2000b, Schroeder and Baydack 2001, and Coates 2007, Lockyer et al. 2013). Studies conducted in Washoe and Elko Counties in Nevada showed that common ravens have the potential to seriously impact greater sage-grouse production (Alstatt 1995, Lockyer et al. 2013). Another study conducted in NE Nevada showed that common raven abundance was strongly associated with greater sage-grouse nest failure, with resultant negative effects on greater sage-grouse reproduction (Coates 2007). Dinkins et al. (2016a), also found that common ravens are significant predators of greater sage-grouse nests and chicks in south western and south central Wyoming. Peebles et al. (2017) found that at the study area of Dinkins et al. 2016a, with continued common raven removal, greater sage-grouse mortality was not affected or only partially affected by compensatory mortality from other predators, based on monitoring of birds at leks where common ravens were removed as part of a research experiment. As cited by Copeland et al. (2014), "The common raven is identified as the most frequent predator during nesting season in sage-grouse predator studies conducted recently in the Great Basin (Coates et al. 2008, Lockyer et al. 2013)". The common raven is thought to be the greatest threat to greater sage-grouse recruitment.

In areas of altered habitat (change in land use or land cover that impacts the local ecosystem) there is potential for increased predation on all life stages of greater sage-grouse (Schroeder and Baydack 2001, Connelly et al. 2004, Coates 2007). Research in western Wyoming attributed increased greater sage-grouse nest depredation to high corvid abundances, which resulted from increases of anthropogenic food and perching subsidies in areas of natural gas development (Holloran 2005). In the same Wyoming location, Bui (2009) found common raven abundance increased in association with oil and gas development. In Nevada, human-made structures in the environment increase the effect of common raven predation, particularly in areas where canopy cover has been reduced, and little cover is available for chick or adults to hide from predators (Coates 2007). In addition, human development that includes new perching opportunities for common raven, can also increase predation. The same held true in southeastern Idaho (Coates et al. 2014)

Due to environmental factors, such as Nevada being the driest State in the nation (statewide average annual precipitation of 10 inches), coupled with altered sagebrush habitats from anthropogenic activities (Coates 2007) otherwise suitable habitat has changed into habitat sinks (very low quality habitat) for greater sage-grouse. In sink populations, the death rate exceeds the birth rate and the population exists only through immigration. Further, the USFWS believes that where habitats have been altered by human activities, predation could be limiting local greater sage-grouse populations (Federal Register/Vol. 75, No. 55/ Tuesday, March 23, 2010/ Proposed Rules). Hagen (2011) found limited information suggesting that predator management for greater sage-grouse protection may provide short-term relief for areas that act as a population sink.

NDOW (2004b) and Copeland et al. (2014) prescribe predation management projects to protect greater sage-grouse during more vulnerable strutting, nesting and early brood periods, on a short term basis, and in conjunction with habitat improvement projects.

The USFWS receives MBTA permit requests every year to take common ravens to protect public safety at airports, address livestock depredation, and reduce impacts to species of special concern such as greater sage-grouse. WS-Nevada and NDOW apply for these MBTA permits on a regular basis as part of fulfilling their agencies respective roles. Other entities, such as local governments and businesses, may also apply for MBTA permits and request WS-Nevada conduct work under them. As part of the USFWS responsibilities under MBTA to manage sustainable populations of birds, the agency monitors population trends using the best available information to inform permit decisions. When USFWS decides to issue permits to take MBTA protected species, they must assess the cumulative impacts of the decision.

Concerns over declines in greater sage-grouse populations resulted in numerous petitions filed with the USFWS to provide protection under the ESA for various portions of the greater sage-grouse range. In response to a petition to list the greater sage-grouse as a threatened or endangered species, the USFWS conducted a status review of the species and on October 2, 2015, issued a 12-month finding that the species was not warranted for listing. Thus the status of the greater sage-grouse pursuant to the Endangered Species Act is "not listed."

Similarly, the USFWS conducted a status review for the bi-state population of the greater sage-grouse after receiving a listing petition. On October 28, 2013, the USFWS proposed to list the bi-state population of the greater sage-grouse as a threatened species. However, on April 23, 2015, the USFWS withdrew the proposed rule because it determined the bi-state population of the greater sage-grouse did not meet the ESA's definition of either a threatened or endangered species. The USFWS was sued on its decision to withdraw the proposed listing rule, and on May 15, 2018, the court found the USFWS‘s decision arbitrary and capricious without addressing the remedy. On March 31, 2020, the USFWS again withdrew the proposed rule to list the Bi-State DPS of the greater sage-grouse and the proposed rule under section 4(d) to designate critical habitat.

1.11.5.9 *Other Species*

WS-Nevada may be requested to use IPDM to help protect other species as well. If a management agency finds that a particular species, including federally threatened or endangered species, has been impacted by predation, WS-Nevada may be requested to assist in determining if IPDM efforts could help protect the species, and implement any appropriate IPDM actions to address it.

1.11.6 *What is the Need for WS-Nevada Assistance with Disease Surveillance?*

The increasing connectedness of our world and the increasing use intensity of our landscape amplify the potential for spillover of emerging and re-emerging pathogens in wildlife, livestock, pets, and humans. Some pathogens that circulate in wildlife are known to pose threats to livestock, pet, and human health. Threats include both mortality and morbidity, which can manifest in reduced individual growth rate, reduced fecundity, or reduced product yield. An active wildlife disease program provides WS-Nevada and cooperators with valuable information on what wildlife species are being exposed to what pathogens and an index on the level of exposure. Additionally, WS-Nevada disease sampling allows for better communication and collaboration with our partners and quicker response time to potential disease outbreaks due to trained personnel.

Detecting changes in the wildlife species exposed to pathogens and/or the level of exposure within a species indicates a change in the pathogen, host, and environment triad. This information is crucial to making disease mitigation and response decisions.

Disease surveillance and monitoring as a component of existing PDM activities reduces disease surveillance costs by eliminating a redundancy of effort in capturing predators to obtain samples. Further, under this opportunistic sampling method, only those predators captured as part of PDM activities are sampled for pathogens, thus eliminating the additive wildlife mortality that would be incurred if the PDM and wildlife disease programs were separate. Additionally, by removing individuals, PDM activities reduce the number of potential disease hosts, which may contribute to pathogen control.

Because WS-Nevada has access to many animals, either while still alive or shortly after death, as an inherent component of the activities, NDA and NDOW have requested blood and tissue samples along with the APHIS-WS National Wildlife Disease Surveillance and Emergency Response Program as an additional part of its field operations. These samples are used to test for diseases such as a plague titer from mammalian blood (primarily from coyotes). Requests for samples have increased substantially, especially because of the APHIS-WS National Wildlife Disease Surveillance and Emergency Response program. Blood samples tested for plague have helped county health departments identify plague "hot spots" within Nevada, which has assisted county health departments provide public notification regarding the risk of plague contact in these areas. WS-Nevada does not kill animals for this purpose; all samples are collected as a by-product of other operations.

1.12 What is the Effectiveness of the National APHIS-WS Program?

1.12.1 *What are Considerations for Evaluating Program Effectiveness?*

The purpose behind integrated wildlife damage management is to implement methods in the most effective manner while minimizing the potentially harmful effects on people, target and non-target species, and the environment. Defining the effectiveness of any damage management activity or set of activities often occurs in terms of losses or risks potentially reduced or prevented. Inherently, it is difficult to forecast damage that may have been prevented, since the damage has not occurred and therefore must be forecasted.

Effectiveness is based on many factors, with the focus on meeting the desired WDM objectives. These factors can include the types of methods used and the skill of the person using them, with careful implementation of legal restrictions and best implementation practices. Environmental conditions such as weather, terrain, vegetation, and presence of humans, pets, and non-target animals can also be important considerations.

To maximize effectiveness, field personnel must be able to consistently apply the APHIS-WS Decision Model (Section 2.3.1.1) to assess the damage problem, determine the most advantageous methods or actions, and implement the strategic management actions expeditiously, conscientiously, ethically, and humanely to address the problem and reduce harm to non-target animals, people, property, and the environment. Wildlife management professionals recognize that the most effective approach to resolving any wildlife damage problem is to use an adaptive integrated approach, which may call for the strategic use of several management methods simultaneously or sequentially (Courchamp et al. 2003).

APHIS-WS and professional wildlife managers acknowledge that the damage problem may return after a period of time regardless of the lethal and/or non-lethal strategies applied if a) the attractant conditions continue to exist at the location where damage occurred, b) predator densities and/or the availability of transient/juvenile animals are sufficient to reoccupy available habitats, and/or if c) predators cannot be fully restricted from accessing the problem area due to conditions and size of the damage site.

The ability of an animal population to sustain a certain level of removal and to eventually return to pre-management levels does not mean management strategies were not effective for addressing the particular event, but that periodic lethal and/or non-lethal management actions taken during a critical time of the year in specific places may be necessary in specific circumstances. The rapid return of local populations to pre-management levels also demonstrates that limited, localized actions taken to resolve a particular damage problem have minimal and/or temporary impacts on the target species' population (Sections 3.5, 3.7 and 3.8).

The use of non-lethal methods described in Appendix A and B, such as harassment or fright methods, typically requires repeated application to discourage those animals from returning, which increases costs, moves animals to other areas where they could also cause damage, and is typically temporary if habitat conditions that attracted those predators to damage areas remain unchanged. Therefore, both lethal and some non-lethal methods often result in the return of the same or new animals to the area, unless the conditions are changed and/or the animals are physically restrained from the area, such as by fencing.

One of WS-Nevada's objectives is to ensure that all PDM actions cumulatively would not cause adverse effects on statewide target predator populations, or on populations of non-target species (Sections 3.5, 3.6 and 3.7). Therefore, WS-Nevada's policy is not to cause population-wide or even localized long-term adverse impacts to the target species' populations (unless to meet NDOW management objectives), or any adverse impacts to populations of native non-target species.

Dispersing and relocating problem predators, particularly animals that have learned to take advantage of resources and habitats associated with humans, could move the problem from one area to another, or the relocated animal could return to its original trapping site. NDOW policy is to euthanize all captured coyotes and smaller predators and to never relocate problem animals, because of the healthy size of the populations statewide and the high risk of moving the problem along with the animal. These NDOW policies avoid causing damage problems in the receiving site, reduce the risk that the animal will return to its original home range, and avoid potentially causing the death of the animal due to occupied territories or unfamiliarity with the new location.

Based on an evaluation of the damage situation using the APHIS-WS Decision Model, the most effective methods should be used individually or in combination based on experience, training, and sound wildlife management principles. The effectiveness of methods are evaluated on a case-by-case basis by the field employee as part of the decision-making process using the APHIS-WS Decision Model for each PDM action and, where appropriate, field personnel follow-up with the cooperator.

1.12.2 *How Has the US Government Evaluated the Effectiveness of APHIS-WS PDM Activities?*

Different values can and do exist among wildlife management agencies, APHIS-WS cooperators, and animal rights and conservation groups regarding wildlife removals, especially lethal removals (for example, Lute and Attari 2016). For meeting various objectives, the government recently conducted two detailed audits of APHIS-WS PDM programs, including the effectiveness of the programs and compliance with federal and state laws and regulations. The audits found that the APHIS-WS PDM programs were both effective and cost-effective.

1.12.2.1 2015 USDA Office of Inspector General Report for Program Effectiveness

In FY 2014, the USDA Office of Inspector General (OIG), conducted a formal audit of the APHIS-WS Wildlife Damage Management program (OIG 2015).

The primary objective of the audit was to determine if wildlife damage management activities were justified and effective.

The audit was conducted because the agency had received considerable media attention creating controversy among the general public, animal rights organizations, and conservation groups based on allegations of unsanctioned activities conducted by some of APHIS-WS field personnel. The OIG had received numerous hotline complaints and letters from the general public and animal rights and environmental groups alleging the use of indiscriminant methods capturing non-target species, animals not dying immediately with associated concerns about humaneness (especially being held in traps), and allegations of lack of agency transparency regarding its activities.

For the audit, OIG representatives:

- Observed 40 APHIS-WS field personnel from five states, with audit locations selected based on the high number of takes of selected predators, the most unintentional kills, and/or the most hours on the job with the fewest takes;
- Interviewed 15 property owners/managers and 27 state game and wildlife officials;
- Reviewed Cooperative Service Agreements;
- Sampled logbook entries and reconciled them with the MIS data from January 2012 through January 2014; and
- Reviewed NEPA documentation for predator control.

Auditors observed field personnel setting and checking traps, snares, M-44 devices, and conducting other typical field activities, and interviewed the employees regarding their use of the APHIS-WS Decision Model to assess predation, including auditor confirmation of predator kills of livestock. The auditors watched specifically for indiscriminant killing of non-target animals and suffering of captured animals not immediately killed by the field employees, and found that the field personnel were "generally following prescribed and allowable practices to either avoid or mitigate these conditions."

In cases where non-target animals were captured or animals not killed immediately, the field employee had followed prescribed agency practices, adhering to applicable laws and regulations. Auditors also observed 2 aerial shooting operations, one for coyotes and one for feral swine, with good coordination between aerial and ground crews and full adherence to applicable laws and regulations. Auditors observed that all producers visited were using some form of non-lethal predator management, such as fencing, guard animals, and human herders, and noted that producers, not APHIS-WS field personnel, most appropriately are responsible for implementing such methods because most available non-lethal methods focus on management of the conditions rather than management of the offending animal.

The audit found that operations involving field personnel and aerial shooting operations "revealed no systemic problems with the process or manner with which the APHIS-WS conducted its predator control program, complying with all applicable federal and state laws and regulations and APHIS-WS' directives associated with wildlife damage management activities." The auditors also recognized that "Federal law provides WS broad authority in conducting its program. It also allows WS to take any action the Secretary considers necessary with regards to injurious animal species, in conducting the program."

Based on the interviews, the OIG concluded:

> "As one property owner put it, "WS [field specialists] are an absolute necessity for our business. The number of sheep they save is huge and we cannot function without them…WS specialists are professional and good at what they do." In support of this same point, a State game official we interviewed explained that WS provides help for wildlife and is run efficiently. A State agricultural official we interviewed characterized the collaboration of State and Federal programs to manage control of predators and protect domestic livestock and wildlife as 'seamless.' "

OIG had no findings or recommendations to improve the field operational and aerial shooting program actions and found them both to be justified and effective.

1.12.2.2 2001 Government Accountability Office (GAO) Report to Congressional Committees

The US Government Accountability Office (GAO) is an independent, nonpartisan agency that works for Congress. Often called the "Congressional watchdog," GAO investigates how the federal government spends taxpayer dollars (http://www.gao.gov/about/index.html). At the request of Congress, the GAO conducted a review of the APHIS-WS' IPDM program in 2001 to determine:

- The nature and severity of threats posed by wildlife (is there a need for APHIS-WS programs?);
- Actions the program has taken to reduce such threats;
- Studies conducted by APHIS-WS to assess specific costs and benefits of program activities; and
- Opportunities for developing effective non-lethal methods of predator control on farms and ranches.

The GAO met with APHIS-WS personnel at the regional offices, program offices in four states, field research stations in Ohio and Utah, and the National Wildlife Research Center in Colorado. In each state visited, they interviewed program clients, including farmers, ranchers and federal and state wildlife management officials. To obtain information on costs and benefits, they interviewed APHIS-WS economists, APHIS-WS researchers and operations personnel, program clients, and academicians. They also interviewed wildlife advocacy organizations, including the Humane Society of the United States and Defenders of Wildlife, and conducted and an extensive literature survey.

The report summary states:

> "Although no estimates are available of the total costs of damages attributable to them, some wildlife can pose significant threats to Americans and their property and can cause costly damage and loss. Mammals and birds damage crops, forestry seedlings, and aquaculture products each year, at a cost of hundreds of millions of dollars. Livestock is vulnerable as well. In

> fiscal year 2000, predators (primarily coyotes) killed nearly half a million livestock – mostly lambs and calves – valued at about $70 million. Some predators also prey on big game animals, game birds, and other wildlife, including endangered species…
>
> "Wildlife can attack and injure people, sometimes fatally, and can harbor diseases, such as rabies and West Nile virus, that threaten human health…We identified no independent assessments of the cost and benefits associated with Wildlife Services' program. The only available studies were conducted by the program or with the involvement of program staff. However, these studies were peer reviewed prior to publication in professional journals. The most comprehensive study, published in 1994, concluded that Wildlife Services' current program, which uses all practical methods (both lethal and nonlethal) of control and prevention, was the most cost effective of the program alternatives evaluated. Other studies, focused on specific program activities, have shown that program benefits exceed costs by ratios ranging from 3:1 to 27:1 [depending on the types of costs considered].
>
> "Nevertheless, there are a number of difficulties inherent in analyses that attempt to assess relative costs and benefits. Of most significance, estimates of the economic benefits (savings) associated with program activities are based largely on predictions of the damage that would have occurred had the program's control methods been absent. Such predictions are difficult to make with certainty and can vary considerably depending on the circumstances.
>
> "Wildlife Services scientists are focusing most of their research on developing improved non-lethal control techniques. In fiscal year 2000, about $9 million, or about 75% of the program's total research funding (federal and nonfederal) was directed towards such efforts. However, developing effective, practical, and economical non-lethal control methods has been a challenge, largely for two reasons. First, some methods that appeared to be promising early on proved to be less effective when tested further. Second, animals often adapt to non-lethal measures, such as scare devices (e.g., bursts of sound or light)."

The GAO review found that most non-lethal control methods – such as fencing, guard animals, and animal husbandry practices – are most appropriately implemented by the livestock producers themselves, with technical assistance from APHIS-WS, and most cooperators are already using some non-lethal methods before they request assistance from APHIS-WS.

1.12.2.3 *Conclusion*

Two recent detailed and extensive government audits of the APHIS-WS IPDM program, one requested by Congress and one conducted by the USDA Office of Inspector General, found that the need exists for IPDM on public and private lands using both lethal and non-lethal methods as implemented by APHIS-WS when requested for protecting:

- Human health and safety, including threats from predators and zoonoses,
- Livestock, agricultural crops, and other assets and property, and
- Resources under the jurisdiction of federal and state wildlife agencies.

The audits found that:

- Such programs are cost-effective and justified;
- The programs are conducted in compliance with federal and state laws and agency policies and directives; and
- The programs are both desired and effective in meeting the needs.

1.12.3 *What is the Efficacy of Large Predator Control for Protection of Livestock and Sensitive Species?*

1.12.3.1 *Background*

Berger (2006) states that predator control is one of the oldest, most globally widespread forms of wildlife management, and that, in the 17 western states, 87% of federal funding for livestock protection involves larger predators, mostly coyotes. For sensitive wildlife species, even if human-caused habitat changes are the ultimate causes of population decline, predation may be the near-term causes of extirpation or extinction when the population is already otherwise under stress (for example, Goodrich and Buskirk 1995, Mosnier et al. 2008).

Studies of effectiveness at reducing livestock depredation often inappropriately mix broad-scale studies at state-wide levels with local, ranch-scale studies (for example, Harper et al. 2008, Poudyal et al. 2016), and studies involving seasonal livestock grazing (where livestock may be within an animal's home range for part of the year) and year-round livestock grazing (Blejwas et al. 2002).

WS-Nevada IPDM works at reducing livestock losses at the producer/cooperator level. Any livestock protection strategy must involve a partnership between the producers and WS-Nevada to tailor methods to effectively address specific damage situations. A large proportion of WS-Nevada PDM work involves requests for assistance in addressing coyote depredation on livestock (Sections 1.11.2 and 3.5). Comments from the public during similar APHIS-WS NEPA processes focused heavily on concerns with coyote depredation work (USDA APHIS WS 2011; 2016). Routinely, removing individual predators such as raccoons, badgers, and foxes takes care of the problem, especially if the cooperator also partners with WS-Nevada to address the conditions causing the problems. Coyote depredation, however, may be a recurrent problem, especially in areas where livestock lambing and calving overlaps with coyote territories and movements, and new coyotes replace depredating coyotes. The high degree of selectivity of lethal and capture methods used by WS-Nevada for all PDM activities involving predators included in this EA is discussed in Sections 1.12.3.3 through 1.12.4 and Appendix A, indicating a high degree of effectiveness in focusing on the depredating animal, and their humaneness is discussed in Section 3.9. Therefore, this discussion will focus primarily on the effectiveness of WS-Nevada PDM lethal and non-lethal methods regarding large predator depredations on livestock, with some recent papers regarding the effectiveness of lethal and non-lethal PDM methods on wolf depredation included because of the degree of similarities in social and depredation patterns between coyotes and wolves, as well as mountain lion depredation.

Effective coyote removal depends on the nature of the problem, presence or absence of historical patterns, relative size of the area, season of year, timing of depredations or anticipated depredations, and efficacy, selectivity, and efficiency of methods used (Knowlton et al. 1999). Linnell et al. (1999) address the potential effectiveness of focusing predator control efforts on "problem individuals" rather than populations as a whole. The authors define a problem individual within a species that is adaptable, territorial, complex, long-lived, and exhibits individuality through behavior changes is defined as one that kills more livestock than other individuals, especially in a situation where all individuals have livestock with their home range.

Considering the effectiveness of methods or combinations of methods should optimize the degree of intensive management relative to the biological importance of individual predators in the population, since each method typically works for a limited period of time as new animals replace those removed, and management methods should be used during the season or period having the greatest potential for conflicts between predators and humans. The primary factors that should be considered when developing a PDM strategy include the biological efficiency, the economic efficiency, and its ability to increase and assuage human tolerance to damage. The success of a management technique often must be measured by the tolerance of humans to predators, their presence, and resulting damage, which is a social and psychological construct, not a predator control and ecology issue (Shivik 2006; Section 1.4.3).

1.12.3.2 *Coyote Population and Social Dynamics Related to Livestock Predation and Management*

Since the Knowlton and Stoddart (1983) study was published, researchers and PDM practitioners agree that, at a minimum, the territorial alpha pair is the basic unit of coyote, as well as wolf, populations.

Few North American predators show greater adaptability in the face of exploitation than the coyote. Recent studies indicate that livestock located within or near coyote territories, especially during the temporal overlap of livestock calving/lambing and coyote pupping seasons, may experience a higher level of predation. Studies have found that coyote livestock depredation is almost exclusively caused by the alpha breeding pair (Knowlton et al. 1999, Gese et al. 1996b, Sacks et al. 1999b, Blejwas et al. 2002, Jaeger 2004). Within a pack, only the alpha pair breed and only 10% of the young from a given pair need to survive and reproduce to replace the pair. The remaining 90% of the beta and transient animals in a pack either stay in the pack without reproducing, die, or disperse (Knowlton et al. 1999). Therefore, population size and the territories themselves tend to remain relatively stable over time.

Selective removal of the alpha breeding pair shortly after the first depredation occurs so that any replacement pair does not have time to breed before the calving/lambing season concludes may be highly effective. However, selectivity for the alpha pair within their territory may be difficult because the alpha animals know their territory well, and new objects or human activity may also be well known, tracked, and avoided. Methods, including trapping and use of M-44s, may be less effective at directly selecting for individual alpha animals because it is not possible to know which animals make up the alpha pair without either DNA samples taken from saliva left on depredated animals or identifying when the depredation ceases during the lambing/calving season that year or the next (Jaeger 2004, Mitchell et al. 2004). Gantz and Knowlton (2005) suggest that late winter aerial shooting of coyotes living at high mountain elevations in close proximity to the grazing allotments in need of depredation relief would possibly include the territorial coyotes apt to be present the following summer and, therefore, reduce the likelihood that the territories would be repopulated by breeding coyotes the following spring.

Sterilizing the alpha pair to keep them from reproducing while maintaining their territory may be effective if the alpha pair can be identified and live captured (Till 1992, Mitchell et al. 2004). Killing the pups of the alpha breeding pair in the den may be the most selective method, as the presence of pups needing sustenance appears to strongly influence depredation by breeding pairs and only the breeding alpha pair has pups (Blejwas et al. 2002, Jaeger 2004, Mitchell et al. 2004). Ground or aerial shooting at or near the den can often be highly selective for the alpha animals. Succeeding in removing the alpha pair or their pups reduces depredation until another breeding pair with pups becomes established in the territory and if that breeding pair decides to begin livestock depredation. The time period before depredation begins again may range from days to many months, if not the following spring, depending on the situation and when the animals are removed (Blejwas et al. 2002, Jaeger 2004).

However, coyote depredation rates are also influenced by livestock husbandry and management practices, breed and age of livestock, environmental factors, coyote biology and pack behavior, and the type and intensity of depredation management programs (Knowlton et al. 1999). Studies have shown that removal of the "problem individuals" (corrective removal) even without knowing their status within the pack, and preventive removal prior to the livestock lambing/calving season, may also be effective at the ranch/farm level (Wagner and Conover 1999).

1.12.3.3 *Effectiveness of PDM methods for Coyote Depredations*

Authors have discussed the effectiveness and selectivity of various methods commonly used by producers and/or PDM field personnel Table 1.18). For capture and removal methods, effectiveness and selectivity also depends highly on the skill, experience, and expertise of the user.

Table 1-18. Effectiveness of Coyote Depredation Reduction Methods (adapted from Mitchell et al. 2004, Jaeger 2004, Shivik, 2006 and Shivik et al. 2014).

Non-lethal Methods (more effective when directly interactive with the coyote)		
Method	**Advantages**	**Disadvantages**
Fencing	May be nearly 100% effective if constructed correctly (high, and cannot dig under)	Only effective in small areas where livestock can be enclosed and watched; high construction and maintenance costs
Birthing sheds, lighting corrals at night	May be effective with sufficient human presence	Only effective in small areas where livestock can be enclosed and watched; high construction and maintenance costs
Herders	May be effective with unpredictable and constant human presence	Human-intensive; only effective if stock are not widely dispersed in areas with sufficient cover for predators
Guard animals (dogs, llamas, donkeys)	May be effective with unpredictable and constant human presence, and if well trained	Only effective if stock are not widely dispersed in areas with sufficient cover for predators; may be killed by predators; may attack pets if in recreation area; some may begin to kill livestock; wolves may befriend guard dogs
Physical harassment (paintball with capsicum powder, rubber bullets, beanbag rounds, harassing dogs)	May be effective with unpredictable and constant human presence; address individual animals causing conflict at the time of conflict or potential conflict	Some ammunition may be limited to use by law enforcement; some ammunition, such as rubber bullets, may harm animals; harassment may have to be repeated if animals become habituated
Aversion (lithium chloride)	May be affective for short time, if the animal can tie it directly to the presence of livestock	Not effective if in baits, because animal does not associate the aversion with the livestock attacked; must be maintained; animals may habituate
Shock collars attached through snares	Still in testing stage	Expensive; must be attached to depredating animal through a snare or capture, and activated when the animal is near livestock
Electronic guard strobe light/alarm sound	Needs collared animals to activate the mechanism so that the harassment is directly associated with the activities, rather than random activation	Animals may habituate rapidly to random activation, especially if the animal does not associate the alarm with their presence; not currently commercially available

Sterilization	May be effective if sterilize alpha breeding pair that maintain territory without pups in areas where livestock is seasonal	May be difficult to identify alpha breeding pair unless at the den; may be expensive and labor intensive if alpha pair not identified
Lethal Methods (more effective when selective for target species and offending individuals; may be important tool for a successful reintroduction of a large predator because of the option for removing them when they cause conflict; improves trust of cooperators in effectiveness)		
Method	**Advantages**	**Disadvantages**
Capture and lethal devices (traps, snares, M-44s)	Highly selective for species when used with appropriate baits, sets, and equipment	May not be as selective for targeting individual coyotes; younger, beta, transient coyotes substantially more vulnerable than alpha coyotes in territory
Aerial shooting	Highly selective for species, indication of pre-season effectiveness under some circumstances	May not be as selective for targeting individual coyotes; younger, beta, transient coyotes substantially more vulnerable than alpha coyotes in territory; unable to know if alpha coyote unless associated with a den
Sodium nitrate canisters (denning)	Highly selective for targeted alpha breeding pair to reduce depredation; reduces need to kill other adult coyotes that may not be offenders	May have problems with negative public perception
Coyote calling/ground shooting	Highly selective for species, possibly for individuals; calling may be used to lead field personnel to the den	May not target individual offending animals unless occurring at or near the time of depredation or animals are associated with a den; may also involve beta animals, especially helper animals at the den

1.12.3.4 *Effectiveness of PDM Methods for Wolf Livestock Depredations*

As wolf behavior, territoriality, and behavior is similar to that of coyotes, considering how to evaluate the effectiveness of wolf damage management may have relevance for coyotes as well. These papers may provide some important considerations regarding effectiveness of various approaches to pack lethal and non-lethal management. WS-Nevada is not proposing to target wolves with any PDM activities and has completed informal consultation for PDM activities that may inadvertently affect wolves. This discussion is provided as a review of recent studies and discussion on PDM efficacy.

For wolves recolonizing in the Midwestern US, human activity associated with trapping at a particular farm, even if unsuccessful, may reduce livestock depredation more than not trapping at all (Harper et al. 2008). In an often cited publication, Wielgus and Peebles (2014) conducted an effectiveness study involving wolves in the same area as Harper et al. (2008) and reported apparent correlations between increasing the number of removals of wolves up to the number representing <25% of the wolf population (at which point they speculate that the number of breeding pairs decline, resulting in less livestock depredation) and increasing loss of livestock to depredation. The authors admitted that they did not know the reason for this 'counter-intuitive' finding, and suggested that further research is needed. However, Poudyal et al. (2016) evaluated the same data set as Wielgus and Peebles (2014) used in order to test their findings. The authors found problems with the soundness of Wielgus and Peebles (2014) statistical methods and analytic oversights in their analyses. These included conducting analysis at the state level, which confounds statistical relationships by combining packs, and at the biological scale of the individual pack, which is more appropriate based on wolf biology and ecology and livestock management practices. Poudyal et al. (2016) found wolf removals in one year actually resulted in fewer depredations the following year at the level of the wolf pack, in support of the findings of other researchers in the same geographic area. The authors concluded: "Had the 'counter-intuitive' findings [of Wielgus and Peebles (2014)] not been scrutinized closely through replication, the accidental findings would be/been propagated as truth. Any management and conservation practices and decisions informed by such accidental findings can be problematic."

In a 20-year study, Bradley et al. (2015) evaluated the effectiveness of three wolf management treatments in reducing livestock depredation in Montana, Idaho, and Wyoming. The study analyzed 967 depredations by 156 wolf packs on primarily sheep and cattle operations. The authors found that no lethal removal resulted in a median time to the next depredation of 19 days, lethal removal of some of the pack members resulted in a median recurrence time of 64 days, and removal of the entire pack resulted in a median recurrence time of 730 days after a new pack occupied the territory. Compared to no wolf removal, removal of the entire pack reduced subsequent depredations by 79%, and partial pack removal reduced the occurrence by 29% if the removals occurred within seven days of the depredation event. The authors suggest that pack size is the best predictor of recurring depredation events, with the probability of such an occurrence increased by 7% for each animal left in the pack. The authors indicated that effectiveness of wolf management in reducing depredation must be evaluated at the wolf pack or territory level (also suggested by Musiani et al. 2005), while recovery of wolf populations must be evaluated at a broader regional or statewide scale. With no or partial removal, 53% and 31% of the packs, respectively, were counted as breeding pairs the following year, increasing the risk of depredation. The authors could not evaluate the effectiveness of non-lethal preventive methods, such as husbandry, fencing, and harassment, because of the wide diversity of methods used, inconsistency in their application, and sparse record keeping. As with other studies, the authors caution against extrapolating their findings to other areas and time periods.

Stone et al. (2017) studied adaptive use of non-lethal strategies for minimizing wolf depredation on sheep managed on open range grazing operations in Idaho. Various non-lethal methods were applied and adapted in areas based on terrain, proximity to wolf den or rendezvous sites, and avoiding overexposure to harassment methods resulting in habituation. The methods involved increased human presence, especially at night; increased numbers of livestock guarding dogs after wolf pups left the den, which avoided aggressive wolf behavior toward the dogs; use of high powered halogen spotlights at night; harassment devices activated by radio collars on wolves; fladry at the right height, including fladry placed on electrified fences; penning sheep at night when wolves were suspected nearby; starter pistols firing blanks and loud air horns when wolves were present; intermittent bright flashing lights; and following wolves using radiotelemetry. Trained field technicians worked closely with the shepherds, including camping at night near the sheep bedgrounds, working with the management agency to devise alternative grazing rotations to avoid encounters, alternating harassment methods to reduce habituation, helping determine the strategy of what methods, how many to use, and when to change methods, and ensuring that the non-lethal methods were implemented effectively.

This was not a rigorous study design with randomized treatment and control sites that contrasted management strategies, thus the authors recommend that the results should be interpreted cautiously. There could be inherent differences in predation rates from the area in which their case study occurred that are not accounted for in their study design. Furthermore, as pointed out in the paper, they did not consider regulated hunting and trapping and administrative removal of entire wolf packs that was ongoing in the area, which could have impacted their results in unknown ways. The authors recommend a combined approach incorporating consistent human presence at night, wolf monitoring with radio collars to determine and predict pack movements, and appropriate deterrents carefully applied. Estimated costs from the projects ranged from $22,000 to $48,000 annually, with technician labor and field transportation representing more than 85% of the total annual costs. An unquantified but significant amount of labor was provided as volunteer help, which was not included in the calculated costs. The applicability of this study to other systems is unknown, for example, with cattle in open range grazing situations. The conclusion that increased human presence and the use of nonlethal tools in an adaptive fashion could apply as recommendations for livestock producers when conditions as outlined in this paper warrant this strategy. Those conditions include sheep grazing in open rangeland grazing systems, resources to improve ability to monitor sheep and wolves particularly at night, and cooperation from natural resource agencies responsible for managing grazing on public lands. Some of the livestock operators continued using the non-lethal strategies outlined in this paper.

1.12.3.5 *Relationship of Hunting and Mountain Lion Depredation*

A recent paper by Teichman et al. (2016) studies long-term data sets regarding age and sex of mountain lions taken during hunting seasons and those taken on depredation in western Canada. They found correlations between human encroachment into mountain lion habitat increasing the potential for depredation, and that young mountain lions were more likely to occur in areas used by people than other age classes. Dispersing juveniles were more likely to cause conflict with humans when traveling through fragmented habitats and high-risk areas including areas of human habitation, roads, and ranches, where juveniles, especially males, may attack livestock. The authors found correlations with human hunting tending to take larger adult animals rather than smaller juveniles (trophy hunting), which may increase immigration of dispersing juveniles from neighboring areas. They found that high hunting-related mortality in the same or preceding time period was positively associated with mountain lion-human conflict, especially with young males, as hunters typically target larger adults. Hunting can disrupt social structures leading to increased juvenile immigration and result in younger age structure in the population. They concluded that juvenile male mountain lions appeared more susceptible to conflict if hunted more intensively. The data also suggested that similar to other carnivores, mountain lion populations can persist in regions with high human densities as long as human hunting pressure is low. The authors recommend that targeting individuals causing the conflict may be an effective way to address human conflicts with large carnivores and caution against the use of hunting as a tool for managing conflict with larger predators. They also acknowledge that their data shows only correlation and not causation and acknowledged that lethal PDM that targets the individual causing the damage is one way to address human-mountain lion conflict.

1.12.3.6 *Conclusions*

Most authors recognize that more research is needed regarding coyote ecology and biology related to social dynamics and use of livestock and natural prey, and costs, benefits, and disadvantages (Knowlton et al. 1999, Blejwas et al. 2002, Mitchell et al. 2004).

Because of inherent population dynamics of large predators, including immigration/emigration, recruitment, territoriality, social dynamics, and inherent behavioral and learning adaptability, as well as differences in livestock management methods and changing circumstances, PDM for livestock and sensitive species protection will by definition be short-term and necessarily repeated as needed (Knowlton et al. 1999, Goodrich and Buskirk 1995, Mosnier et al. 2008). Targeting the individual(s) causing the conflicts is a demonstrated way to address specific conflict situations. APHIS-WS NWRC is constantly working to develop and test new lethal and non-lethal methods for predators. APHIS-WS and WS-Nevada field personnel are highly experienced and trained in use and deployment of methods to increase effectiveness and selectivity (Sections 3.7 and 3.9).

WS-Nevada is consistently requested to assist with depredation and damage involving many different large predators, including coyotes and mountain lions. The targeted PDM methods and applications, both lethal and non-lethal, have been shown to effectively assist cooperators with losses and damage, improving the economic viability of individual operations.

1.12.4 *Are Field Studies of Effectiveness of Lethal PDM for Livestock Protection Sufficient for Informed Decision-Making?*

A recent paper (Treves et al*.* 2016) criticizes research methods used for evaluating the effectiveness of lethal PDM for protection of livestock and recommends suspension of such PDM methods that do not currently have rigorous evidence for functional effectiveness until studies are conducted using what the authors call a "gold standard" study protocol. The "gold standard" protocol recommended by the authors is called the Before/After-Control/Impact (BACI) protocol, which uses a sampling framework to attempt to assess status and trends of physical and biological responses to major human-caused perturbations in the environment. It involves sampling in the area proposed for perturbation before the perturbation occurs and after the perturbation occurs, and comparing the results to each other and to those measured in a control area. This protocol is often used in controlled biomedical research and point-source pollution or localized restoration studies, where the human-caused perturbation is relatively localized and non-mobile.

In order to meet the "gold standard" requested by Treves et al*.* (2016), BACI is best applied using multiple control sites that are sufficiently similar to the perturbed site (Underwood 1992) in order to overcome inherent natural variability in ecological systems, a very difficult standard. Unreplicated sampling involved in the BACI model inherently does not provide the strong inferences that Treves et al. (2016) requests for their "gold standard" (Underwood 1992).

In the case of predation management on livestock, finding multiple field study sites that not only prohibit predator management while also allowing livestock grazing is difficult. As experienced in Marin County, California, in the absence of professional predator removal, livestock producers often hire a commercial company or remove animals themselves, often using methods that are not selective for the offending animal (Shwiff et al*.* 2005, Larson 2006).

Depredation on livestock involves highly mobile animals capable of learning and behavior adaption, with seasonal and social biological variations, tested against highly variable livestock management practices and inherently highly variable conditions such as weather, unrelated human activities (such as hunting or recreation), and natural fluctuations in habitat and prey quality and abundance.

APHIS-WS understands and appreciates interest in ensuring PDM methods are as robust and effective as possible. The APHIS-WS NWRC collaborates with experts from around the world to conduct these studies and findings are published in peer-reviewed literature. APHIS-WS supports the use of and uses rigorous, scientifically sound study protocols. APHIS-WS also realizes that field studies involve many variables that cannot be controlled and assumptions that must be acknowledged when trying to analyze complex ecological questions. Wildlife research is inherently challenging because scientists are not working in a "closed" system, such as a laboratory. Researchers must apply study protocols that are capable of differentiating between natural inherent fluctuations and statistically meaningful differences.

Two alternative field designs that are commonly used in wildlife research include a switch-back model and paired-block approach. In the case of a study of the effectiveness of predator management methods on addressing livestock depredation, a switch-back study design involves at least two study areas, one (or more) with predator removal and one (or more) without predator removal. After at least two years of data collection, the sites are switched so that the one with predator removal becomes the one without predator removal, and vice versa, with an additional two years of data collection. The paired-block design involves finding multiple sites that are similar that can be paired and compared. For each pair, predators are removed from one site and not from the other. Using study designs with radio collars on highly-mobile terrestrial predators with interacting social systems also provide a robust method for determining the actual movements, locations, periodicity and seasonality, activity type, social interactions, habitat use, scavenging behavior, and other important factors associated with individual animals, allowing statistical analysis for some study questions and providing the capability for clearer conclusions.

Underwood (1992) states: "BACI design, however well intentioned, is not sufficient to demonstrate the existence of an impact that might unambiguously be associated with some human activity thought to cause it…[because] there is no logical or rational reason why any apparently detected impact should be attributed to the human disturbance of the apparently impacted location…Thus, such unreplicated sampling can always result in differences of opinion about what the results mean, leaving, as usual, the entire assessment to those random processes known as the legal system."

Therefore, APHIS-WS has determined that it is fully appropriate to continue using existing tools and methodologies, and to continue developing and testing new tools and methods to meet the need for PDM per its statutory mission.

1.13 What Role Does Cost-Effectiveness Play in WDM and NEPA?

A concern commonly raised by the public during similar APHIS-WS NEPA processes expressed about government-supported predator damage management is whether the value of livestock or game population losses are less than the cost of using at least some public funds to provide predator damage management services (USDA-APHIS-WS 2011; 2014; 2016).

However, this concern indicates a misconception of the purpose of predator damage management, which is not to wait until the value of losses is high, but to prevent, reduce, or stop losses and damage where it is being experienced, the property owner's level of tolerance has been reached, and assistance is requested. PDM would reach its maximum success if it prevented all losses or damage, which would mean the value of losses or damage due to predators would be zero. However, in the real world, it is not reasonable to expect zero loss or damage (see Section 1.11.2). Also, wildlife damage management involves not only the direct costs (costs of actual lethal and non-lethal management) but also the considerations of effectiveness, minimization of risk to people, property, and the environment, and social considerations (Shwiff and Bodenchuk 2004).

Evaluating the economic value of losses that would be avoided or reduced with implementation of a predator damage management program is inherently difficult and very complex (Shwiff and Bodenchuk 2004). Relevant scientific literature suggests that, in the absence of predation management, predation rates on livestock would likely increase (Bodenchuk et al. 2000; Section 1.11.2).

Methodologies that attempt to evaluate the economic values of livestock losses and reducing those losses can depend on many variables, such as local market values for livestock, age, class and type of livestock preyed upon; management practices used; geographic and demographic differences; and applicable laws and regulations. However, attempting to evaluate the economic value of success of conservation projects, such as improving the number of surviving elk calves per 100 cows in an areas experiencing high predation in the spring, or the economic value of the predator itself is even more difficult, because wildlife populations have no inherent measurable monetary value, and any such value must therefore be evaluated indirectly, such as through willingness to pay for consumptive or non-consumptive recreation, for example (Section 1.13.6). Section 1.13.4 discusses other factors, complexities, and methods involved in evaluating the economic values of predator damage management.

1.13.1 *Does APHIS-WS Authorizing Legislation Require an Economic Analysis?*

No. The statute of 1931, as amended does not incorporate consideration of economic valuations and cost-effectiveness for the WDM program as part of decision-making (Section 1.5.1). In addition to authorizing the WDM services, it provides for entering into agreements for collecting funds from cooperators for the services the agency provides.

1.13.2 *Does NEPA and the CEQ Require an Economic Analysis for Informed Decision-making?*

Section 102(2)(B) of NEPA requires agencies to:

> "[I]dentify and develop methods and procedures...which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decision making along with economic and technical considerations…"

NEPA ensures that federal agencies appropriately integrate values and effects that cannot be quantified from an effects or cost-effectiveness standpoint into decision-making. Such unquantifiable values can include, for example, the value of viewing wildlife, human health and safety, aesthetics, and recreation.

The CEQ regulations at 40 CFR §1502.23 takes a similar position in support of the law:

> "If a cost-benefit analysis relevant to the choice among environmentally different alternatives is being considered for the proposed action, it shall be incorporated by reference or appended to the statement as an aid in evaluating the environmental consequences. To assess the adequacy of compliance with section 102(2)(B) of the Act the statement shall, when a cost-benefit analysis is prepared, discuss the relationship between that analysis and any analyses of unquantified environmental impacts, values, and amenities. *For purposes of complying with the Act, the weighing of the merits and drawbacks of the various alternatives need not be displayed in a monetary cost-benefit analysis and should not be when there are important qualitative considerations. In any event, an environmental impact statement should at least indicate those considerations, including factors not related to environmental quality, which are likely to be relevant and important to a decision."* (Emphasis added)

WS-Nevada has determined that there are important qualitative values that are relevant and important to its decision-making that are considered in this EA, but that those considerations will not be monetized.

Cost-effectiveness is an important factor in IPDM decisions but not the primary goal of APHIS-WS. Whenever a request for assistance is received, WS-Nevada field personnel consider additional constraints, such as environmental protection, land management goals, presence of people and pets, and social factors using the APHIS-WS Decision Model. These constraints may increase the cost of implementing PDM actions while not necessarily increasing its effectiveness, yet they are a vital part of the APHIS-WS program (Connolly 1981, Shwiff and Bodenchuk 2004). Connolly (1981) examined the issue of cost-effectiveness of federal predator damage management and concluded that public policy decisions have been made to steer the program away from being as cost-effective as possible, including the restriction of management methods believed to be highly effective but less environmentally or socially preferable, such as toxic baits, including traps and the livestock protection collar (LPC), which is highly specific to the offending animal (Shelton 2004). Also, state and local jurisdictions are limiting the methods available for PDM. Thus, the increased costs of implementing the remaining more environmentally and socially acceptable methods to achieve other public benefits besides resource and asset protection could be viewed as mitigation for the loss of effectiveness in reducing damage.

Services that ecosystems provide to resources of value to humans can be considered in qualitative and/or economic terms. The Memorandum entitled "Incorporating Ecosystem Services into Federal Decision Making" issued by the CEQ, the Office of Management and Budget (OMB) and the Office of Science and Technology Policy (OSTP) on October 7, 2015 (Donovan et al. 2015) does not require an economic test for the ecological services to be considered valuable.

The Memorandum states:

> "*[This memorandum] directs agencies to develop and institutionalize policies to promote consideration of ecosystem services, where appropriate and practicable, in planning, investments, and regulatory contexts. (Consideration of ecosystem services may be accomplished through a range of qualitative and quantitative methods to identify and characterize ecosystem services, affected communities' needs for those services, metrics for changes to those services, and, where appropriate, monetary or nonmonetary values for those services.)…Adoption of an ecosystem-services approach is one way to organize potential effects of an action within a framework that explicitly recognizes the interconnectedness of environmental, social, and, in some cases, economic considerations, and fosters consideration of both quantified and unquantified information.*"

Therefore, neither NEPA nor CEQ guidance requires economic analyses for informed decision-making unless relevant to the understanding differences among alternatives.

The qualitative considerations at issue in this EA are evaluated in Chapter 3 and the agency's decision based on all considerations, including non-quantifiable values, will be explained in the decision document.

1.13.2.1 *Are the Recommendations of Loomis (2012) for Economic Analysis Applicable to APHIS-WS Activities?*

A non-peer reviewed Issue Paper prepared by Loomis (2012) for the Natural Resources Defense Council (NRDC) "strongly recommended" that APHIS-WS improve its economic analysis methods for its IPDM programs. APHIS-WS disagrees with the author's conclusion and recommendations.

Loomis (2012) argues, and Bergstrom et al. (2014) agrees, that APHIS-WS should apply the same economic approach required by Congress for large capital improvement projects using natural resources (such as water) by:

> "honestly evaluating which programs are legitimately a high priority for funding [which] may aid Wildlife Services in dealing with USDA and US Office of Management and Budget…While economics should not be the only factor considered in natural resources management, economics is frequently an issue raised by one side or the other in these contentious debates over predator management. Having accurate and objective economic analysis can aid Wildlife Services in judging the validity of these claims."

Loomis (2012) questions the actual need for livestock protection from predators in support of agricultural profitability, and strongly recommends that economic analyses be conducted by APHIS-WS. His argument is based on policies of several federal agencies with substantially different missions and projects for preparing economic analyses as the basis for "strongly recommend[ing]" that APHIS-WS do the same.

The agencies the author uses as examples are those that either fund or construct major civil works actions (capital improvement projects) with long life spans, such as the US Army Corps of Engineers (USACE), the Federal Highway Administration (FHWA), the Bureau of Reclamation (BOR), Tennessee Valley Authority (TVA), and the Federal Emergency Management Agency (FEMA). Loomis (2012) especially uses the National Economic Development requirements for large water projects funded and/or constructed by BOR and USACE as the example for APHIS-WS use. However, Congress has specifically required that the BOR and USACE consider the National Economic Development (NED) for decision-making for their large civil works water projects (such as large dams, river management, etc.) that "necessarily confronts choices among possible alternative courses of actions that involve tradeoffs in economic and other opportunities" (USACE 2009). The NED is required because, as the report quotes from the USACE *Principals and Guidelines* "Contributions to national economic development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units… [with regards to selecting a particular plan for a particular water-related civil works project] "A plan recommending Federal action is to be the alternative plan with the greatest net economic benefit consistent with the Nation's environment (the NED plan)"… [which must be selected] "unless the Secretary of a department or head of an independent agency grants an exception when there is some overriding reasons for selecting another plan, based on other Federal, State, local and international concerns." This requirement assumes that "federal civil works investments should be considered only for project plans that maximize net economic benefits – measured in terms of a single index of monetary value – realized by the nation as a whole." Decision-making for USACE and BOR large water-related civil works projects is driven primarily by economic and public benefits considerations at the national level, with other factors given secondary consideration.

The NRCS, another example used by Loomis (2012), is required by Congress to conduct economic analyses for agency decision-making regarding whether to fund conservation projects, especially under Congressional statutes such as Farm Bills (NRCS Manual 200 Natural Resources Economic Handbook Part 613.0; http://directives.sc.egov.usda.gov/viewDirective.aspx?hid=37536). FHWA considers costs of various alternative ways of meeting highway transportation needs, but is not required to rely on the results of economic analyses for its decision-making.

It is clear that these examples of agency uses of economic analyses, most of which are Congressional statutory requirements for large civil works projects or other large Federally-funded projects, are not directly relevant to a "fee for service" agency such as APHIS-WS in which Congress has not required any economic test for its WDM services, and which is supported by both Congressional appropriations and cooperator contributions and funds. The need for large capital improvement projects that use or impact large quantities of natural resources are typically already approved and funded by Congress through legislation; the agency decisions remaining are specifically how to meet the approved need through the consideration of the cost-effectiveness of alternative means, as mandated by Congress through consideration of the NED at the national level. These analytic economic models and considerations required by Congress to be used for decision-making by federal agencies regarding large civil works/capital improvement) projects are not applicable for APHIS-WS decision-making at the national, regional, or local levels.

1.13.3 *How Have Recent Studies Considered Economic Evaluation of WDM Activities?*

Recognizing that many factors affect the viability and profitability of livestock operations, such as weather, the cost of wages and supplemental feed, livestock meat and wool market prices (Berger 2006), as well as the increase in synthetic fibers, predation on livestock is clearly one. NASS (2005) reported that predator losses represented a large percentage of losses when compared with six non-predator related losses of cattle and calves nationwide. For example, 190,000 losses of cattle and calves were reported by NASS in 2005. Compared to total losses, including predator losses, for losses due to poor health, losses during calving, and weather-related losses, predation accounted for 8.9%, 24.9%, and 40.9% respectively. Livestock losses due to predation are also not experienced uniformly on all properties across the industry; a few producers often absorb the majority of losses, especially those on public rangelands and private properties adjacent to such protected habitats (Shelton 2004). A study in Wyoming of ranch-level economic impacts in a range cattle grazing system conducted by economics professors at the University of Wyoming (Rashford et al. 2010), indicates that predation on calves can have a substantial impact on ranch profitability and long-term viability through loss of calves available for sale, increased variable costs (such as hay and feeds, veterinary costs, fuel, equipment repair, trucking, and labor) per calf, and, anecdotally perhaps, weaning rates from predator harassment. The study found that increased calf loss "takes a larger toll on profits because it erodes the ranch's core profit center, calf sales…The results suggest that predation can have significant impacts on both short-term profitability and long-term viability depending on the mechanism [by which predation can affect profits]." The study identifies social and ecosystem benefits to keeping ranches in the western US viable and profitable through the open spaces and wildlife habitat they provide. The study concludes that "predator control activities would only need to reduce death loss due to predators or reduce predator impacts on weaning rates by approximately 1% to be to be economically efficient…The relationship between predation, ranch viability, and the ecosystem services provided may justify public spending on predator control." Conversely, at a larger scale, Berger (2006) suggested that 77% of changes in sheep numbers correlated positively with lamb prices, hay prices and wage rates, and suggested that cash or other subsidies might be more effective (see Section 1.13.7.2 for a discussion on compensation for depredation). However, APHIS-WS is requested to address losses due to predators at the producer level and does not address losses at a broader economic scale. Further research regarding ranch profitability at the producer level is needed, and differs based on ranch-level conditions, operations, and livestock type.

The audit conducted by the United States Government Accountability Office (2001) concluded, based on studies focused on specific APHIS-WS PDM activities in different areas of the country, they evaluated, that livestock PDM activities are economical, with benefit to cost ratios ranging from 3:1 (comparing the market value of all livestock saved in 1998 with the cost of all livestock protection programs in place) to 27:1 (comparing total savings with federal program expenditures, including a measure that shows the potential ripple effects on rural economies). PDM to protect wildlife shows a benefit to cost ratio of 2:1 to 27:1. Activities performed to protect human health and safety are impossible to quantify, but the value of a human life is incalculable. The GAO (2001), however, recognized that estimates of the economic benefits (savings) associated with program activities are based largely on predictions of the damage that would have occurred had the program's control methods been absent, with inherent uncertainties, substantial variations in circumstances, and inability to distinguish between the results of PDM activities and other factors such as weather, disease, and natural fluctuations in predator and prey populations.

Most economic analyses of the relationship of livestock profitability and predator control are conducted at the scope of contribution to local and regional economies. This approach dilutes the recognition that some ranch operations are impacted financially by predation at a higher rate than others, depending on factors such as livestock being grazed adjacent to quality predator habitat (such as ranches near federally managed lands resulting in "predator drift;" Shelton 2004), grazing overlapping with predator territories, and grazing in areas with high concentrations of unprotected livestock, especially during lambing and calving. Based solely on need expressed by livestock operators on public and private lands, APHIS-WS does not operate on every ranch operation, only those experiencing predation problems, and then only those requesting assistance from APHIS-WS. APHIS-WS operates predator damage management with paying cooperators at the individual ranch operation level, not the regional level, which is not reflected in typical economic analyses published in the literature (for example, Rashford et al. 2010, Loomis 2012). This approach also does not consider support for other needs for which APHIS-WS is routinely requested, such as threats to human/pet health and safety, operations at airports, risk of wildlife disease spread, and protection of property.

A team of economic specialists from the NWRC conducted an economic assessment of select benefits and costs of APHIS-WS in California. The assessment focused primarily on damage in agricultural areas because urban wildlife damage figures were not readily available. During the study year, cooperating California counties paid on average 57% of the cost of their WS-California specialists. Results of the study indicate that for every $1.00 California counties invest in APHIS-WS, they save between $6.50 and $10.00 in wildlife damage and replacement program costs (Shwiff et al. 2005). Considering the total cost of APHIS-WS field personnel, the benefits were found to be between $3.71 and $5.70 for every $1.00 of county investment.

Other studies have shown positive results for benefits to costs. An economic assessment of the California Cooperative Animal Damage Control program was completed for a 10-year period between 1980 and 1990. The results showed a cost to benefit ratio of 1:8 for direct producer benefits, and a cost to benefit ratio of 1:21 for the general public (USDA 1991). Schwiff and Merrill (2004) reported 5.4% increases in numbers of calves brought to market when coyotes were removed by aerial shooting. Wagner and Conover (1999) found that the percentage of lambs lost to coyote predation was reduced from 2.8% to less than 1% on grazing allotments in which coyotes were removed 3-6 months before summer sheep grazing.

Wakeling et al. (2015) used a "cost and return-on-investment" approach to determine the economic cost or benefit of limited coyote removal to benefit pronghorn antelope in Arizona. Two game management units were used as treatments (aerial shooting and foothold trapping conducted) while 2 were used as controls (no aerial shooting, no foothold trapping). The result was that limited lethal removal was not financially effective for the State during the duration of the study e.g., in 1 treatment unit, the cost of the coyote removals was $197,071, whereas the return to the economy (revenue from hunting permits + revenue from food, lodging, ammunition and supporting equipment) was $97,576.22. The authors did point out that when implemented correctly, limited lethal predator removal may provide relief to a prey population in danger of extirpation. They also point out the financial cost of population replacement (post extirpation) can be tremendous and far exceed the temporary cost of manipulating predator populations.

Variables that would change the cost to benefit ratio of a damage management program include: local market values for livestock, age, class and type of livestock preyed upon, management practices, geographic and demographic differences, local laws and regulations and APHIS-WS polices, the skill and experience of the individual APHIS-WS employee responding to the damage request, and others.

1.13.4 *What are the Various Factors and Methods for Evaluating Cost-Effectiveness?*

Bodenchuk et al. (2002), Shwiff and Bodenchuk (2004), and Shwiff et al. (2005) describe the primary types of considerations for conducting economic analyses of PDM:

- **Direct Benefits:** These are typically calculated as the number of individual animals saved from predation, representing a cost savings, in that with predation management a certain number of losses or amounts of costs can be avoided. The dollar value of the species or animals saved represents the direct benefits of the program and the losses avoided by producers. However, determining the market value for livestock and wildlife species saved is difficult, with livestock usually valued using market price, which is typically conservative, and wildlife species using civil values. Number of animals lost in the absence of PDM activities is difficult to determine. Also reported losses are most likely substantially fewer than actual losses, as many losses are not reported to authorities, not all losses are found in the field, and many carcasses found are too consumed or decayed to make a clear determination of cause of death and species responsible.

- **Spillover Benefits (secondary, indirect, or incidental benefits):** These benefits are an unintentional side effect of the primary purpose of the PDM program, and may be evaluated using multiplier values from the direct benefits. Spillover benefits can include benefits to wildlife populations in the same geographic area. Indirect benefits can include benefits to local and regional economies.
- **Intangible Benefits:** Such benefits include increased cooperation from landowners as a result of the implementation of PDM, such as facilitating landowner participation in other conservation efforts or potentially minimizing amateur efforts to control predators, which may not be as selective or humane as those conducted by trained professionals.
- **Direct Economic Effects/Costs:** These costs reflect the value of losses to the livestock operator and the associated reductions in purchases for directly supporting those livestock as well as the costs of lethal and non-lethal PDM activities for protection of livestock and/or localized wildlife species, such as valued big game species, recently introduced native species, or ESA-listed species,.
- **Indirect Economic Effects:** These effects are generated as livestock loss alters producer purchases of supplies from other industries in the region and outside the region, resulting in additional jobs, increased income for the region, and greater tax revenues.

All of these factors are complicated, interrelated, and difficult to delineate and quantify. As different economic studies use different factors, values, and multipliers, they are very troublesome to make comparisons.

The following summarizes the types of economic analyses typically applied to predator damage management, especially associated with livestock contributions to regional economies (discussed in Schuhmann and Schwabe 2000, Shwiff et al. 2005, Rashford and Grant 2010, Loomis 2012, Shwiff et al. 2012):

- **Cost: Benefit Analysis:** Considers measures of costs that include financial costs (out of pocket expenditures such as for fencing and guard dogs) and opportunity costs (benefits that would not be availability to society based on predator control actions taken today) and measures of benefits as evaluated by a consumer’s (increase in enjoyment/satisfaction) or producer’s (increases in profit) willingness-to-pay (WTP) for one more unit of the identified “good”, considered either on a personal level or societal level. On a personal level, the “good” is considered to have economic value if the individual person (recognizing that individuals have differing value systems) receives enjoyment/ satisfaction from the “good” and if the “good” is to some degree scarce. Opportunity costs must also be considered – costs/resources spent on a good that cannot then be used for another purpose. On a societal level, many public natural resources, such as wildlife, may not have a direct market value, but provide satisfaction and enjoyment to some (but not all) segments of society. This is a difficult and subjective analysis (despite its attempt at quantification), as the direct and indirect factors and discount rates included in such an analysis must be carefully considered and evaluated accurately for the contribution they play or this type of analysis can substantially misrepresent the actual situation and/or be readily disputed. See Section 1.13.2.1 for an explanation of how this approach is used for large capital improvement projects considered on a project-level basis but applied on a regional and national basis as the foundation for determining if and what level the federal government will provide Congressional appropriations. Congress requires this approach for several agencies for such capital improvement projects for setting federal policy in the large-scale public interest.

- **Willingness-to-Pay:** Studies have identified the WTP for non-market goods such as wildlife recreation (mostly hunting, fishing, and wildlife viewing) for individual species, and, to a substantially lesser degree, ecosystem services, such as clean drinking water, pollination and pest control for agriculture, and renewal of soil fertility. WTP can also be used to monetize existence or passive values, such as the value of knowing that a species exists somewhere in the wild, even if the individual never spends any money to actually experience it in the wild.
- Methods used to determine or using WTP have included:
    - **Recreational Benefits:** Considering the costs of travel to experience enjoyment of non-market recreational experiences (Travel-Cost Method; TCM), using a demand curve above actual travel costs obtained through surveys with recreationists, reflecting actual behavior. Shwiff et al. (2012) summarize the primary criticisms of TCM: assumptions that visitors' values equal or exceed their travel costs, because travel costs are not an accurate proxy for of the actual value of the good; values must also be assigned to the time individuals spend traveling to the site, including opportunity costs (time spent traveling cannot be spent doing some other activity) since each person values their time differently; human access to conservation sites may be limited (including access to private land) and individuals may not be aware or have a preference toward the species associated with a chosen recreation site; and if individuals are not willing or able to travel to the site to expend funds, then this method confers no value.
    - **Existence/ Altruistic/Bequest Benefits** (depending on whether the benefit is enjoyed by the individual now or by other individuals now, or by other individuals in the future): Constructing a hypothetical or simulated market and surveying individuals if they would pay an increase in their trip costs or an increase in their taxes/utility bills/ overall prices for increasing environmental quality, including wildlife populations, recognizing that they higher the dollar amount respondents are asked to pay, the lower the probability that they

would actually pay (Contingent Valuation Method; CVM). This includes situations in which individuals are willing to provide donations to environmental groups to protect resources that they care about but may never experience themselves. Shwiff et al. (2012) summarize the primary criticisms of CVM: the hypothetical nature of the questionnaires, the inability to validate responses, the high costs of conducting this type of survey, and the difficulty of identifying the target audience. Also, public goods such as wildlife do not lend themselves to this type of valuation and this valuation tends to understate the true non-market value.

- **Benefit Transfer to Other Locations:** Extrapolation of WTP results from one area to another, recognizing that the extrapolation may or may not be reasonable or applicable in another area depending on circumstances. Shwiff et al. (2012) summarize the primary criticisms of the benefit transfer method: the reliability of this methods may be inconsistent as this method depends on estimates created using the CVM or TCM methods; wildlife values in one area may be unique and simply transferring the value associated with a species in one location to the same species in another location does not capture local qualities; preferences and willingness to pay for those preferences may not account for all the values and benefits of wildlife conservation projects, including ecosystem services.
- **Regional Economic Analysis:** Shwiff et al. (2012) describe this method as including estimation of secondary benefits and costs associated with the conservation of wildlife species in units of measure that are important to the general public (revenue, costs, and jobs). Increasing wildlife populations (the primary benefit) may have secondary benefits such as increase consumptive and non-consumptive tourism, which can be estimated using multipliers to account for changes spread through economic sectors. Loomis and Richardson (2001) used WTP estimates obtained from CVM and TCM studies for estimating the value of the wilderness system in the US. This requires the use of computer models, which can translate conservation efforts into regional impacts on revenue and jobs. However, secondary benefits or costs cannot be incorporated into a cost-benefit analysis because losses in one region may become gains in another region, potentially leading to offsetting effects.

As Schuhmann and Schwabe (2000) conclude:

- "While these methods [CVM and TCM] are widely used, it is important to stress that none of the approaches mentioned is without its flaws. Indeed, there is continual debate on the validity and tractability of each method…"
- "There is little uncertainty that wildlife-human conflicts impose significant costs on society. Yet, as most wildlife managers, hunters, and nature

> enthusiasts would agree, there is also enormous value associated with these same wildlife resources."

In addition, the Paperwork Reduction Act of 1995 requires agencies to submit requests to collect information from the public to the Office of Management and Budget (OMB) for approval for surveys used for general-purpose statistics or as part of program evaluations or research studies. (United States Office of Personnel Management 2011). Therefore, any surveys conducted for the purposes of determining WTP and related questions must have all survey questions and designs approved by the OMB. Developing a high quality survey require professional assistance in designing, executing, and documenting their surveys. This requirements makes it very difficult and expensive to conduct public surveys.

1.13.5 *What are the Economic Results of the Marin County CA Livestock Protection Program Compared to the WS-California Program?*

1.13.5.1 What is the Marin County Livestock Protection Program?

In 2001, Marin County, California, located north of the San Francisco Bay, created a program for protection of commercial sheep enterprises, called the Marin County Livestock Protection Program. This program redirected the funding Marin County previously spent on a PDM contract with WS-California to a County-run cost-share program reimbursing producers for exclusion and other non-lethal method expenses. The program originally involved: 1) monetary reimbursement to ranchers for their costs associated with creating protective facilities and improvements such as fencing, guard dogs, and scare devices; and 2) indemnification – compensation for livestock lost to predation, using market price/head lost.

Under the current Marin County Livestock Protection Program, qualified ranchers are provided cost-share funding to assist in the implementation of non-lethal management methods to reduce depredation such as new fence construction or improvements to existing fences, guard animals, scare devices, or changes in animal husbandry (herders and shed lambing). The most commonly used methods by producers are guard dogs and fencing (Larson 2006). To qualify for the program, ranchers must have at least 25 head of livestock and must use two non-lethal methods to deter predation, as verified by the Marin County Agricultural Commissioner (Larson 2006). The Marin County program provides an opportunity for cost recovery to enrolled landowners for the purchase or maintenance of nonlethal or exclusionary equipment or maintenance or purchase of guardian animals. The program requires receipts be turned in for supplies/equipment purchased and/or proof of maintenance projects or guardian animals be otherwise documented with the Agricultural Commissioner, but does not require reporting of application of nonlethal or nonlethal methods, resource protection numbers, predation losses, or any other measure of success. The amounts available to producers have varied throughout the program with up to $3000 being available to large sheep operations (those with more than 200-300 ewes) and from $500 to $1500 available to smaller producers (Larson et al. 2016).

Initially, producers who qualified for the program could also receive compensation for sheep and lambs lost to predation. However, when the Marin County Department of Agriculture, in a December 2014 California Public Records Request, was asked for records reflecting whether and to what extent the Program addresses or pays for the depredation by native predators, feral swine (wild hogs and boars), free roaming and/or feral dogs, and other common wild animals, Marin County indicated that the Livestock Protection Program was only a cost-share program which provided limited funds for purchasing fencing materials and guard animals. There are differing accounts as to why the indemnity portion of the program was discontinued. Larson (2006) stated that the program was unable to pay the cost of all losses to predation and, in 2003, compensation payments were capped at 5% of the number of adult animals in the herd. In contrast, statements from the Marin County Agricultural Commissioner have attributed the change in program funding as a response to producer feedback requesting the County prioritize prevention over indemnity. Regardless of the reasons, the indemnity portion of the program has been discontinued.

1.13.5.2 How Do the Costs of the Marin County Program Compare to WS-California Program?

A review of Marin County's budget over the first 5 years of the non-lethal program's implementation found that on average the program cost Marin County 1.3 times the amount that the cooperative APHIS-WS IPDM program cost the county in its highest year (Larson et al. 2016). Marin County's annual cost has ranged from a low of $5400 in FY2011-2012 to a high of $50,354 in FY2002-2003. The average annual cost of the Marin County Livestock Protection Program from 2001-2015 was $28,349 (Larson et al. 2016). The budget evaluation only record the county's cost for implementation, and did not capture the additional landowner costs associated with this program. This cost estimate is for a program limited to providing financial compensation assistance with non-lethal predator damage management to protect livestock and poultry operations larger than a certain size. It does not provide trained personnel to apply this cost-shared equipment in the field or address several of the needs for action that WS-Nevada work on as identified in Chapter 1, including protecting smaller herds of livestock, property protection, work at airports, for public/pet health or safety, or to protect natural resources, including ESA-listed species (Sections 1.11.2 through 1.11.5), nor do non-lethal methods always resolve the predator management problem, even for operations that do qualify for cost-share assistance. The cost of an expanded cost-share program aimed at responding to all of the WS-Nevada needs for action would be considerably more than the estimate for the operation of the Marin County Livestock Protection Program which has a narrower scope of protection.

1.13.6 *Results of ODFW Economic Studies on Economic Values Regarding Hunting and Wildlife*

Although NDOW has not conducted any studies on the economic values regarding hunting and wildlife, ODFW has, and as a neighboring state the results are relevant to this analysis. Specifically, ODFW (2006) conducted an economic analysis of cougar, deer, and elk hunting in Oregon, public agency costs for cougar damage management control, livestock losses, and the "existence values" for people just knowing that a certain species exists, even if they may never visit or benefit directly (see conclusions of this study below). Two reasons people may hold values related to wildlife, even if they do not attempt to see the wildlife in the wild, include preservation of options for future use, and bequeathing natural resources to one's heirs. Economists use terms such as "existence", "bequest", "generational preservation", and "intrinsic values" to define this general category. Although difficult to assess, these values are reflected in expression of social and cultural values. There is broad agreement among economists that these values exist, and ignoring them could lead to serious errors and resource misallocations (Freeman 1993). However, there also is disagreement regarding appropriate terminology and how to measure these values empirically (Freeman 1993). These values are usually investigated by asking hypothetical questions regarding willingness to pay for the existence of the subject in question.

Regarding mountain lion in Oregon, ODFW stated that, in addition to existence values, there is willingness to pay for reducing mountain lion populations to protect big game, humans, and pets, and for excluding mountain lions from specific areas where they conflict with humans and human values. These values are partially captured in hunting and depredation losses. There also are individuals who do not directly incur damage but would be willing to pay for reduced mountain lion numbers, perhaps related to human safety concerns or other perceptions about mountain lions.

A study conducted in Washington State of residents' opinions and attitudes toward hunting and game species management found that nearly 70% of respondents strongly or moderately supported reducing the number of predators in situations to prevent loss of domestic animals such as livestock or pets (Duda et al. 2002). Significant moderate or strong support to reduce predators was also found for protection of threatened or endangered species from predators (76%), increasing game populations (40%), and for addressing human safety (87%; Duda et al. 2002).

A survey of Southwest Oregon residents provided a similar split in opinions. Respondents were generally positive about the opportunity to see a cougar in the wild (Chinitz 2002). However, questions involving mountain lion and the relative health of the environment, quality of life, decline of elk and deer populations, hunting, and management showed significant numbers of respondents are on both sides of the question (Chinitz 2002).

Negative feelings or beliefs are likely related to fear of a mountain lion encounter, perceived and actual impacts on local economies, and resistance to external control or regulation. It is likely that rural inhabitants place a high value on their way of life and attributes related to independence and self-sufficiency. Many of these elements are not directly related to mountain lion hunting, but involve a larger set of social concerns and perceptions. In order to identify and calculate these values, additional work specific to Oregon is required.

These attitudes and opinions could apply to any predator species, not just mountain lion. ODFW (2006) concluded:

> "Integration and use of social sciences such as economics, sociology, psychology and anthropology can improve our understanding of individual values and preferences. These values are reflected in actions of individuals as they participate in diverse activities such as markets, recreation and voting. Biology provides management constraints for a given issue because of population and ecological realities. However, within the range of feasible population levels, policies are dictated by social values. Eventual cougar population levels and methods of population management will depend on evolving social values.
>
> "Two general social elements will be needed as these issues are debated. First, in addition to improving our understanding of biology, bioeconomic efforts are needed to integrate biological outcomes with economic costs and benefits. Public debate can be focused if dependable information can be brought forward to estimate livestock industry, hunting and other social costs and benefits. Second, a public process that recognizes social diversity and the need to air different public attitudes is needed. Complete agreement among all interests may not be attainable, but a process that provides a forum for divergent views can foster cooperation. Although this process can be extremely difficult, the alternative is often driven by special interest effects and micromanagement from both sides of the political spectrum."

ODFW summarized economic considerations and the complexities of evaluating the economic values of a publicly-owned asset such as wildlife in the ODFW Bighorn Sheep Management Plan (2003a). The plan states:

> "Economists typically evaluate two recreational uses of wildlife: hunting and wildlife watching. Further, two different approaches are used to describe the economic importance of wildlife-based activities: financial activity associated with money people spend to buy goods and services on their recreational trips; and net willingness to pay. Expenditures at businesses that provide goods and services produce direct and indirect effects on business revenues, jobs, and personal income at local and state levels. Purchases initiate cash flows with direct effects on businesses and, through the "multiplier process", on income, employment, and the general economy. This approach to valuing things is the expenditure and economic impact approach.
>
> "People buy things because they need or want them and spend money to hunt or watch wildlife because they enjoy doing it. Hunting and wildlife viewing have a personal or user value like any other leisure activity or market goods they purchase. In most cases, people expect a product or activity to be worth at least as much, and probably more, than what they spend to procure it. Thus, people have a "total willingness to pay" for products or activities equal to or greater than what they actually spend. The difference between total willingness to pay and what is actually spent is

> "consumer surplus" or "net economic value." Valuing hunting from the user's viewpoint is the economic value approach.
>
> "The United States Public Trust Doctrine" assigns wildlife resources ownership to State or Federal Governments. Rights to use or appreciate these resources are not often sold in a competitive market. Thus, wildlife and associated recreation is a non-market, or non-financial, economic value. No market prices exist to indicate how society as consumers values resources, or to signal society as a resource producer how much should be supplied. Therefore, economic value is difficult to assess without information available to determine fully what people are willing to pay.
>
> "People seem to intuitively understand economic impact approaches to wildlife values; however, "economic value" or "consumer surplus" concepts are difficult to understand as an economic benefit because it represents money that is not collected as payment for the benefit received. That no one actually charges consumers the full amount they would be willing to pay to use resources does not make the consumer surplus any less real. In concept, uncollected moneys can be thought of as income that remains to be used by the consumer for other purposes.
>
> "To complicate matters, there also are important non-use or "passive use" values associated with wildlife. The most common non-use value is existence value, or willingness to pay just to know a wildlife resource exists. There is disagreement among economists about whether passive use values can be measured accurately (Diamond and Hausman 1994, Hanneman 1994). Regardless, they are qualitatively reflected in expressions of social and cultural values.
>
> "The two measures of economic effects (economic impact and economic value) are different dimensions of the economic importance of fish and wildlife. They must be kept separate when evaluating the economic importance of fish and wildlife, or when being used to improve resource policy decisions.
>
> "Federal benefit-cost analyses generally compare the net economic value or economic surplus of a project to the cost of the project. It also can be used to compare net benefits for alternative management options. Analyses based on this measure can be useful at state, regional or national level.
>
> "In contrast, the economic impact approach is used to estimate the relationship of fish and wildlife related activities to the financial economy (business revenues, jobs, personal income) of a local community, county, multi-county region, or state. Analyses based on economic impact measures are most relevant at the level of local, county or multi-county economies."

ODFW (2006) conducted a quantitative economic analysis of hunting cougar, deer, and elk in its Cougar Management Plan (2006), and found that consumptive use of wildlife provides substantial economic benefit to the state of Oregon and its businesses.

Their analysis concludes:

> "Whether on public or private land, the public asserts its implied rights under the Public Trust Doctrine for fisheries and wildlife protection. In essence, this doctrine assigns rights to use fish and wildlife to citizens of the state, not to landowners (Loomis 1993). Rights to use or appreciate these resources are controlled by state and federal agencies, and are not often bought and sold in a competitive market. Although recreational days are not obtained at a market price, hunting and viewing experiences may be highly valued. Private hunting operations and guide services attempt to capture a portion of this value relative to public hunting opportunities. No market prices exist to indicate how society values wildlife resources, or suggest to society as a resource producer how much should be supplied. Yet non-market values are embodied in people's choices such as time spent, travel expenditures, lodging, and related goods. Choices also are made among many recreational possibilities depending on individual preferences.
>
> "License fees, tag fees, travel, and equipment expenditures capture only a portion of the total value of the hunting experience. Hunters are willing to pay at least as much or more than the total paid for these items. Economists use the concept of "willingness to pay" to explain consumer benefits from use of goods or experiences. The difference between willingness to pay and amount consumers actually pay is termed consumer surplus, or net benefits. It can be conceptualized as the amount consumers save by buying at the price they paid instead of the greatest price they would be willing to pay. Many techniques have been devised to assess values indirectly by using travel cost, contingent valuation (directly asking how much people are willing to pay for the activity), and discrete choice models (how people compare this experience against other experiences that can be valued monetarily).
>
> "Cougar predation on elk and deer may negatively impact related hunting activities in terms of quantity and quality of hunting days. Demand and associated value of hunting-days is dependent on many factors, such as expected success rate, hunter congestion or crowding, quality and type of potential harvested animals, hunt location, and other characteristics of the experience. Therefore, the value of a hunting-day will change as characteristics of the experience change.
>
> "Even more basic is availability or supply of hunting opportunities if allowable harvest decreases. Although there is a decreasing trend in number of hunting licenses sold as a proportion of the total population, demand for big game hunts in eastern Oregon is generally greater than opportunities supplied. As elk and deer populations change, tag numbers and other management measures or regulations adjust to control harvests. More stringent management translates into fewer hunter-days in the field and loss of net economic benefits directly related to the loss of hunter-days. These changes can be examined with bioeconomic analyses that consider biology

and economics assuming the following relationships: Cougar population changes → Impacts on prey populations → Changes in allowable hunter harvest → Change in number and or quality of hunter-days → Change in the net benefits of hunting. If one could reliably forecast changes in prey populations resulting from cougar predation, it would be possible to estimate changes in number of hunter-days according to past experiences with resource fluctuations. Change in the number of days in the field could then be linked to value of a hunting-day to estimate the change in net benefits of hunting.

"The average net economic value of elk hunting in Oregon was $76/day in 2001 (U. S. Fish and Wildlife Service 2003). Using this value, a loss of 1,000 hunter-days would result in a net economic loss to society of $76,000. This may be an overestimate depending on type and characteristics of the hunt. As noted earlier, changes in characteristics of the hunting experience will change demand and associated values of a hunting-day. Although uncertainty exists regarding the level of reduction in number of hunting days and hunting day values, the most difficult challenge involves defining and quantifying sources of prey population fluctuations.

"Economic impacts, a measure of economic activity, are generated by hunting expenditures. Hunter expenditures were estimated for hunts on the Starkey Experimental Forest in 1989 – 1991. A portion of the hunters came from western Oregon, thus hunter expenditures and associated impacts on total personal income were partitioned into statewide and eastern Oregon impacts. Using eastern Oregon income impact estimates inflated to 2003 levels, it is possible to approximate the personal income impact of deer and elk hunting in eastern Oregon WMUs. If resulting change in number of days in the field can be calculated, the change in expenditures and other economic impacts can be considered.

"Surveys conducted by ODFW found that for elk hunting, weighted average expenditures provided a benefit of almost $17 per hunter-day to eastern Oregon income, and for deer hunting, the weighted average was almost $13 per hunter day (in 2003 dollars). Assuming eastern Oregon impacts per hunter-day from Starkey Experimental Forest apply elsewhere in the region and state, estimated total income impacts of deer and elk hunting can be calculated. The Oregon survey found that, for 282, 688 hunter-days for deer hunting and 398,528 hunter-days for elk hunting, over $17M for deer hunting and over $26M for elk hunting were spent in the state.

"As with economic values and net benefits, if resulting changes in number of days in the field can be calculated, change in expenditures and other economic impacts can be inferred. Currently, cougar impacts on prey species such as elk and deer are not possible to estimate reliably, but ranges of costs to the hunting sector may become possible as research progresses."

1.13.7 *What are Economic Concerns Commonly Expressed by Public Commenters to APHIS-WS PDM EAs?*

Commenters often request economic analyses that incorporate the combination of the economic contributions of resource and agricultural protection programs and the economic contribution of wildlife-related recreation and values of the existence of wildlife, especially predators, on ecosystem services and recreation opportunities (USDA-APHIS-WS 2011; 2014; 2016). Aspects of these values are included in this EA in the evaluation of impacts to target and non-target populations (Sections 3.5 and 3.7), ecosystem services and biodiversity (Section 3.8), [sociocultural/wildlife values] and impacts to the recreation experience (Section 3.10).

Commenters during other APHIS-WS NEPA processes commonly express concerns about the economic costs of PDM in relation to the economic values being protected, especially values related to livestock, and whether the use of public funds are appropriate to support private profits (USDA-APHIS-WS 2011; 2014; 2016). These are discussed here and several are included in Section 2.5, Alternatives Not Considered in Detail.

1.13.7.1 Use of Taxpayer Funds for Private Profit, Livestock Losses Considered a Tax Write-off, and Livestock Losses Should Be an Accepted Cost of Doing Business

Some people and groups have commented that they do not want APHIS-WS to use taxpayer funds to benefit private commercial enterprises, such as livestock operations, and that producers should consider their losses to predators as a cost of doing business. Some believe that producers receive sufficient tax write-offs for their predation losses.

The national policy of using taxpayer dollars for subsidizing private or commercial profit, such as for protecting livestock from predators on private or public lands is established by Congress through statutes such as the Federal Land Policy and Management Act (FLPMA), the Multiple Use-Sustained Yield Act requiring multiple use of federally managed lands, including for livestock grazing, and the APHIS-Wildlife Services authorizing Act (Section 1.5.1), and Congressional appropriations. As wildlife belongs to the American public and is managed for many uses and values by tax-supported state and federal agencies, it is national policy that some of the resolution of damage caused by those same species is also publicly supported. Federal and state funds also support research and management of wildlife-related diseases, especially those that can be transmitted to livestock, pets, and humans. Furthermore, APHIS-WS is a cooperatively funded program, and WS-Nevada is also funded by private and commercial entities that request its services.

APHIS-WS is not involved in establishing or approving national policies regarding livestock grazing on federally managed lands or supporting private livestock operations, but provides federal leadership in resolving wildlife-human conflicts and supporting coexistence of wildlife and humans. It is publicly accountable for the work that is requested by public and private entities and landowners, state and federal governments, tribes, and the public, and all activities are performed according to applicable laws and its mission and policies.

WS-Nevada is aware of beliefs that federal wildlife damage management should not be allowed until economic losses become "unacceptable," (Section 1.4.3) and that livestock losses should be considered as a cost of doing business by producers. WS-Nevada receives requests for assistance when the operator has reached their tolerance level for damage or worries about safety and health, as well as in circumstances where the threat of damage is foreseeable and preventable. This tolerance level differs among different people and entities, and at different times. Although some losses can be expected and tolerated by agriculture producers and property owners, WS-Nevada is authorized to respond to requests for assistance with wildlife damage management problems, and it is agency policy to respond to each requester to resolve losses, threats and damage to some reasonable degree, including providing technical assistance and advice. The APHIS-WS Decision Model (APHIS-WS Directive 2.201) is used in the field to determine an appropriate strategy on a case-by-case basis. The APHIS-WS authorizing legislation does not require an economic analysis at any scale of operation (Section 1.5.1 and 1.13.1).

Some people believe that livestock producers receive double financial benefits when APHIS-WS provides services to producers 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 idea is incorrect because the Internal Revenue Service does not allow for livestock losses to be deducted if the killed livestock was produced on the ranch and not purchased from an outside source (Internal Revenue Service 2016). In the western United States, a large proportion of predation occurs to young livestock (lambs, kids, and calves), and many adult ewes, nannies, and cows are added as breeding stock replacements to herds from the year's lamb, kid, and calf crop. Any of these animals lost to predation cannot be "written off" since they were not purchased. These factors limit the ability of livestock producers to recover financial losses through tax deductions.

This issue is appropriately addressed through political processes at the state and federal levels.

1.13.7.2 *Compensation for Losses or Damage Should Replace APHIS-WS PDM*

Wildlife is typically managed by the state, regardless of land ownership (with the exception of tribal land). There is currently no national program to equitably distribute the costs of damage by predators covered in this EA between all consumptive and non-consumptive user groups. APHIS-WS does not have the authority to establish and/or administer such as program. The decision about how to distribute the costs of wildlife management is usually considered a component of state wildlife management decisions, except for those species managed by the USFWS.

Some states and counties have established programs that partially accept monetary responsibility for some types of wildlife damage (for example, Bruscino and

Cleveland 2004). Other states and counties have declined to establish such programs, presumably because they are satisfied with the current balance of the costs of managing predator damage.

The state of Nevada does not provide compensation for losses of livestock to predators.

The Agricultural Act of 2014 (aka the 2014 Farm Bill) has provisions for the federal government to provide indemnity payments to eligible producers on farms that have incurred livestock death losses in excess of the normal mortality, as determined by the Secretary of Agriculture, due to attacks by animals reintroduced into the wild by the Federal Government (such as wolves) or protected by Federal law (such as animals protected under the Migratory Bird Protection Act or the Endangered Species Act). Payments are equal to 75% of the market value of the applicable livestock on the day before the date of death. The Secretary of Agriculture or designee makes that determination. None of the predators considered in this EA are applicable under this statute.

Even if Congress did grant APHIS-WS authority to administer a compensation program, such a program would also require significant additional appropriations. Costs associated with locating and confirming all, or at least a significant majority of, predator losses statewide to implement a compensation program are likely to meet or exceed the WS-Nevada budget, even if resources are reallocated from current operational and technical assistance projects to confirming losses. Searching for lost animals, especially in large grazing allotments or pastures, in areas with remote and/or rough terrain, and areas with extensive shrubs or trees, can be extremely labor intensive. In general, this level of intensive monitoring has only been feasible for limited-scale research projects.

Difficulties related to a compensation-only alternative extend beyond jurisdictional and financial challenges. Reviews of compensation programs indicate that these programs do not generally improve people's tolerance of the species causing damage (Treves et al. 2009) and do not address indirect costs of wildlife damage (Steele et al. 2013). Compensation programs for recovering wildlife species can, in some cases, increase to the point where funds needed for compensation undermine budgets for conserving other species (Treves et al. 2009). Some authors have raised concerns that compensation programs may make producers less risk-averse and less likely to adopt new or improve existing management practices. Bad managers may be compensated at the expense of those who invest in good management techniques. The challenges of designing and managing compensation schemes are so intensive that managers seldom evaluate the overall cost-effectiveness in comparison to the benefits (Nyhus et al. 2003, Bulte and Rondeau 2005, Treves et al. 2009). Treves et al. (2009) suggest that compensation does not necessarily improve tolerance for depredating wildlife, and some producers may reject payments in favor of lethal control.

Compensation could actually increase the number of depredation losses (e.g. predators that prefer livestock over natural prey are not lethally removed and continue to kill livestock), which is contrary to the APHIS-WS objective of encouraging co-existence with wildlife. Bulte and Rondeau (2005) recommend conducting “a careful assessment of local ecological and economic conditions before compensation is implemented.”

For these reasons, WS-Nevada believes that establishing a compensation program for predator damage is not feasible, and that this issue is appropriately addressed through political processes at the state and federal levels.

1.13.7.3 Livestock Producers Should Pay All Costs of PDM

The Act of 1931, as amended, authorizes the Secretary of Agriculture to make expenditure of resources for the protection of agricultural resources. Congress makes annual allocations to APHIS-WS for the continuing federal action of WDM, including PDM. Congress further establishes that APHIS-WS may receive and retain funds provided by other entities (e.g., States, industry, public and private funds) and use them towards those programs from which funds were received. In Nevada, for the FY 2014-FY 2018 time frame, 45% of this funding was from WS-Nevada’s federal allocation and 55% cooperative funding (USDA APHIS 2019). Cooperators pay the costs of non-lethal actions taken, even when recommended by WS-Nevada personnel, and a substantial proportion of the cost for WS-Nevada efforts, including WS-Nevada administrative overhead.

This issue is appropriately addressed through political processes at the federal levels.

1.13.7.4 WS-Nevada Should Subsidize Non-lethal Methods Implemented by Resource Owners

WS-Nevada is a cooperatively funded agency with the majority of its funding comprised of cooperative dollars (as opposed to congressionally allocated money). As such, cooperators provide the funding and direction to WS-Nevada on the types of services they want delivered with the funding they provide and it is implemented in accordance with agency policies. Although WS-Nevada may rarely loan harassment equipment on very limited circumstances, cooperators request that WS-Nevada focus its efforts on those services that the public is less skilled or proficient in doing. Cooperators rely on WS-Nevada to provide technical assistance needed for individuals (including individuals supplementing WS-Nevada efforts) to use their own resources and efforts. The State of Nevada also provides no subsidies for non-lethal methods to resolve damages from the predator species covered in this EA. Subsidies for use of non-lethal methods to selected types of livestock producers is currently offered in Marin County, California by the County to some degree, but the costs and effectiveness are not clearly known (Shwiff et al. 2005, Shwiff et al. 2006; Sections 1.13.5 and 2.5.24).

This issue is appropriately addressed through political processes at the state and federal levels.

1.13.7.5 Incorporate the Environmental Costs of Livestock Grazing on Public Lands into Cost Analyses

Commenters on similar APHIS-WS NEPA processes have requested that APHIS-WS consider the environmental costs of grazing on public lands and other activities in cost analyses (USDA-APHIS-WS 2011; 2014; 2016). As stated earlier, APHIS-WS has no authority to address national policy set by multiple Congressional statutes regarding livestock grazing on federally managed lands, nor annual appropriations related to livestock grazing and other uses on public lands, or private lands, for that matter. APHIS-WS only responds to requests for assistance, and uses the APHIS-WS Decision Model to determine appropriate responses, considering factors that include social and environmental considerations and the specific circumstances and species associated with the damage, in addition to efficacy and costs.

Therefore, this issue is not pertinent to APHIS-WS decision-making, and is appropriately addressed through the political process at the Congressional level.

1.13.7.6 No Federal Funds Should Be Used to Support State PDM Needs for Protection of Game Species

All PDM work for the State of Nevada is reimbursed with non-federal funds, resulting in no net use of federal monies for state PDM needs to protect game species. This issue is appropriately addressed through the political process at the state and Congressional levels.

1.13.7.7 APHIS-WS Should Be Financially Liable for Pet Dogs that Are Incidentally Killed During Operations

WS Directive 2.340 addresses requests for assistance associated with feral (an ownerless or homeless wild dog), free-ranging (dogs that have owners but not under the owner's direct control), or hybrid dogs (a canid that is the progeny of a domestic dog and a wild wolf or coyote that is either feral or free-ranging). In Nevada, the primary responder to damage caused by dogs is either a local animal control authority or the local county sheriff. However, WS-Nevada can respond upon request for assistance with dogs to damage to agriculture, livestock, to protect human health or safety, and at airports and airfields, some of which may be caused by feral or free-ranging dogs.

WS-Nevada will conduct dog damage management in coordination with and after obtaining concurrence from county, local, or tribal authorities with jurisdiction over dog control, either by type of damage or on a case-by-case basis, as appropriate. Nevada NRS 244.359 and NRS 269.225 provide for counties and cities to pass ordinances prohibiting dogs from running at large, including pets. NRS 575.020 provides for liability against dog owners for dogs engaged in killing, wounding, injuring, or chasing livestock. County ordinances allow for liability if the dog causes injury or property damage, as well as disposition of the offending dog (compensation is handled through civil court).

The primary concern, however, is when WS-Nevada field personnel incidentally take a pet dog while attempting to take another target species. APHIS-WS Directive

2.340 states: "Where WS personnel determine that a captured dog is a pet, WS personnel shall inform the land/resource owner as soon as is practicable….This policy does not in any way preclude WS personnel from appropriately defending themselves, their working animals, or restrained animals captured pursuant to official WS actions, from dog attacks." WS-Nevada field personnel take appropriate actions to avoid incidental take of pet dogs and do not set devices that could capture dogs in recreational areas whenever possible. All capture traps are set to reduce the risk of damage to the animal (Sections 2.4.1.2, and 3.9). If the dog has identification allowing determination of the owner, the owner is informed as soon as possible. If not, then the dog is released on site.

There is no legal authority for financial liability against APHIS-WS personnel when operating consistent with federal and state law and APHIS-WS Directives.

1.13.7.8 PDM Should be Funded Through a State Head Tax

It is the policy of the federal government that a livestock head tax for funding PDM must be established voluntarily and through authorities other than the Federal government. Although NRS 567.110 provides the authority/vehicle for a head tax (not to exceed 20 cents per head) on sheep and goats in Nevada, this tax has not been instituted.

This issue is appropriately addressed through the political process at the state or county level.

2 Alternatives and Alternatives Not Considered for Comparative Analysis

2.1 What Alternatives Are Considered in Detail in this EA?

The following alternatives are evaluated in detail in this WS-Nevada IPDM EA and are described below.

Alternative 1. No Action Alternative - Continue WS-Nevada PDM assistance outside of WAs and WSAs (with the exception of protecting human health and safety)**,** with inherent reasonable fluctuations of tempo, volume, and lethal and non-lethal operational and technical support.

Alternative 2. Proposed Action - Modified Current Program. A continuance of the current program modified to allow PDM in wilderness areas and wilderness study areas to protect livestock, human health and safety, when requested and where approved by the land-managing agency.

Alternative 3: Non-lethal PDM Required Before Applying Lethal Assistance (No Preventive Lethal PDM). WS-Nevada would provide both technical assistance and operational assistance, but WS-Nevada would not provide any lethal management until nonlethal methods have been tried and determined to be inadequate in each depredation situation. WS-Nevada would not conduct any preventive PDM.

Alternative 4: WS-Nevada Provides PDM Lethal Assistance Only for Cases of Human/Pet Health or Safety. WS-Nevada would provide PDM assistance, including lethal and non-lethal assistance, only when requested for protecting human/pet health or safety; all other assistance would only use non-lethal methods and/or technical assistance.

Alternative 5: No WS-Nevada PDM Activities. WS-Nevada would not conduct PDM activities in Nevada. PDM would still be implemented by Department of Agriculture, Division of Animal Industry Field Assistants (State component of WS-Nevada) and other legally authorized entities, such as NDOW, USFWS, property owners, commercial PDM companies, and certified NDOW volunteers.

2.2 What is Included in this Chapter?

This chapter describes:

- Detailed descriptions of the 5 WS-Nevada IPDM alternatives evaluated in detail in Chapter 3, including current WS-Nevada IPDM program (no action alternative) and various levels of WS-Nevada involvement in IPDM activities in Nevada;
- APHIS-WS directives and associated protective measures that WS-Nevada must follow, and state laws and regulations that all those involved in management of predator damage and who take wildlife lethally for a variety of purposes, including private citizens, must follow; and

- IPDM alternatives that are not evaluated in detail in this EA, with rationale.

2.3 What WS-Nevada Activities Are Included in Each Alternative?

The 5 alternatives are described in detail below. The effectiveness of each of these alternatives in addressing WS-Nevada objectives (Section 1.5.2) is evaluated in Section 3.13). Alternatives that were determined not to be reasonable, practical, or effective are described in Section 2.5, with the rationale provided for not evaluating each one in detail. Protective measures, and APHIS-WS policies and relevant state laws and regulations for addressing the issues are identified in Section 2.4 after the description of the alternatives and incorporated into all alternatives as applicable that include WS-Nevada activities.

2.3.1 *Alternative 1. Continue the Current Federal and State Cooperative Integrated Predator Damage Management Program (No Action)*

2.3.1.1 *How Do WS-Nevada Field Personnel Select an IPDM Strategy Using the APHIS-WS Decision Model?*

For all alternatives in which WS-Nevada provides requested services, WS-Nevada uses the APHIS-WS Decision Model (Figure 2.1; WS Directive 2.201) as part of Integrated Predator Damage Management for evaluating the situation and determining the most effective strategy to address the situation. Additionally for all alternatives, non-lethal methods are employed by livestock producers (see Section 1.11.2.6, Appendix A for descriptions of non-lethal methods and Appendix C for detail of non-lethal methods that livestock producers employ in Nevada).

The Decision Model is not a written documented process for each incident, but rather a mental problem-solving process. This process is similar to adaptive management strategies used by all wildlife management professionals when addressing a wildlife damage problem, including biologists who work for some of the lead and cooperating agencies for this EA. To use an analogy, it is also similar to assessment processes used by fire departments when they arrive on a scene and determine the most effective and safe strategy for resolving a situation. WS-Nevada employees are trained and experienced in IWDM, and they respond to a request and assess the problem using the APHIS-WS Decision Model (see below).

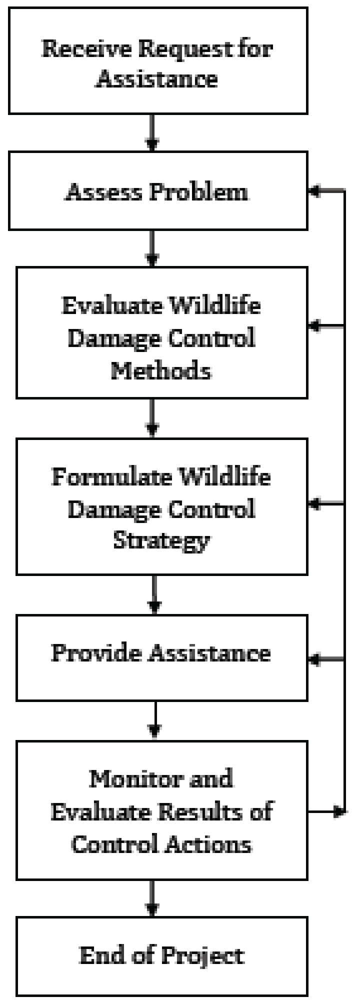
Under the APHIS-WS Decision Model, throughout the agency, and by agency directive and policy, APHIS-WS field personnel assess the problem and evaluate the appropriateness of available damage management strategies and methods based on biological, economic, and social considerations. Following this evaluation, methods deemed to be practical and effective for the situation are incorporated into a management strategy. After the selected strategy has been implemented, the property/resource owner monitors and evaluates the effectiveness, sometimes with WS-Nevada assistance. If needed, management strategies are then adjusted, modified, or discontinued, depending on the results of the evaluation.

The thought process and procedures of the APHIS-WS Decision Model include the following steps (Figure 2.1):

1. **Receive Request for Assistance:** WS-Nevada only provides assistance after receiving a request for such assistance. The employee can respond by providing professional technical assistance, information, recommendations, and advice at any time, on-site or through verbal or written communication. If the requester needs further on-site active assistance, the WS-Nevada specialist and the requester will agree to the level of service and enter into a work agreement.
2. **Assess Problem:** Once on site, the WS-Nevada field specialist makes a determination as to whether the assistance request was within the authority of WS-Nevada. If an assistance request is determined to be within agency authority, the specialist gathers and analyzes damage information in the field to determine applicable factors, such as what species was responsible for the damage, the type of damage, the extent of damage, and the magnitude of damage. Other factors that WS-Nevada's employees often consider include the current economic loss or current threat, such as the threat to human safety, the potential for future losses or continued damage, the local history of damage in the area, environmental considerations, and what management methods, if any, were used to reduce past damage and the results of those actions.
3. **Evaluate Management Methods:** Once a problem assessment is completed, the field specialist conducts an evaluation of available management methods to recommend the most effective strategy, considering available methods in the context of their legal and administrative availability and their acceptability based on biological, environmental, social, and cultural factors.
4. **Formulate Management Strategy:** The field specialist formulates a management strategy using those methods that the employee determines to be practical and effective for use, considering additional factors essential to formulating each management strategy, such as available expertise, willingness of the property owner, legal constraints on available methods, costs, and effectiveness.
5. **Provide Assistance:** After formulating a management strategy, technical assistance and/or direct operational assistance to the requester is provided as appropriate (see WS Directive 2.101).
6. **Monitor and Evaluate Results of Management Actions:** When providing direct operational assistance, effectiveness of the management strategy is monitored, primarily by the cooperator, with assistance by WS-Nevada when appropriate. Monitoring is important for determining whether further assistance is required or whether the management strategy resolved the problem and if additional work is necessary.
7. **End of Project:** When providing technical assistance, a project normally ends after the WS-Nevada field specialist provided recommendations and/or

advice to the requester. A direct operational assistance project normally ends when WS-Nevada's field specialist is able to eliminate or reduce the damage or threat to an acceptable level to the requester or to the extent possible. Some damage situations may require continuing or intermittent assistance from WS-Nevada and may have no well-defined termination point, as work must be repeated periodically to maintain damage at a low level, such as coyote control when new animals move into a vacant territory that overlaps with livestock use, or safety operations at airports.

Figure 2.1. APHIS-WS Decision Model (WS Directive 2.201).



2.3.1.2 What is the Process for Verifying Losses and Damage?

Conflicts with predators can be in the form of a threat of damage, such as a history of predation of livestock in an area, predators known to be in the area, and/or damage that has or is currently occurring. Damage reported to WS-Nevada, such as predation or injury, is recorded in the APHIS-WS MIS database as "reported" damage. If employees are able to verify that the damage occurred, it is recorded in

MIS as "verified" damage (defined as resource or production losses examined by a WS-Nevada specialist during a site visit and determined to have been caused by a specific predator species). Confirmation of the species that caused the damage and the extent of the problem are important steps toward establishing the need for implementing the PDM activities and the methodologies that will be most effective to resolve the problem.

Several factors can increase the complexity of determining whether a depredation event occurred and, if so, which species is responsible for the damage. Responding to a request in a timely manner is critical in order to view the scene and livestock remains before they become degraded or obscured. The "scene" can include evidence of a struggle, hair, scat, tracks, or wounds on an animal, which may be indicative of a particular predator's method of attacking livestock or wild animals. Many factors, including consumption of the remains from a predator or other scavengers, natural decomposition, and local climate variables, can impact the condition of the livestock remains and make it harder for WS-Nevada personnel to determine the predator species responsible.

Field employees carefully examine the surrounding area and often perform a field necropsy to observe or collect evidence, such as bite/claw marks, trauma, and hemorrhaging. Natural causes of death, such as injury, illness, and animal health are also considered during the necropsy.

The location of the dead animal and how it is oriented can indicate the depredating species since predator species have typical patterns or ways that they kill their prey. Occasionally there is sufficient evidence to conclude that depredation did occur, but insufficient information to make a determination as to which predator species was involved. When insufficient evidence remains, or the carcass or scene is unable to be verified, the loss is considered to be *reported* and the species most likely to have cause the damage is recorded in the MIS database. Employees use their experience and the information available to make the best determination of the species involved in the depredation, when possible, and take action as warranted and in accordance with APHIS-WS policy and state and federal law.

In most cases, when addressing livestock predation, WS-Nevada field personnel do not attempt to locate every depredated carcass reported by ranchers, but attempt to verify sufficient levels of damage to establish the need to take action and develop the appropriate strategy using the WS Decision Model (APHIS-WS Directive 2.201). Therefore, in many cases, damage reported by WS-Nevada does not actually reflect the total number of livestock or other resource affected, but provides an index of the annual damage occurring and sufficient information to develop the management strategy. Since producers experiencing loss may or may not contact WS-Nevada to report their losses or to request assistance, even fewer instances of depredation are documented. Producers often try to resolve the damage themselves or may request the assistance from other entities, such as commercial companies permitted by NDOW and listed on their website (Section 1.7).

2.3.1.3 Background to the No Action Alternative

The No Action alternative continues the current implementation of an adaptive integrated approach utilizing non-lethal and lethal techniques (Appendix A), identified through use of the APHIS-WS Decision Model, to reduce damage and threats caused by predators in Nevada, with the exception of WAs and WSAs in which PDM can only be conducted for protection of human health and safety at request of NDOW. In the event of a human health and safety incident, the WA managing agency may authorize PDM under an emergency determination (BLM 6340 (BLM 2012b), FSM 2300 (USFS 2007)). Any action taken in WAs or WSAs would be in coordination with the applicable management agency on a case-by-case basis to ensure that the PDM action would be in compliance with agency policies (Section 1.11.7).

A major goal of the WS-Nevada program is to resolve and prevent damage caused by predators and to reduce threats to human safety. To meet this goal, WS-Nevada continues to respond to requests for assistance with technical assistance and/or operational assistance to entities that enter into an agreement with WS-Nevada. APHIS-WS activities are authorized by federal law and funded by both Congressional appropriations and funds provided by entities that enter into agreements with APHIS-WS state offices. For WS-Nevada activities (not including feral swine), this funding is made up of Congressional appropriations (about 49%), Federal and State interagency agreements (about 47%) and private, commercial, or other cooperators (about 4%). The presence of a WS-Nevada agent in any given county is dependent on the need and financial support.

The adaptive approach to managing predator damage integrates the use of the most practical and effective methods to resolve a request for assistance as determined by a site-specific evaluation using the APHIS-WS Decision Model, applied at the most appropriate time. In addition to direct operations, WS-Nevada also continues to provide assistance to federal and state agencies, city/town managers, agricultural producers, property owners, and others requesting assistance with information regarding the use of appropriate non-lethal and lethal techniques (technical assistance).

To be most effective, damage management activities should begin as soon as predators begin to cause damage or are expected to begin to cause damage, such as in the spring during coyote pupping while livestock are simultaneously lambing or calving. Waiting until damage is ongoing may make the problem more difficult to resolve since individual animals become conditioned to an area and familiar with a particular location. For example, the method of making an area with vulnerable livestock unattractive can be difficult to achieve if damage has been ongoing. WS-Nevada works closely with those requesting entities to identify situations where damage could occur. WS-Nevada personnel implement or recommend effective non-lethal and/or lethal damage management activities as early as possible in order to increase the likelihood of those methods achieving the appropriate level of damage reduction.

Under this alternative, WS-Nevada, in consultation with NDOW as appropriate, will continue to respond to requests for assistance outside of WAs and WSAs by:

- Taking no action if warranted;
- Providing non-lethal and/or lethal technical assistance to property owners or managers on actions they could take to reduce damages caused by mammals; or
- Providing non-lethal and lethal operational assistance and, when appropriate, technical assistance to a property owner or manager.

WS-Nevada would only respond to requests for assistance in WAs and WSAs for human health and safety at the request of NDOW and as authorized by applicable land management agency.

WS-Nevada also continues to work with NWRC and other professional entities to produce and distribute materials and provide educational programs on methods for preventing or reducing predator damage.

Any PDM must be consistent with Federal and State laws and regulations, including requirements for reporting take to the appropriate regulatory agency.

2.3.1.4 What are the General Components of the WS-Nevada Activities in Alternative 1?

The current WS-Nevada wildlife damage management approach includes the following general components:

- **Collaboration and Project Identification**

APHIS-WS State programs enter into cooperative partnerships in all aspects of operational wildlife damage management when requested by agency partners, tribes, and private entities. Cooperative partnerships may be developed to implement predator damage management activities in targeted areas and for targeted resource protection, such as agricultural areas, areas with threatened or endangered species and other natural resources, urban/suburban areas to reduce property damage, or other locations to address specific damage needs, such as protection of human health and safety (Sections 1.7, 1.8 and 1.11.2 through 1.11.6).

- **Education and Training**

WS-Nevada provides professional courses and training to agencies, organizations, the public, property owners and managers, and cooperators upon request on wildlife management and biology, wildlife damage management, and non-lethal and lethal techniques for managing the risk of damage to encourage co-existence. Many APHIS-WS personnel, including scientists at the NWRC publish professional papers and speak at conferences and meetings to further the science and application of wildlife damage management.

- **Technical Assistance**

Property owners or managers requesting assistance from WS-Nevada are provided with information regarding the use of effective and practical non-lethal and lethal techniques and/or IPDM strategies, including advice, training, and, to a limited degree, loan of equipment. Technical assistance training can be over the phone, on-site, or in instructional meetings. WS-Nevada provides training on depredation investigations related to human health and safety to NDOW, law enforcement, and other officials. Additionally, WS-Nevada provides training to the public on how to avoid wildlife conflict and conducts workshops on non-lethal methods for producers and resource owners. Technical assistance is described in detail in Appendix A.

- **Operational Assistance**

When WS-Nevada employees conduct PDM activities, whether non-lethal or lethal, this is considered Operational Assistance. In most cases, WS-Colorado provides a combination of technical assistance and operational assistance. Often, non-lethal recommendations provided by WS-Nevada are conducted by the resource owners, because it is logistically or economically more practical. These same resource owners may request WS-Nevada to conduct lethal PDM, because they find it to be safer, more effective, and/or more cost-effective.

Property owners or managers may choose to take lethal management action themselves when authorized by law. They can also use contractual services of private businesses, use volunteer services of private organizations, request assistance from NDOW and/or its agents, request to use the services of WS-Nevada (direct operational assistance), or take no action.

- **Preventive (Proactive) Damage Management**

Preventive (proactive) damage management involves applying management strategies before damage occurs, based on historical problems and data. Many resource management strategies and physical exclusion methods are intended to prevent damage from occurring. For example, fencing is often used to keep predators out of livestock pastures to prevent predation. When requested, WS personnel provide information and conduct demonstrations, or take action to prevent future losses from recurring.

Preventive IPDM is a strategy that applies lethal and/or non-lethal PDM action before expected damage occurs, based on historically recurring problems. Most non-lethal methodologies, whether applied by WS-Nevada or resource owners, are used to prevent damage from occurring and therefore fall under this category of PDM methods. When requested, WS-Nevada personnel can provide information, conduct demonstrations, or take direct action to prevent additional losses from recurring.

For example, in areas where substantial livestock depredations have occurred on lambing or calving grounds in the past, WS-Nevada may provide technical assistance in the form of information about livestock guarding animals, fencing, or other husbandry techniques. Additionally, if requested and appropriate, WS-Nevada may conduct lethal predator management by removing multiple predators (coyotes only, as defined and authorized in NAC 503.035) in a specific area before lambing or calving begins in an attempt to preemptively prevent continued depredation.

The rationale for conducting preventive damage management differs little in principle from holding controlled hunts for deer or elk in areas where agricultural damage has been a historical problem. By reducing the number of predators, specifically coyotes, operating in a territory near livestock, the risk of damage at the time is potentially reduced. Rather than requesting assistance from WS-Nevada, property owners may request NDOW and/or its agents, NDOW-licensed commercial companies and/or those with aerial depredation permits from NDOW to conduct such activities.

- **Corrective Damage Management**

Corrective PDM is the use of non-lethal and/or lethal methods in response to current or ongoing damage, in an effort to prevent additional damage from occurring. This may also be referred to as reactive PDM. Corrective PDM is conducted in any area where current damage is reported or verified, and where damage is reasonably expected to continue in the absence of PDM. As requested and appropriate, WS personnel provide information, conduct demonstrations, or take action to prevent future additional losses. Corrective actions may include a combination of… wildlife damage management approaches, technical assistance, and operational damage management assistance. The purpose of corrective PDM is not to punish the predator(s) causing the damage; the purpose is to stop the damage.

Resource managers and others requesting operational assistance are provided with information regarding the use of effective nonlethal and lethal techniques, including recommendations as to effective long-term strategies for reducing risk of wildlife damage. When appropriate, WS-Nevada also provides operational assistance using lethal and non-lethal methods within an integrated PDM strategy.

For example, in an area where coyotes are currently depredating sheep, a WS-Nevada field specialist may provide information about livestock guarding animals, fencing, or husbandry techniques. If these techniques are already in use, or fail to stop the damage, WS-Nevada may recommend or conduct lethal PDM in an attempt to remove the coyotes which are causing the damage. This may result in a temporary reduction in the local coyote population. However, other coyotes will likely immigrate into the area to re-fill this niche, such that the local coyote population would not be affected in the long-term. The goal is to provide relief from damage without affecting the local coyote population in the long-term, or affecting statewide coyote populations.

Property owners may request NDOW and/or its agents, NDOW-licensed commercial companies, those with NDOW permits for aerial shooting and or conduct such activities themselves rather than requesting assistance from WS-Nevada.

- **Carcass Disposal**

Unless otherwise regulated by Nevada law, WS-Nevada disposes of carcasses to make them less accessible to scavengers by moving them out of view into a brush pile, placing them in existing carcass pits on private property, or occasionally disposing of them in designated landfills or transfer stations when other methods are not feasible or available. Animals taken during aerial operations are seldom if ever recovered because it is not always safe to land aircraft in the field, and it is seldom cost-effective or time-effective to make multiple landings during a flight. Also, aircraft have weight restrictions which control transportation of extra cargo for safety reasons, which is especially critical for low-level flights.

Nevada laws and regulations regulate the disposal of carcasses of animals: game mammal, carnivore and common raven (NRS §503.050).

All carcass disposal is consistent with APHIS-WS Directives 2.510 and 2.515 (Section 2.4.1.8) and state law.

- **Monitoring**

WS-Nevada, in coordination with NDOW, BLM, USFS and USFWS, as appropriate, monitors the results and impacts of its program. The impacts discussed in this EA are monitored and evaluated in 3 ways:

> 1) WS-Nevada determines if any additional information that arises subsequent to the NEPA decision from this EA would trigger the need for additional NEPA analysis. WS-Nevada reviews implementation results and the related NEPA documents as needed to ensure that the need for action, issues identified, alternatives, regulatory framework, and environmental consequences are consistent.
>
> 2) WS-Nevada, in coordination with NDOW and USFWS when appropriate, monitors impacts on target and non-target predator populations through its MIS database. The MIS information is used to assess the localized and cumulative impacts of WS-Nevada activities on specific target predator and non-target wildlife populations. WS-Nevada provides detailed information on animals removed, quarterly and annually to NDOW and annually to the USFWS to assist these agencies with managing species and resources under their jurisdictions.
>
> 3) WS-Nevada, in coordination with BLM and USFS, monitors PDM activities in WAs and WSAs to ensure that wilderness character is preserved and WSA suitability for future preservation of wilderness is not impaired, using the WS-Nevada MIS database. WS-Nevada provides detailed information on

PDM activities to BLM and USFS annually to assist these agencies with analyzing effects and managing lands under their jurisdictions.

2.3.1.5 What Types of Actions are Included in Alternative 1?

Alternative 1 continues the current WS-Nevada IPDM assistance as requested, accounting for inherent, realistic fluctuations in the level of assistance provided.

Most requests for PDM assistance come from private resource owners, particularly livestock operators, who may use private and/or public lands. The majority of the livestock owners base their livestock operations on their private land, but many of these individuals also graze their livestock on public lands for a portion of the year, usually spring through fall.WS-Nevada also receives requests for PDM assistance to protect other assets, such as:

- Domestic pets and personal and commercial structures or properties;
- Natural resources, from NDOW, and tribes; and
- Human health and safety, from private and government entities.

Most of these requests come from private individuals; however, requests for assistance may also come from public entities, such as NDOW, NDA, and other local, state, federal, or tribal entities. PDM assistance provided by WS-Nevada personnel may be conducted on public, private, state, tribal, and other lands or any combination of these land class types, as appropriate (Section 1.9.4 and Table 2.2).

APHIS-WS has signed national level MOUs with BLM, USFS, and the USFWS. In addition, WS-Nevada has a signed MOU with NDOW and signed agreements with NDOW and NDA to provide wildlife damage management services upon request (Sections 1.7 and 1.8). Usually, requests for management work on BLM and USFS land come from the livestock permittees and NDOW. All anticipated WS-Nevada activities on USFS and BLM lands are outlined in WS-Nevada Annual Work Plans for each National Forest and BLM area of interest, usually grazing allotments. When work is proposed, annual coordination meetings are held between WS-Nevada and personnel from the land management agencies and NDOW to discuss accomplishments, status of work, issues of concern, and any anticipated changes in proposed work plans.

2.3.1.6 *In What Types of Areas Would WS-Nevada Operate?*

These areas include sites/locations where PDM is anticipated to continue to occur or reoccur and WS-Nevada has been requested to actively work or is considering accepting work (excluding WAs and WSAs unless involving human health and safety at request of NDOW and authorized by the applicable land management agency). These planned activities are those that are covered under existing cooperative agreements or are identified along with planned management areas in Annual Work Plans with the USFS or BLM. Livestock depredation control work is focused in areas where livestock are most abundant and during times when they are most vulnerable to predators such as during calving and lambing. Requests for assistance in reducing property damage, protecting natural resources, and threats to human/pet health and safety are by their nature intermittent and thus less predictable in time and geographic location.

Under the current WS-Nevada activities, the frequency, locations, cooperators (private, state, federal, tribal and others), varieties of PDM work, and numbers of target and non-target animals taken have varied over the years. WS-Nevada expects these degrees of variation to continue into the future, and, therefore, for the purposes of the impact analyses in this EA, sets reasonable outside bounds for these factors for continuing the current activities. WS-Nevada recognizes that requests for its assistance are on a case-by-case basis. Regardless of the situation, the WS-Nevada employees are trained and experienced, and they respond using the APHIS-WS Decision Model to determine whether a response is warranted and, if so, the most effective strategy (Section 2.3.1.1).

Therefore, this alternative includes PDM actions within areas and locations in which WS-Nevada currently operates for entities that have received assistance from WS-Nevada; would foreseeably operate consistent with this EA upon request; and within which WS-Nevada has been requested for assistance, even if those areas are not currently under agreements (Figure 2.2).

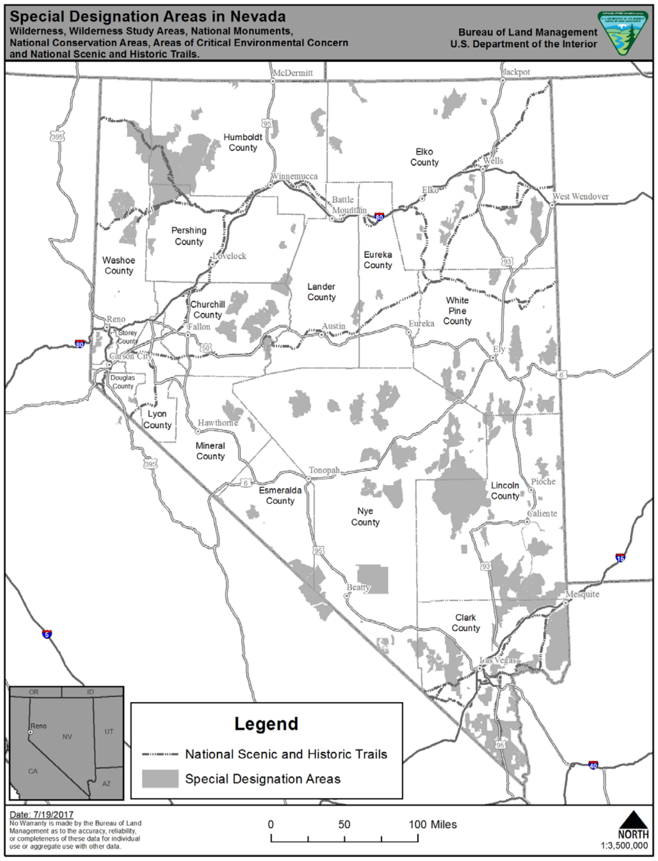
Unforeseen areas or currently unplanned activities, including emergency response, are areas or locations where WS-Nevada has not operated or had agreements to operate, yet an entity experiencing predator damage, threats, or risks to human/pet health or safety requests assistance from WS-Nevada. Unforeseen PDM activities are handled on a case-by-case basis as the need arises, in response to a request. If PDM is requested on lands classified as other than private, WS-Nevada notifies the land management agency as soon as practicable or as agreed upon in MOUs.

This alternative includes WS-Nevada conducting PDM operations within currently unforeseen areas as long as the operations are consistent with actions and impacts as described in this EA, and as applicable:

- Federal and state law and regulations;
- APHIS-WS policies and Directives;
- Lethal and non-lethal methodologies as described and applied according to this EA;
- The protective measures included in this EA;
- Federal land management plans and federal Annual Work Plans and state or tribal objectives and requirements, excluding WAs and WSAs (with the exception of protecting human health and safety when authorized by the land management agency);
- The results of formal and informal consultations with the USFWS per the ESA (Section 3.6);
- Sustainable population levels as evaluated in Sections 3.5 and 3.7; and

- The actions would not trigger substantive environmental issues or effects that are not addressed in this EA.

Figure 2.2. Areas within which WS-Nevada has Operated in the State, and within which it could respond to requests for assistance under Alternative 1 (unshaded areas).



2.3.1.7 What Types of Methods Are Used in Alternative 1?

As detailed in Appendix A, WS-Nevada can use and/or recommend many methods, including combinations of methods for IPDM strategies.

WS-Nevada, NDOW and/or its agents, NDOW-licensed commercial companies, NDOW-permitted aerial operators, or the property owners themselves may implement PDM methods. Implementing non-lethal methods such as husbandry or structural barriers are generally the responsibility of the property owners. Depending on the circumstances of a particular PDM situation, lethal methods may be needed to address the immediate problem during the time period while non-lethal methods are implemented. The design of the APHIS-WS Decision Model (Section 2.3.1.1), which provides for the consideration of lethal and non-lethal methods, allows WS-Nevada to use and recommend the most effective and practical methods available, while accounting for the many legal, logistical, biological, ethical, and environmental variables in each unique damage situation.

Detailed descriptions of lethal and non-lethal methodologies are found in Appendix A; brief summaries are included below.

- **Non-lethal methods**

Non-lethal methods can be used to disperse, prevent or restrict access or otherwise make an area unattractive to predators causing damage, thereby reducing the risk that predators can cause damage or threats at the site and immediate area. Non-lethal methods are given priority by WS-Nevada field specialists when addressing requests for assistance, when applicable and effective (WS Directive 2.101). However, non-lethal methods are not necessarily used to resolve every request for assistance if deemed inappropriate or potentially ineffective by WS-Nevada personnel under the APHIS-WS Decision Model within the practices of IPDM (Section 2.3.1.1, Figure 2.1). WS-Nevada personnel may recommend that lethal methods be used initially to resolve the immediate problem while non-lethal methods are implemented, such as fence construction.

Non-lethal methods used or recommended by WS-Nevada may include habitat manipulation, husbandry, hazing, fencing, aversive/harassment devices, herding, and livestock guard animals (Appendix A). WS-Nevada may occasionally loan harassment equipment such as propane cannons and pyrotechnics to livestock producers. In many situations, the implementation of non-lethal methods, such as construction of fencing, is the responsibility of the requestor to implement. Many of these methods require regular maintenance and/or human presence to be effective. For dispersing predators, the proper timing is essential. Using methods soon after damage begins or soon after threats are identified increases the likelihood of success.

In most situations, a cooperating entity has already tried reasonable non-lethal methods to resolve damage prior to contacting WS-Nevada for assistance. In those cases, the methods used by the requester were either unsuccessful or the reduction in damage or threats had not reached a level that was tolerable to the requesting entity. In those situations, WS-Nevada could use other non-lethal methods, attempt to continue the use of the same non-lethal methods, and/or recommend or use lethal methods. Typically, the implementation of non-lethal methods, such as exclusion-type barriers, is the responsibility of the requester, which means that, in those situations, the only options available to WS-Nevada field specialists involve the use of lethal methods, if determined to be appropriate and potentially effective under the APHIS-WS Decision Model.

- **Lethal methods**

After receiving a request for assistance and conducting a field review, trained and certified WS-Nevada personnel may determine that lethal methods are appropriate. Lethal methods are often used to reinforce non-lethal methods, to remove animals that have been identified as causing damage or posing a threat to human safety, and/or to reduce the risk of depredation reoccurring in an area where it has occurred in the past. The use of lethal methods results in temporary and small local reductions of the numbers of predators in the area where damage or threats are occurring or are expected to reoccur. The number of animals removed from the area using lethal methods under this alternative is dependent on the number of predators involved with the associated damage or threat, the potential for reoccurrence of depredation, especially on livestock or natural resource species, and the effectiveness of methods used.

Lethal methods used by WS-Nevada employees include ground shooting, aerial shooting, snaring, live trapping, such as using snares, nets, cage traps, and foothold traps (followed by mechanical or chemical euthanasia) or methods such as chemical toxicants when lawful. These methods are described in detail in Appendix A. WS-Nevada employees follow the American Veterinary Medical Association (AVMA 2013) euthanasia recommendations for free-roaming and captured animals in program activities, where practical and effective (APHIS-WS Directive 2.505, and Sections 2.4, 3.9 and 3.10.3.3), and use the most humane and rapid methods available under the circumstances and per the APHIS-WS Decision Model (Sections 2.3.1.1, Appendix A, and Section 3.9).

Aerial shooting with fixed-wing aircraft is generally one of the most effective control methods where terrain is relatively flat, and it is the preferred method because of its selectivity, accessibility, effectiveness and ability to traverse rough terrain during winter weather. Aerial shooting with rotary-wing aircraft (helicopter) compliments fixed-wing aircraft operations when air is thinner (such as high elevation) and operations require slower passes, such as in narrow canyons. In addition, these methods provide the greatest area of coverage needed to protect livestock and natural resources. Other control methods, such as foothold traps, snares, M-44s and ground shooting, are also used in combination with aerial shooting in these areas. During spring, coyotes and common ravens inflict the greatest predation losses coinciding with lambing, calving, kidding and fawning. Therefore, PDM is intensified with all necessary methods including traps, snares, M-44s, DRC-1339 and shooting being used.

WS-Nevada responses to requests for preventive aerial shooting have occurred in a portion of all counties with the exception of Clark. Aerial shooting occurs only on lands where it is authorized and when under agreement. During late fall thru mid-spring (November through May), requests for PDM assistance on lambing and calving grounds on private property and some BLM grazing allotments are scattered throughout Nevada, with the exception of Clark County. Aerial shooting from fixed wing and rotary wing aircraft may occur from January thru June for protection of antelope and mule deer fawning, mainly on public lands in Eureka, Elko, Nye, White Pine and Lincoln Counties when NDOW requests assistance in meeting their recruitment goals. Aerial shooting can also be conducted by other entities under permit from NDOW to remove coyotes for livestock protection (Section 1.7).

The current WS-Nevada program is or may be conducted on private, public, tribal, and other lands where a request has been made, the WS-Nevada employee has determined that the problem is caused by a predator, and appropriate agreements for assistance have been finalized. All management actions comply with appropriate federal, state, territorial, tribal, and local laws (Section 2.4). Any strategy involving reducing the number of predators in a particular area during a regulated hunting/trapping season is the responsibility of NDOW as authorized by state law.

- **Methods that May Be both Lethal and Non-Lethal**

Some methods may be part of either a lethal or non-lethal strategy, or a combination of both. For example, foothold and cage traps may be used to capture animals for relocation/translocation or for euthanizing upon capture, depending on the circumstances, species, policy and regulatory requirements, and management objective. As described in Section 1.7, NDOW policy prohibits relocating certain species of predators, such as coyotes, skunks and raccoons, and predators that have a risk of continuing the problem in their new location, may spread disease, or not fare well due to intraspecific competition. APHIS-WS policy also discourages relocation of captured offending animals for the same reason (APHIS-WS Directive 2.501; Section 2.4.1.8). Relocation of captured problem animals is also opposed by the American Veterinary Medical Association, the National Association of State Public Health Veterinarians and the Council of State and Territorial Epidemiologists because of the risk of disease transmission among wild mammals. Therefore, many animals captured using non-lethal methods are often euthanized per State and APHIS-WS policy.

- **Minimization Measures**

See Section 2.4 for list of minimization measures, including APHIS-WS Directives, state law and regulation, ESA terms and conditions and measures pertinent to this alternative. Table 2.1 summarizes proportion of WS-Nevada annual predator take by method, Table 2.2 annual predator take by land class, Table 2.3 annual predator take by County, Table 2.4 annual predator take by BLM district, Table 2.5 annual predator take by FS ranger district. Most predators taken by WS-Nevada during PDM activities occur on private land (coyotes=49.6%, common ravens=27.9%).

Table 2-1. WS-Nevada Proportion of Lethal Take of Predators during PDM by Method FY 2012-2016.

Common Name	Trap/ Snare	M-44	DRC-1339	Sodium pento-barbital	Gas Cartridge (dens)	Aerial Shooting	Firearms	Hand Capture
Coyote	23.7%	5.1%	0	0	3.8%[2]	59.2%	8.2%	0
Common raven	0	0	99.3%	0	0	0	.4%	.2%
Badger	95.3%	0	0	0	0	0	4.1%	.5%
Mountain lion	45.8%	0	0	0	0	0	54.2%	0
Striped skunk	51.6%	0	0	45.2%	0	0	1.6%	1.6%
Raccoon	88.9%	0	0	0	0	0	2.2%	8.9%
Bobcat	94.1%	0	0	0	0	0	5.9%	0
Red fox	92.3%	0	0	0	0	0	7.7%	0
Free-ranging/feral dog	66.7%	33.3%	0	0	0	0	0	0
Kit fox	20%	80%	0	0	0	0	0	0
Black bear	80%	0	0	0	0	0	20%	0
Free-ranging/feral cat	1	0	0	0	0	0	0	0
Gray fox	100%	0	0	0	0	0	0	0
Spotted skunk	0	0	0	100%	0	0	0	0

[1] Difference between calculated proportion and 100% due to rounding and minor use of other methods.
[2] Based on 4 coyotes taken/den.

Table 2-2. Proportion of Annual Lethal Take of Predator Species by WS-Nevada during PDM by Land Class FY 2012-2016[1]

Species (Total WS-Nevada 5-year take)	Private	BLM	Forest Service	State	County/ City	Tribal	Other Public	Military	% Total Predator Take by Species
Coyote (21,851[2])	49.6%	46.2%	2.7%	.3%	0	.3%	.6%	.3%	52.7%
Common raven (19,031)	27.9%	68.1%	0	>.1%	3.6%	0	0	>.1%	45.9%
Badger (239)	12.6%	83.3%	.4%	.4%	.8%	0	0	2.5%	.6%
Mountain lion (120)	20.8%	59.2%	15.8%	0	.8%	0	0	0	.3%
Striped skunk (78)	70.5%	0	0	5.1%	15.4%	0	0	0	.2%
Raccoon (58)	93.1%	0	0	3.4	1.7%	0	0	1.7%	.1%
Bobcat (20)	20%	75%	5%	0	0	0	0	0	>.1%
Red fox (15)	0	53.3	40%	0	6.7%	0	0	0	>.1%
Feral/Free-ranging dog (13)	100%	0	0	0	0	0	0	0	>.1%
Kit fox (8)	62.5%	25%	0	0	0	0	0	12.5%	>.1%
Black bear (7)	85.7%	14.3%	0	0	0	0	0	0	>.1%
Feral/free ranging cat (5)	100%	0	0	0	0	0	0	0	>.1%
Gray fox (1)	0	100%	0	0	0	0	0	0	>.1%
Spotted skunk (1)	0	0	0	0	100%	0	0	0	>.1%
% Total Predator Take by Land Class	39.5%	56.4%	1.5%	.2%	1.7%	.2%	.3%	.2%	

[1]Difference between calculated proportions and 100% due to rounding.
[2]Includes dens taken based on average of 4 coyotes per den.

Table 2-3. Average of Annual Lethal Take of Target Predator Species by WS-Nevada during PDM by County (FY 2012-2016).

County	Coyote[1]	Common raven	Mountain lion	Raccoon	Striped skunk	Badger	Bobcat	Feral cat	Black bear	Red fox	Feral dog	Spotted skunk	Kit fox
Carson City	2.2	0	0.8	0	0	0	0	0	0	0	0	0	0
Churchill	117.2	52.8	0	1	0.6	1.2	0	0.6	0	0	0.2	0	0.2
Clark	2	0	0	0	0	0	0	0	0	0	0	0	0
Douglas	27.4	0	0	0	0	0	0	0	0.4	0	0	0	0
Elko	971.4	904.6	2.2	0	1.6	25.6	0.2	0	0	1.8	0	0	0
Esmeralda	0.4	0	0	0	0	0	0	0	0	0	0	0	0
Eureka	493.4	153.4	1	0	0	2.8	0	0	0	0.6	0	0	0
Humboldt	879.8	476.8	0.6	0	0	0.2	0	0	0	0	2.2	0	0
Lander	365	199.4	0.2	0	0	0.2	0.8	0	0	0.2	0	0	0
Lincoln	148.4	757	0.8	0	0	6.4	0	0	0	0	0	0	0
Lyon	133	91	2.2	0.4	1.8	0.2	0	0	0.6	0	0	0	0
Mineral	1.4	0	0	0	0	0	0	0	0	0	0	0	0
Nye	148.2	163.4	1.4	0	0.2	0.4	0.2	0	0	0	0	0	0
Pershing	245.6	48.6	0	0	0	0	0	0	0	0	0	0	0
Storey	1.4	0	0.8	0	0	0	0	0	0	0	0	0	0
Washoe	206.8	208.2	7.8	10	11	0.4	1	0.4	0.2	0	0	0.2	0
White Pine	626.6	750.8	6.2	0	0.4	10.2	1.6	0	0	0.4	0	0	0
Totals	**4370.2**	**3806**	**24**	**11.4**	**15.6**	**47.6**	**3.8**	**1**	**1.2**	**3**	**2.4**	**0.2**	**0.2**

[1]Includes dens taken based on average of 4 coyotes per den.

Table 2-4. Average of Annual Lethal Take of Target Predator Species by WS-Nevada during PDM by BLM Jurisdiction FY 2012-2016.

Predator Species	Battle Mountain	Carson City	Eagle Lake	Elko	Ely	Las Vegas	Suprise	Winnemucca	Total
Coyote[1]	391	33.6	10.6	489.4	651	0	61	502.2	**2138.8**
Common raven	4.8	156.4	0	17.8	152.2	0	3	143.2	**477.4**
Mountain lion	0.8	0.4	0.2	2.6	4	0	3.2	2	**13.2**
Bobcat	0.2	0	0	0.4	1.2	0	0.8	0	**2.6**
Badger	2.4	0	0	17.6	2.6	0	0	0	**22.6**
Red fox	0.8	0	0	0.6	0.6	0	0	0	**2**
Total take by Jurisdiction	**400**	**190.4**	**10.8**	**528.4**	**811.6**	**0**	**68**	**647.4**	**2656.6**

[1]Includes dens taken based on average of 4 coyotes per den.

Table 2-5. Average of Annual Lethal Take of Target Predator Species by WS-Nevada during PDM by USFS Ranger District from FY 2012-2016.

Predator Species	Ely	Mountain City	Ruby Mountains	Austin	Bridgeport	Total
Coyote[1]	22.8	14.6	61.4	15.8	3.6	**118.2**
Bobcat	0.2	0	0	0	0	**0.2**
Mountain lion	3.4	0	0	0	0.4	**3.8**
Badger	0	0.2	0	0	0	**0.2**
Red fox	0	1.2	0	0	0	**1.2**
Total Take by Ranger District	**26.4**	**16**	**61.4**	**15.8**	**4**	**123.6**

[1]Includes dens taken based on average of 4 coyotes per den.

2.3.1.8 What is Involved in Management of Wildlife Hazards to Aircraft and Air Passengers?

Upon receiving a request for assistance for PDM from a civil/Department of Defense (DoD) airport authority, WS-Nevada can provide a variety of services, including assessing the situation, developing an operational plan, and assisting with implementing the plan. WS-Nevada may identify and evaluate hazards to aircraft and operations due to problematic predators present and when requested, prepare a Wildlife Hazard Assessment. WS-Nevada may assist the airport/DoD facility in developing a Wildlife Hazard Management Plan to address those hazards and threats or be requested to assist airports in implementing an existing management plan. The Wildlife Hazard Management Plan may be combined with recommendations for resolving all wildlife species causing hazard threats at the airport. However, while aviation hazards caused by predatory animals are included in this EA, avian hazards (with the exception of common ravens) are outside the scope of this EA and are covered under other NEPA analysis.

Direct operational activities consist of various harassment, live-capture, and lethal removal techniques aimed at removing mammalian predators and common ravens causing hazards. WS-Nevada personnel also provide ongoing technical assistance to airport/DoD managers regarding methodologies to reduce the presence of wildlife in areas of operations within airports/DoD facilities, including providing technical assistance on various habitat management projects that could be implemented by airport personnel. In addition, WS-Nevada promotes improved wildlife strike hazard recordkeeping, provides wildlife identification services (such as collecting evidence such as feathers or fur, which may be all that is remaining after a strike), and monitors animal numbers at participating airports to assist in developing an effective predator damage management program.

2.3.1.9 What is Involved in Management of Predator Damage to Natural Resources?

Upon receiving a request for assistance to manage predators damaging natural resources (Section 1.11.5), WS-Nevada assists NDOW in removing predators, using lethal methods and/or trap and translocation methods, as outlined in NDOW Predator Plan or as requested by NDOW. WS-Nevada would also be able to provide assistance to USFWS for the protection of federally threatened or endangered species if the need were to arise using methods similar to responding to NDOWs need for action.

Bighorn Sheep Protection

NDOW has and may again request that WS-Nevada conduct PDM to protect Rocky mountain bighorn sheep from mountain lion predation in 2 counties of eastern Nevada, Elko and White Pine. Methods used are primarily tracking/trailing with hounds with lethal removal conducted with a firearm. Mode of transportation is typically mule-back.

California bighorn sheep have/potentially would receive protection from mountain lion predation in Washoe, Humboldt and Pershing Counties, although populations also exist in Lander, Eureka and Elko Counties. Methods used are typically snaring with some track/trailing with hounds with lethal means provided by firearm.

Desert bighorn sheep have/potentially would mainly receive protection from mountain lion predation in Lincoln, Nye, White Pine, Clark, Esmeralda, Eureka, Churchill, Pershing, Mineral Lyon and Storey Counties. Methods used are/would be a combination of tracking/trailing with hounds followed by lethal removal with firearm and snaring.

Mule Deer Protection

Mule deer protection from lion and/or coyote predation has/may potentially occur throughout Nevada in targeted areas as requested by NDOW. Methods for coyote removal include fixed wing and rotary wing aircraft, trapping/snaring, calling, use of decoy dogs in concert with calling and site shooting. Methods for lion removal would be similar, but without the use of aircraft and dogs would be used for tracking/trailing, not decoying.

Pronghorn Antelope Protection

Antelope protection from coyotes may potentially occur throughout Nevada as requested by NDOW. Fixed wing and rotary wing aircraft would be primary components, some trapping/snaring, calling and shooting and calling with the use of decoy dogs followed with firearm removal could also occur.

Greater Sage-grouse Protection

Greater sage-grouse protection from common raven, coyote and badger predation could occur throughout Nevada as requested by NDOW. Common raven removal would be for protection of nests/eggs/broods during the spring months. DRC-1339 treated egg baits would be the primary component used, although firearms are also used. Coyote removal would mainly occur with the use of fixed and rotary winged aircraft, though trapping, snaring, calling and shooting and calling in concert with decoy dogs followed by removal with firearms may also occur. Badger removal would be mainly with the use of trapping, although snares and firearms may also be used.

Wild Turkey Protection

Turkey protection from badger, raccoon, striped/spotted skunk, and coyote predations may occur if requested by NDOW. This work has mainly occurred in the past and would continue periodically in State wildlife management areas in Lyon and Clark Counties when recruitment is below thresholds. Coyote removal is typically with the use of foothold traps/snares, firearms and calling. Badger removal is typically with foothold traps, but could also include the use of firearms and snares. Raccoon removal would primarily occur with the use of cage traps and dog proof traps, though use of foothold traps, firearms and snares may also occur. Skunk removal would mainly occur with the use of cage traps and shooting, although use of dog proof traps, snares and foothold traps may also occur.

2.3.1.10 What Other Entities Conduct PDM in the Absence of WS-Nevada Action?

As defined by the 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). The Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations" (Question 3; https://ceq.doe.gov/nepa/regs/40/40p3.htm), states:

> "*Where a choice of "no action" by the agency would result in predictable actions by others, this consequence of the "no action" alternative should be included in the analysis.*"

Therefore, WS-Nevada will analyze not only the effects of its actions, but also the potential impacts that would occur when another entity takes the same or similar action in the absence of the APHIS-WS action.

A county-run cost-share program that replaced WS-California activities for livestock depredation demonstrated individual livestock producers and their agents routinely practice snaring, calling and shooting, and denning in an effort to kill coyotes, most intensely in winter and spring. When incidences of "hot spots" occur with multiple losses on adjacent ranches, ranchers may collaborate on hunting parties in an effort to reduce coyote numbers in the area (Larson 2006; Section 1.13.5).

State agencies also have legal authority to respond to and manage wildlife conflicts. As discussed in Section 1.7, NDOW and NDA have legal wildlife damage management authority, and NDOW issues depredation permits and permits for aerial shooting. NDOW can also use volunteers, particularly those with trained pursuit dogs, for predator damage management for mountain lions and bears, and licensed commercial wildlife damage management companies, typically for addressing human conflicts with smaller predators. For many predators not managed as game or furbearer mammals in Nevada, property owners can also remove such animals causing depredation or damage with a permit issued by NDOW or without a permit, depending on the species (Section 2.4.4.1). In addition, NDOW can set take limits for game and furbearer predators during hunting and trapping seasons to manage population levels to meet state objectives, which may include for protecting game species in specific wildlife management units (Section 1.7). County and local authorities are primarily involved with complaints regarding feral/free-ranging dogs and cats.

Private and commercial property owners can also request assistance from companies that have a license from NDOW (NDOW 2016c) to provide those services, or those private and commercial property owners may authorize another person(s) as their agent to remove damaging species as outlined in NAC 503.710, NAC 503.720, NAC 503.730, NAC 503.740 and NAC 503.760. Currently 21 licensed companies are identified on the NDOW website; however, only 2 companies explicitly advertise conducting programs on coyote damage, 1 of which also advertised conducting programs on mountain lion damage (NDOW 2016c).

Per NAC 503.710-503.740 and 503.760, NDOW issues permits, including those for aerial hunting per the Fish and Wildlife Act of 1956 as amended, to landowners, lawful tenants, and lessees to take predatory animals. Coyotes, skunks, weasels, badgers, raccoons and ringtails are classified as unprotected in Nevada (NAC 503.035) and can be taken by any legal method. NRS 501.376 allows the take of black bear and mountain lion to protect life or property when a person feels that they are in immediate danger. NRS 502.010 allows the take of any unprotected bird or mammal to protect persons or property in the immediate vicinity of homes or ranches affected by such species. NRS 503.470 allows the take of any fur-bearing mammal doing damage provided a permit is obtained from the department.

Given that Federal, State, commercial, and private entities routinely receive authorization to conduct predator damage management from NDOW, and that most methods for resolving predator damage are available to both WS-Nevada and to NDA (including DRC-1339) and non-federal entities (except for M-44s, which are available for use in Nevada for use only by WS-Nevada employees), it is clear that, even under all the alternatives, including those in which WS-Nevada is not involved with direct (lethal) PDM, other entities will be conducting PDM (Section 2.3.1.10 and 3.4).

All non-lethal methods and most lethal methods are available to non-WS-Nevada entities. Only WS-Nevada has authority to use M-44s in Nevada per the EPA label. M-44s are not commonly used by WS-Nevada staff (average 223 coyotes per year, with approximately 5% of average annual coyote take by WS FY 2012 through FY 2016 (MIS 2017). WS-Nevada generally uses M-44s in situations where coyotes have proven difficult to remove using other methods. Given the relatively low number of coyotes taken using M-44, non-WS-Nevada entities are likely to compensate for loss of use of M-44s through more extensive use of traps, snares, and shooting. Only WS-Nevada and NDA have authority to use DRC-1339 SLN NV-150001 in Nevada for common raven removal (average 3,767.2 common ravens per year with approximately 99.3% of annual common raven take by WS-Nevada FY 2012 through FY 2016 (MIS 2017).

2.3.2 *Alternative 2. Modified Current Program (Proposed Action)*

Alternative 2 is a modification of the Current Program (Alternative 1) to allow WS-Nevada to conduct PDM in wilderness areas (WAs) and wilderness study areas (WSAs) for the protection of livestock, human health and safety, disease/parasite transmission, and federally threatened or endangered species. Any work proposed in WAs or WSAs would be subject to additional review and approval by the land managing agency (BLM or USFS), in compliance with wilderness administration policies. **Under this alternative, all work outside of WAs or WSAs would have the same processes, components, and geographic scope as Alternative 1. Therefore, the description below is limited to the additional work proposed in WAs and WSAs and intended to be considered in conjunction with those elements described under Alternative 1.**

Any work to protect federally-listed species in WAs or WSAs would be conducted at the request of wildlife management agencies, such as USFWS or NDOW. WS-Nevada may also conduct disease sampling of any animal taken from WA or WSA. Use of APHIS-WS Decision Model and process for verifying losses to livestock and damage in WAs and WSAs would be the same as under Alternative 1, and is more explicitly outlined in Section 2.3.2.4, below. PDM strategies and methods described in Alternative 1 may be used under Alternative 2, however those used in WAs or WSAs would be applied in a manner that conforms to management policies in the Wilderness Act, Federal Land Policy Management Act, BLM policies 6330 (BLM 2012a), 6340 (BLM 2012b), USFS Manual (FSM) 2300 (USFS 2007), MOUs and Annual Work Plans (AWPs) with APHIS-WS (Section 1.8.2.2). Specific non-lethal and lethal methods proposed for use in WAs and WSAs are listed in Sections 2.3.2.3.1 and 2.3.2.3.2, below. All methods proposed for use in WAs or WSAs are analyzed in this EA, however, selection, approval, and application of any PDM in WAs and WSAs will be further reviewed by the land managing agency, as described in Section 1.8.2.3, on a case-by-case basis.

2.3.2.1 *What PDM Strategies that may be implemented in WAs and WSAs by WS-Nevada under Alternative 2?*

Alternative 2 includes all of the activities proposed under Alternative 1 plus the possibility of conducting PDM in WAs and WSAs, if requested. Alternative 2 includes all components described under Alternative 1 in Section 2.3.1.4. The discussion below is specific to how those same components might be applied to PDM in WAs and WSAs. Some PDM methods listed in Alternative 1 and used in non-wilderness settings are not appropriate for WAs or WSAs. Final selection of methods for PDM in a WA or WSA will rely on approval by the wilderness management agency through the AWP process described in Section 1.8.2.3.

Collaboration and Project Identification

WS-Nevada enters into cooperative partnerships in all aspects of operational wildlife damage management when requested by agency partners, local governments, tribes, and/or private entities. Cooperative partnerships may be developed to identify alternatives, develop strategies, and implement PDM activities in targeted areas and for targeted resource protection, such as livestock, protection of human health and safety or federally threatened or endangered species (Sections 1.7, 1.8 and 1.11.2, 1.11.4, 1.11.6 and 1.11.7). WS-Nevada would only request permission to implement PDM for the protection of federally listed T&E species if a wildlife management agency determined it was necessary and requested WS-Nevada's assistance. Any additional authorizations, consultations, or environmental analyses necessary to conduct such work would be coordinated with the appropriate agencies prior to conducting any PDM. This may include, but is not limited to, additional wilderness Minimum Requirements Analyses (MRA), Minimum Requirement Decision Guides (MRDG), or additional ESA Section 7 consultations.

Technical Assistance

Resources owners or managers requesting assistance from WS-Nevada are provided with information regarding the use of effective and practical non-lethal and lethal techniques and/or IPDM strategies, including advice, training, and, to a limited degree, loan of equipment. Technical assistance training can be over the phone, on-site, or in instructional meetings. WS-Nevada provides training on depredation investigations related to human health and safety to NDOW, law enforcement, and other officials. Additionally, WS-Nevada provides training to the public on how to avoid wildlife conflict and conducts workshops on non-lethal methods for producers and resource owners. Questions related to WA and WSA laws and/or policy are referred to the land managing agency. WS-Nevada is not a regulatory agency, therefore cooperators are not obligated to follow the provided recommendations or report back to WS-Nevada. Technical assistance is described in detail in Appendix A.

Operational Assistance

When WS-Nevada employees conduct PDM activities, whether non-lethal or lethal, this is considered Operational Assistance. In most cases, WS-Nevada provides a combination of technical assistance and operational assistance. Often, non-lethal recommendations provided by WS-Nevada are conducted by the resource owners, because it is logistically or economically more practical. These same resource owners may cooperate with WS-Nevada to conduct lethal PDM, because they find it to be safer, more effective, and/or more cost-effective.

WS-Nevada wildlife damage management activities involve an integrated approach using a range of non-lethal and lethal techniques which can be used singly or as part of an integrated approach. WS-Nevada may use ground shooting along with calling, decoy dogs or tracking/trailing dogs, foothold traps, neck and foot snares afoot or horseback in WAs. For methods WS-Nevada may use in WSAs, please see Table 2.7.

Corrective Damage Management

Corrective damage management involves applying management strategies to stop or reduce current losses. As requested and appropriate, WS-Nevada personnel provide information, conduct demonstrations, or take action to prevent future additional losses. Corrective actions may include a combination of wildlife damage management approaches, technical assistance, and operational damage management assistance.

When appropriate, WS-Nevada also provides damage management assistance (operational assistance) using lethal and non-lethal methods within an IPDM strategy. Resource managers and others requesting operational assistance are provided with information regarding the use of effective nonlethal and lethal techniques, including recommendations as to effective long-term strategies for reducing risk of wildlife damage.

For example, in areas where verified livestock depredations are occurring, WS-Nevada field specialists may provide information about livestock guarding animals, husbandry techniques, and/or conduct operational, often lethal, damage management activities to stop the losses.

When deployed in WAs and WSAs, lethal and non-lethal methods are intended to be short-term attempts at reducing damage currently occurring. Non-lethal methods can also be used to prevent damage from reoccurring in areas with historical loss. However, these methods cannot ensure predators do not return once those methods are discontinued. Resource owners and managers may request assistance from NDOW and/or its agents, or conduct such activities themselves rather than requesting assistance from WS-Nevada.

WS-Nevada is not proposing **Preventive Damage Management** as described in Section 2.3.1.4, as a PDM strategy in WAs or WSAs. Under Alternative 2, preventive damage management may be conducted only outside of WAs or WSAs.

Carcass Disposal

Nevada laws and regulations regulate the disposal of carcasses of animals: game mammal, carnivore and common raven (NRS §503.050). WS-Nevada disposes of carcasses to make in accordance with APHIS-WS Directives 2.510 and 2.515 (Section 2.4.1.8) and state law.

Monitoring

WS-Nevada, in coordination with NDOW when appropriate, monitors the results and impacts of its program. The impacts discussed in this EA are monitored and evaluated in 2 ways:

1) WS-Nevada determines if any additional information that arises subsequent to the NEPA decision from this EA would trigger the need for additional NEPA analysis. WS-Nevada reviews implementation results and the related NEPA documents as needed to ensure that the need for action, issues identified, alternatives, regulatory framework, and environmental consequences are consistent.

2) WS-Nevada, in coordination with NDOW when appropriate, monitors impacts on target and non-target predator populations through its MIS database. The MIS information is used to assess the localized and cumulative impacts of WS-Nevada activities on specific target predator and non-target wildlife populations. WS-Nevada provides detailed information on animals removed, quarterly and annually to NDOW and annually to the USFWS to assist those agencies with managing species and resources under their jurisdictions.

3) In addition to sharing information with NDOW and USFWS as indicated in (2) above, WS-Nevada also coordinates actions conducted in WAs and WSAs with BLM and USFS Wilderness Leads during the annual work plan process. WS-Nevada also provides detailed information on animals removed on an annual basis.

2.3.2.2 *What Types of Actions in WAs and WSAs are included in Alternative 2?*

WS-Nevada would conduct PDM in WAs and WSAs to protect livestock, human health and safety, federally threatened or endangered species at the request of management agencies and conduct disease surveillance only when and where a need exists and PDM assistance is requested. Most requests for PDM assistance would be from livestock producers that have valid grazing permits to graze their livestock in WAs and WSAs. Requests for PDM assistance for human health and safety in WAs or WSAs are very rare. Requests for PDM assistance for federally threatened or endangered species in WAs or WSAs has not occurred in over 10 years.

According to FSM 2320, the USFS would only approve PDM activities in USFS-managed wilderness "where control is necessary to protect federally listed threatened or endangered species, to protect public health and safety, or to prevent serious losses of domestic livestock" (p. 31). According to BLM MS-6340, PDM activities that could be approved in BLM-managed wilderness "may be necessary to conserve federally listed threatened, endangered species, or candidate species, to prevent transmission of diseases or parasites affecting wildlife and humans, or to prevent serious losses of domestic livestock" (p. 1-60 – 1-61). According to BLM MS-6330, PDM activities "in WSAs should be undertaken only: A. to prevent transmission of diseases or parasites affecting human health or safety; B. to prevent transmission of diseases or parasites affecting other native wildlife; C. to protect domestic livestock within the WSA; or D. to enhance recovery of federally listed threatened or endangered species" (p.1-42).

Table 2.6 provides average predator take in WAs and WSAs for Fiscal Years 2012-2016. This is provided to give context to the limited nature of WS-Nevada's likely work in WAs and WSAs for the protection of livestock.

Table 2-6. Average Annual Take by Species and Method in WAs and WSAs (FY 2012-2016).

Common Name	Firearms	Gas Cartridge	Neck Snares	Traps, Foothold
Badger	0	0	0	>1
Coyote	19	0	5	9
Coyote den	0	<1	0	0
Grey fox	0	0	0	>1
Mountain lions	3	0	<1	0

WS-Nevada does not anticipate conducting any PDM in WAs or WSAs for the protection of federally listed or candidate species under this NEPA document. These proposals may require additional NEPA that is more specific to the situation and would involve close coordination and planning with the natural resource management agency requesting the PDM (e.g. USFWS or NDOW), however the use of the proposed PDM methods are analyzed in Chapter. The necessary MRA and any additional NEPA would be prepared prior to conducting such work. The analysis in this EA may be used to inform that process.

WS-Nevada also does not anticipate the need to conduct any PDM to prevent disease transmission in WAs or WSAs. Should WS-Nevada be requested to conduct such work, BLM or USFS would prepare a MRA. WS-Nevada and BLM/USFS would evaluate the need for additional NEPA.

Emergencies

BLM Manual 6340 allows exceptions to the normal process of approval for actions in BLM-managed wilderness in cases of emergency; emergency is defined as "a situation that requires immediate action because of imminent danger to the health or safety of people or livestock." Normally, an action proposed in wilderness is subject to a MRA through the use of the MRDG and a subsequent project-specific NEPA analysis (Section 1.8.2.3). In emergencies, "the minimum requirements concept should be incorporated into emergency planning so that the minimum necessary methods and tools can be used to resolve emergencies while preserving wilderness character to the greatest extent practicable;" however, "the MRDG should not be used at the time of response to an emergency" (BLM 6340, Appendix B-1). If there is a threat to human health or safety or to livestock related to disease transmission that meets the definition of an emergency, then actions to respond to the emergency could be authorized in wilderness through the BLM's emergency process.

In WSAs, "in emergencies, any action necessary to prevent loss of life or property may be taken, even if the action will impair wilderness suitability…In addition to emergencies, the BLM may take actions that would otherwise violate the non-impairment standard to protect public safety. These actions are limited to remediation of human-caused hazards in the WSA (e.g. mine adits)" (BLM 6330, p. 1-11). The actions proposed in WSAs in Alternative 2 would not violate the non-impairment standard, and if there is a threat to public safety that meets the definition of an emergency, then actions to respond to the emergency could be authorized in WSAs through the BLM's emergency process.

Proposals for PDM activities in WAs or WSAs for the purpose of protecting human health and safety would likely meet both policies' definition of an emergency, and if so, may be considered and potentially approved as such in BLM-managed wilderness and WSAs. Prior to conducting PDM in WAs or WSAs, WS-Nevada will coordinate with BLM to determine if the MRA process or additional NEPA analysis are necessary.

2.3.2.3 *What Types of Methods Are Proposed for Use in WAs and WSAs?*

WS-Nevada may use and/or recommend many methods, including combinations of methods for IPDM strategies. See Appendix A for detailed description of methods and Appendix B for methods used by WS-Nevada District. Non-lethal methods are given priority by WS-Nevada field specialists when addressing requests for assistance, when applicable and effective (WS Directive 2.101). However, non-lethal methods are not necessarily used to resolve every request for assistance if deemed inappropriate or potentially ineffective by WS-Nevada personnel under the APHIS-WS Decision Model within the practices of IPDM (Section 2.3.1.1, Figure 2.1).

WS-Nevada, NDOW and/or its agents, or the livestock/resource owners themselves may implement PDM. Implementing preventive, non-lethal methods, such as husbandry, is generally the responsibility of the livestock owners, however WS-Nevada may recommend methods or strategies for implementation. Depending on the circumstances of a particular PDM situation, lethal methods may be needed to address the immediate problem during the time period while non-lethal methods are implemented (e.g. procuring a guard animal, hiring additional range riders). The design of the APHIS-WS Decision Model (Section 2.3.1.1), which provides for the consideration of lethal and non-lethal methods, allows WS-Nevada to use and recommend the most effective and practical methods available, while accounting for the many legal, logistical, biological, ethical, and environmental variables in each unique damage situation.

Detailed descriptions of lethal and non-lethal methodologies are found in Appendix A, but brief summaries for methods that may be included in WAs and WSAs are included below and in Table 2.7 for WSAs at the end of this section.

Technical Assistance

When responding to a request for assistance in WAs or WSAs, WS-Nevada may simply provide advice or education on ways to manage livestock to prevent damage from occurring. This technical assistance may include things that WS-Nevada could not implement ourselves, as we do not determine what livestock are grazed, how they are managed, etc. Providing technical assistance assists the producers in their attempt to prevent or stop damage without needing any operational assistance from WS-Nevada. Producers are not obligated to follow the recommendations of WS-Nevada, and may choose a different course of action all together. Nor are they required to report back to WS-Nevada in any form. While WS-Nevada does not implement these actions, the strategies listed below may be recommended to producers in WAs or WSAs, as appropriate, under Alternative 2.

<u>Technical Assistance Strategies Provided by WS-Nevada</u>

Education:
- *General biology and behavior of predators*

Resource Management Practices:
- *Change class of livestock*
- *Behavior selection of livestock*
- *Shifts in breeding schedules*

Animal Husbandry:
- *Herders and range riders*
- *Guard animals*
- *Benching of sheep*

2.3.2.3.1 Non-lethal methods

The most common non-methods employed include: guard dogs, herd dogs, herders, range riders, benching of sheep[5], and harassment with firearms. Non-lethal methods can be used to disperse, prevent or restrict access or otherwise make an area unattractive to predators causing damage, thereby reducing the risk that predators can cause damage or threats at the site and immediate area.

WS-Nevada does not propose to use lights, sirens or call boxes in WAs because they are disruptive to the wilderness experience. WS-Nevada may recommend their use only where the land management agency determines they are not a prohibited use. Generally, the implementation of non-lethal methods is the responsibility of the requestor. Many of these methods require regular care and/or human presence to be effective, making it more cost effective for the range riders or herders to implement them and provide upkeep, as opposed to hiring WS-Nevada personnel for something that time intensive. Proper timing in the application of any method is also essential to disperse predators. Using methods soon after damage begins or soon after threats are identified increases the likelihood of success. Again, producers may implement non-lethal strategies right away where it is time critical, before contacting WS-Nevada for additional assistance.

Non-lethal Methods Proposed For Use WAs and WSAs

Shifts in breeding schedules
Guard dogs and herd dogs
Herders and range riders
Behavior selection of livestock

Non-lethal Methods Proposed for Use Only In WSAs

Harassment Methods
Electronic distress sounds and alarm calls
Visual scaring techniques
Aerial hazing/harassment/dispersal

2.3.2.3.2 Lethal Methods

In response to a predation event, WS-Nevada personnel may determine that lethal methods are appropriate. Lethal methods are often used to reinforce non-lethal methods and to remove animals that have been identified as causing damage or posing a threat to human safety. In WAs, lethal removal is applied only to the individual predators that caused the depredation, whereas in WSAs lethal removal may be applied to the individual predator or groups of predators that caused damage. WS-Nevada strives to be as target specific as possible through PDM method selection and implementation strategies.

[5] Benching of sheep is the use of geographic features, such as bowls in the landscape, to consolidate livestock for more effective guarding.

Lethal methods proposed by WS-Nevada for use in WAs and WSAs include:

Lethal Methods Proposed for use in WAs

Ground shooting
Calling
Trained tracking/trailing/decoy dogs
Trapping/snaring

Lethal Methods Proposed for use in WSAs

Ground shooting
Calling
Trained tracking/trailing/decoy dogs
Trapping/snaring
Tranquilizers/immobilization
M-44s
Large gas cartridges
DRC-1339 treated eggs
Aerial shooting, overflights and landings
Chemical and gas euthanasia

Discussion of methods can be found in Appendix A, however, specific discussion on the use of transportation methods for WAs and WSAs is provided below.

Aerial Operations and Land Transportation

Aerial shooting from fixed-wing aircraft is one of the most effective PDM methods where terrain is relatively flat, and it is often the preferred method because of its selectivity, accessibility, effectiveness and ability to traverse rough terrain during winter weather. Aerial shooting with rotary-wing aircraft (helicopter) compliments fixed-wing aircraft operations when air is thinner, such as high elevation, or when operations require slower passes, such as in narrow canyons. In addition, these methods provide the greatest area of coverage needed to protect livestock and federally threatened or endangered species in WAs and WSAs. Aerial shooting is allowed and proposed in WSAs, but not in WAs and is not allowed or proposed for preventive damage management. WS-Nevada is only proposing aerial shooting in WSAs where livestock depredation has recently occurred. All management actions would comply with appropriate federal laws and wilderness management policies (Section 2.4).

When WS-Nevada receives a request for assistance in a WA or WSA, personnel travel to the location of the reported loss to conduct a site visit. Travel into and out of WAs may be accomplished one of two ways, via foot travel or on horseback. Horses or mules are fed a certified weed-free diet to protect the ecosystems and prevent undesirable plants from colonizing wilderness. Travel into WSAs may allow for the use of motorized vehicles on existing primitive routes (BLM WSA Manual 6330). Vehicle access would be limited to existing roads, unless off-road travel is specifically allowed by the land managing agency and conforms to the LRMPs and RMPs.

WS-Nevada personnel follow guidelines as specified in WS-Nevada AWPs as developed in cooperation with the land management agency. These plans 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 as specified in the plan(s).

WS-Nevada would conduct PDM in accordance with BLM RMPs and USFS Land and Resource Management Plans (LRMP). PDM in WAs would be in accordance with wilderness policies, any necessary Minimum Requirements Analysis (MRA), AWPs, and MOUs. Should any WSAs managed by the BLM or the USFS be officially designated as WAs in the future, PDM would be performed in accordance with updated AWPs, BLM Manual 6340, *Management of Designated Wilderness Areas,* enacting legislation, and any restrictions on PDM in WAs outlined in this EA.

Table 2-7 PDM Methods and Activities that are Allowed[6], Prohibited, Proposed or Not Proposed in WSAs.

Method[1]	BLM and USFS WSAs	Authorizing or Prohibiting Source
Education	Allowed and proposed	BLM Manual 6330 (WSA) (BLM 2012a).
Physical exclusion	Conditionally allowed, but not proposed	In general, permanent "facilities" would be prohibited unless they are determined to be necessary to protect public safety for remediation of human-caused hazards in the WSA or unless it is determined that the facility(ies) would protect or enhance wilderness characteristics or values. In general, temporary facilities could be allowed if the facility(ies) and its use will not create new surface disturbance (disruption or trampling that would necessitate reclamation, rehabilitation, or restoration in order for the site to appear and function as it did prior to the disturbance). Each proposal, whether for permanent or temporary facilities, would be reviewed on a case-by-case basis, and is subject to the applicable Resource Management Plan. Proposals would be approved through the appropriate NEPA process according to the guidance offered in BLM Manual 6330, Management of Wilderness Study Areas.
Animal husbandry	Allowed and proposed	Pursuant to any applicable terms or stipulations in the grazing permit
Habitat management	Conditionally allowed, but not proposed	"Architectural design" and "Managing the habitat" actions may only be allowed for protection or enhancement of

[6] Methods "allowed" must further be approved on a case-by-case basis by the Region Forester, for USFS WAs and WSAs.

		wilderness characteristics, or to recover a federally listed threatened, endangered, or candidate species. Each proposal would be reviewed on a case-by-case basis, and is subject to the applicable Resource Management Plan. Proposals would be approved through the appropriate NEPA process according to the guidance offered in BLM Manual 6330, Management of WSAs. "Reducing food attractants" actions are generally encouraged in WSAs and align with Leave No Trace principles. Actions associated with disposal of livestock carcasses would be pursuant to applicable terms or stipulations in the grazing permit or applicable state statutes; motorized or mechanical transport for disposal is allowed only within "open areas designated prior to the passage of FLPMA unless the area was subsequently limited or closed in a Land Use Plan decision, or on primitive routes (or "ways") identified by the BLM as existing on the date of the passage of FLPMA (or prior to the designation date for Section 202 WSAs not reported to Congress).
Modifying animal behaviors	Allowed and proposed	
Motorized/ Mechanical Transport	Allowed and proposed	Mechanical methods are allowed, with the exception of the deployment of any mechanical method from an aircraft that requires cross-country use of motorized vehicles or mechanical devices to retrieve equipment, except in areas designated as "open" before the passage of FLPMA is prohibited. Proposals for exceptions meeting this criteria could be considered on a case-by-case basis, subject to the applicable Resource Management Plan, if those proposals are determined to be necessary to protect public safety for remediation of human-caused hazards in the WSAs or to protect or enhance wilderness characteristics or values.
Aerial shooting & overflights	Allowed and proposed	Allowed as long as the action does not require cross-country use of motorized vehicles or mechanical devices to retrieve equipment, except in areas designated as "open" prior to the passage of FLPMA.
Aircraft landing	Allowed and proposed (remote likelihood)	Allowed as long as the use will not create new surface disturbance (disruption or trampling that would necessitate reclamation, rehabilitation, or restoration in order for the site to appear and function as it did prior to the disturbance) and the action does not require cross-country use of motorized vehicles or mechanical devices to retrieve equipment, except in areas designated as "open" prior to the passage of FLPMA.
Ground shooting	Allowed and proposed	

Carcass disposal (left on-site)	Allowed and proposed	Allowed. WS-Directive 2.515 states that all wildlife carcasses, whether in whole or part, will be disposed of consistent with Federal, State, County, and Local regulations and WS Directive 2.210 "Compliance with Federal, State, and Local Laws and Regulations." Animals euthanized with drugs that may pose secondary hazards to scavengers must be disposed of according to Federal, State, County, and Local regulations, drub label instructions, or lacking such guidelines, by incineration or at a landfill approved for such disposal. Motorized or mechanized transport for removal is only allowed within "open" areas designated prior to the passage of FLPMA, unless the area was subsequently limited or closed in a Land Use plan decision, or on primitive routes (or "ways") identified by the BLM as existing on the date of the passage of FLPMA.
Chemical repellents	Allowed not proposed	
Gas cartridges	Allowed (with appropriate authorization) and proposed	BLM Manual 6330 (WSA) (BLM 2012a). Pending pesticide use notification processes with USFS and/or BLM (per MOUs). Any unburned portion of the cartridge would be removed from the WSA
Tranquilizer and immobilization methods	Allowed and proposed	
Chemical and gas euthanasia	Allowed and proposed	
Physical euthanasia (gunshot)	Allowed and proposed	
M-44s	Allowed and proposed	EPA label (2010) subject to chemical application notification processes with USFS and/or BLM (per MOUs) BLM Manual 6330 (BLM 2012a).
DRC-1339	Allowed and proposed	Pending chemical application notification processes with USFS and/or BLM (per MOUs). BLM Manual 6330 (BLM 2012a). BLM Manual 6830 (BLM 1988).
Motorized equipment	Allowed and proposed	Allowed as long as the use will not create new surface disturbance (disruption or trampling that would necessitate reclamation, rehabilitation, or restoration in order for the site to appear and function as it did prior to the disturbance). BLM Manual 6330 (BLM 2012a).
Motorized Vehicles	Allowed and proposed (conditionally)	Allowed within "open" areas designated prior to the passage of FLPMA, unless the area was subsequently limited or closed in a Land Use plan decision, or on primitive routes (or "ways") identified by the BLM as existing on the date of the passage of FLPMA. BLM Manual 6330 (BLM 2012a).
Equine & foot travel	Allowed and proposed	BLM Manual 6330 (BLM 2012a).

2.3.2.4 *How Does WS-Nevada Apply the Decision Model to PDM in WAs and WSAs?*

In Section 2.3.1.1 of this EA, WS-Nevada described the APHIS-WS Decision Model that is applied to all wildlife damage management. This section is intended as a narrative of how the decision model and its steps would be applied when WS-Nevada receives a request for assistance in a WA or WSA. This section show the decision model accounts for the special considerations given to wilderness character and using the "minimum tools" concept. It does not encompass all potential scenarios in wilderness and is only an example for illustration.

1. **Receive Request for Assistance**

Depredations on livestock are largely seasonal, coinciding with lambing/calving season, so WS-Nevada can anticipate WS-Nevada generally receives requests for assistance in WAs and WSAs during April-September when most sheep are lambing, grazing, and/or moving through grazing allotments. A few WAs and WSAs that are low in elevation, close to a ranch, or are temperate in climate have grazing intermittently throughout the year and may require limited PDM from October through March. Although sheep and calves are susceptible to predation at any time, predation rates are typically the highest between March and June. The increase in predation is attributed to the contemporaneous occurrence of lambing/calving season and the increasing dietary needs of predator offspring.

WS-Nevada only responds to requests for assistance in WAs and WSAs from livestock producers in possession of a valid grazing permit, issued by the land management agency.

2. **Respond to Request for Assistance**

When WS-Nevada receives a request for assistance in a WA or WSA, personnel travel to the location of the reported loss to conduct a site visit. Travel into and out of WAs may be accomplished one of two ways, via foot travel or on horseback (horse would be on a certified weed-free diet). Travel into WSAs may allow for the use of motorized vehicles on existing primitive routes (BLM WSA Manual 6330 (BLM 2012a)).

3. **Assess Problem**

Once WS-Nevada personnel are on site, they take various steps to verify the type, extent, and cause of reported damage. This will include first-hand inspection of the operation and kill site, along with interviews with the herder/camp tender. Questions answered include, but are not limited to:

What resource (livestock) are present and what damage was experienced? This generally involved sheep or cattle, and noting the age of the injured/killed livestock is important to selecting a PDM approach.

What damage was experienced? This requires determining if the livestock was wounded or killed and how many head of livestock are affected. An estimate of costs associated with the loss will be ascertained.

Where did the damage occur? Determining if the damage occurred within the WA/WSA is important to assessing whether or not necessary PDM must take place in wilderness. Similarly, it is possible that a predator may move out of WA or WSA, resulting in PDM not being conducted in the WA or WSA or that incident.

Finally, was the damage caused by a predator or is there another likely explanation? Livestock found dead in the field may not have been killed by a predator. Natural mortality resulting from disease, injury, animal health conditions, or age are also considered and a necropsy may be performed to discover the cause.

Predator species have patterns/methods of killing their prey that help identify the predator. Therefore, WS-Nevada personnel carefully examine the area surrounding the kill site for sign (e.g. tracks, scat, indication of a struggle, drag marks, location of the dead animal, evidence of death by pecking, and how it is oriented) which assist in identifying the depredating species and its behavior. Evidence discovered during a necropsy, such as bite mark measurements, claw mark presence, trauma, and hemorrhaging, further assisting in identification of the depredating species and specific animal/animals that caused the depredation(s).

4. Evaluate Available PDM Methods

A wide range of PDM strategies and methods are described in Appendix A. However, only a few have been identified as being suitable for work in WAs and/or WSAs (Section 2.3.2.3). BLM Manuals 6330 (BLM 2012a) and 6340 (BLM 2012b) requires that the criteria for selecting a PDM method include "need, location, environmental conditions, preservation of wilderness character, and applicable federal and state laws." FSM 2320 instructs "Focus control methods on offending individuals and under conditions that ensure minimum disturbance to the wilderness resource and visitor." Effects on wilderness character, specifically the *untrammeled* quality, are important when recommending or applying PDM methods in WAs and wilderness characteristics in WSAs. In those areas, WS-Nevada implements the minimum amount of PDM necessary to stop the damage in order to comply with BLM Manuals 6340 and 6330. The PDM "control measures" applied in WAs and WSAs must also have the effect of targeting the offending animal in WA (BLM 6340), or offending animal or group of animals in WSAs (BLM 6330). Methods such as lights or sirens designed to scare predators from the vicinity of livestock must be applied continually and may have the desired effect of resolving damage, however they would produce an undesirable effect on wilderness character and may not be the "minimum amount of control necessary to solve the problem" in WAs (BLM 6340). For this reason, nonlethal and lethal methods that are unduly disruptive to wilderness may be excluded from consideration on a case-by-case basis. Below are non-lethal methods proposed for use in WAs and WSAs.

Non-Lethal Methods

Technical Assistance
General biology and behavior of predators

Resource Management Practices:
Change class of livestock
Behavior selection of livestock
Shifts in breeding schedules

Animal Husbandry:
Herders and range riders
Guard animals
Benching of sheep

Additional Non-lethal Methods Proposed for use and/or Recommended for use as Technical Assistance in WSAs.

Modifying Animal Behaviors:
Electronic distress sounds and alarm calls
Visual scaring techniques
Aerial hazing/harassment/dispersal

Lethal Methods Available for use in WAs and WSAs under Alternatives 2

Lethal Methods for use in ***WAs***
Ground shooting
Calling
Trained tracking/trailing/decoy dogs
Trapping/snaring

Lethal Methods for use in ***WSAs***
Ground shooting
Calling
Trained tracking/trailing/decoy dogs
Trapping/snaring
Tranquilizers/immobilization

M-44s
Large gas cartridges (unburned portion would be retrieved)
DRC-1339 treated eggs
Aerial shooting, overflights and landings
Chemical and gas euthanasia
Motorized vehicle use (for conveyance only)

5. Formulate Strategy for Implementing PDM and Provide Assistance

The formulation of a PDM strategy is specific to each request for assistance and requires a thorough assessment of the problem followed by the application of one or more of the methods listed above. Various combinations of resources and predators require different approaches to a) reduce the loss while b) using the minimum amount of PDM possible and c) targeting only the offending animal/group of animals. Below are a few scenarios to demonstrate the thought processes.

If livestock was killed by coyote or bobcat – WS-Nevada would locate the depredating coyote or bobcat by applying field experience (e.g. voice howling/reading tracks (heavy on the front indicates carrying weight)/following wool trail/drag marks/terrain/features/trailing with dog). Once the depredating coyote(s)/bobcat is/are found, ground shooting would be used with or without calling and/or a decoy dog to lure in the coyote. If the ground shooting approach is unsuccessful, then foothold traps or neck snares (depending on which precludes the chance of catching a non-target animal) would be used. The animal would then be euthanized with a firearm. If serious loss to domestic livestock has ceased, the equipment would be removed and WS-Nevada would leave the WA (with nothing left behind). Prior to departing the area, WS-Nevada would review the animal husbandry methods used by the herder and offer additional non-lethal technical assistance to reduce the chance of future depredations.

If livestock was killed by a mountain lion(s) – WS-Nevada would locate the depredating mountain lion(s) by using field experience (e.g. using length of stride, size of paw, tracking/reading the terrain to find corridor used and/or tracking/trailing with dogs) and then euthanize it with a firearm. If tracking/trailing dogs are not used, foothold trap(s) with a heavy pan tension device (which excludes smaller non-target animals) would be set at the depredation site (if best option, based upon field experience, to catch the specific animal and cause the least amount of disturbance). If non-target animals, such as black bear, are feeding on the mountain lion kills, then non-target exclusion techniques and tools, such as non-target exclusion fencing tunnels, would be used with a neck snare. If a black bear attempts to go through the exclusion tunnel, the tunnel-snare system will collapse and nothing will be caught unless the system is reset. Prior to departing the area, WS-Nevada would review the animal husbandry methods used by the herder and offer additional non-lethal technical assistance to reduce the chance of future depredations.

If livestock was killed by a black bear – WS-Nevada would locate the depredating black bear by applying field experience (e.g. using length of stride, size of paw, tracking/reading the terrain to find corridor used and/or tracking/trailing with dogs). If tracking/trailing dogs are used, the black bear would be euthanized after it has been treed/bayed. If the black bear is expected to return to the kill, WS-Nevada would wait and site shoot the black bear (complimented with calling if necessary). If the above capture options are not used, foot/neck snare(s) would be placed at the depredation site or at a corridor leading to the kill site. Prior to departing the area, WS-Nevada would review the animal husbandry methods used by the herder and offer additional non-lethal technical assistance to reduce the chance of future depredations.

If livestock was killed by common ravens- WS-Nevada would locate the depredating ravens by observing the kill site and behavior of ravens and ground shoot the depredating raven(s) (if in WA) and/or use DRC-1339 treated eggs if in WSAs. Prior to departing the area, WS-Nevada would review the animal husbandry methods used by the herder and offer additional non-lethal technical assistance to reduce the chance of future depredations.

6. **Monitor the Action and Evaluate the Results**

Check Equipment – WS-Nevada would return to inspect equipment in accordance with WS Directives 2.401, 2.415 and 2.450 (Section 2.4.1) and NDOW-WS-Nevada MOU. If an animal is live captured, it would be euthanized in accordance with WS Directive 2.430 and 2.505.

Carcass disposal- WS-Nevada would move animal away from any trail or well-trafficked area if possible, so that it would be unlikely to be observed by the public enjoying wilderness, in accordance with APHIS-WS Directive 2.515.

Re-assess - If losses to livestock have ceased, the equipment would be removed from the WA or WSA, leaving nothing behind. If loss to domestic livestock has not ceased, assess problem, identify depredating species, and evaluate methods to apply, formulate strategy and provide assistance. Equipment and strategies may be repositioned or changed to further address the losses, and WS-Nevada personnel would continue to monitor the equipment.

Coordination and reporting- As per AWP, WS-Nevada would contact the management agency prior to and after conducting work in WAs or WSAs. Unplanned Activities in WAs or WSA outside of what is outlined in AWPs will be discussed with the applicable land management agency for approval. Annual reports documenting activities within WAs and WSAs will be provided to the land management agencies and discussed during the following years' AWP.

2.3.3 *Alternative 3. Non-lethal PDM Required Before Applying Lethal Assistance (No Preventive Lethal PDM)*

Under Alternative 3, non-lethal operational assistance and lethal technical assistance would continue to be used as described in Alternatives 1 and 2. The difference is under what circumstances WS-Nevada would conduct lethal PDM. Under Alternative 3, WS-Nevada would not conduct preventive lethal PDM and would use non-lethal methods first, and until proven ineffective, in response to each request for assistance regardless of severity, intensity, and immediacy of the damage or threat or the results of application of the APHIS-WS Decision Model. Under Alternatives 1 and 2, non-lethal methods are given preference when responding to a request for assistance, however, where a non-lethal method is unlikely to be effective, WS-Nevada personnel may recommend lethal methods. However, under Alternative 3, WS-Nevada could only conduct lethal PDM after:

- Livestock grazing permittees and operators, landowners, and resource managers show evidence of sustained and ongoing use of nonlethal or husbandry techniques aimed at preventing or reducing predation prior to receiving WS-Nevada assistance with lethal PDM methods;
- Employees of WS-Nevada use or recommend appropriate and reasonable non-lethal techniques in response to a confirmed damage situation prior to using lethal methods; **and**
- WS-Nevada has recorded and confirmed that the use of reasonable non-lethal techniques had failed to keep livestock or other losses below an acceptable level, as determined by the cooperator.

Depredation from previous years or seasons could not be used as a reason for WS-Nevada applying lethal management, as this is considered preventive. Cooperators would still have the option of implementing lethal control measures on their own or through commercial companies (where authorized). WS-Nevada would continue to recommend lethal and non-lethal management when and where appropriate as technical assistance.

2.3.4 *Alternative 4. WS-Nevada Provides IPDM Lethal Assistance Only for Cases of Human/Pet Health or Safety*

WS-Nevada provides full PDM technical assistance, including both lethal and non-lethal methods, and lethal operational assistance only when requested for protecting human/pet health or safety. All other operational assistance could only use non-lethal methods. For instances of human/pet health, all lethal and non-lethal PDM methods *as described* in Alternative 1 and/or Alternative 2 (where/as allowed in WAs and WSAs) are available for recommendation and/or use, *as described* in Alternative 1 and/or Alternative 2 (where/as allowed in WAs and WSAs). For all instances not including humans, pets, and ESA-listed species, only the non-lethal operational methods and lethal and non-lethal technical assistance are available for use.

See Section 2.4 for list of minimization measures, including APHIS-WS Directives, state law and regulation pertinent to this alternative.

2.3.5 *Alternative 5. No WS-Nevada Involvement in PDM Activities*

WS-Nevada (federal employees) would not be involved in any predator damage management efforts in Nevada. PDM would still be implemented by other legally-authorized entities, such as NDA Division of Animal Industry- Nevada Wildlife Services (including use of DRC-1339 for common raven damage/removal), NDOW, USFWS, property/resource owners, commercial PDM companies, and certified NDOW volunteers (Sections 1.7 and 2.3.1.10). Entities experiencing damage caused by predators could continue to resolve damage by employing all methods legally available, since the removal of predators to alleviate damage or threats would occur despite the lack of involvement by WS-Nevada.

WS-Nevada would not provide assistance with any aspect of managing damage caused by predators in Nevada, including lethal and non-lethal technical or operational assistance and actions. Requesters would need to seek PDM information on existing and new methods (including methods developed and tested by the APHIS-WS NWRC) from other sources such as NDOW, University of Nevada Extension Service offices, or pest control companies. Currently, NDOW only provides direct wildlife damage management assistance in limited situations, but does provide technical assistance and issues depredation permits for such activities as appropriate and within available resources. Requests for PDM information directed to WS-Nevada would be redirected to these entities. Questions involving WA and WSA laws and/or policy will be/are referred to the managing agency.

2.4 What Are the Protective Measures including Policies, Consultation Measures and State Laws that WS-Nevada Implements to Avoid or Reduce Adverse Effects?

The measures listed in this section improve the safety, selectivity, and efficacy of predator damage management activities, and reduce or eliminate unwanted environmental effects. WS-Nevada PDM activities have incorporated these measures into the current program, and these measures are also incorporated into any other described alternative in which some level of operational WS-Nevada activities would occur (Alternatives 1, 2, 3, and 4), as relevant. For example, APHIS-WS policies involving lethal take included in its directives would not apply to alternatives in which WS-Nevada would not take lethal action, although the agency could recommend such actions under technical assistance.

While the following measures are implemented by WS-Nevada, not all procedures pertain to the prevention or minimization of environmental impacts, such as personnel safety procedures for firearms. However, all the measures included in this section address issues considered in detail in Chapter 3.

The measures in this section are organized into 4 major parts:

- APHIS-WS policies included in formal directives, categorized into 16 topics
- WS-Nevada formal and informal consultations with the USFWS
- Additional measures
- Relevant State of Nevada laws and regulations

2.4.1 *APHIS-WS Policies in Formal Directives*

Individual measures in italics are direct quotes from APHIS-WS policies and formal directives. Any revisions to APHIS-WS policies and formal directives shall be followed.

2.4.1.1 *APHIS-WS Administrative Policies*

WS Directive 2.210: Preference for Non-Lethal Methods When Appropriate
WS Directive 4.130: Requests for Assistance
WS Directive 1.210: Compliance with Federal, State, and Local Laws and Regulations

a.	*Technical and direct control assistance may involve the use of either lethal or non-lethal methods, or a combination of the two. Preference is given to non-lethal methods when practical and effective.* (WS Directive 2.101)
b.	*Wildlife damage management services are provided only in response to requests for assistance.* (WS Directive 2.201)
c	*All employees (Federal and non-Federal) are responsible for conducting official duties in compliance with all Federal laws, and also applicable State and local laws that do not directly and substantively conflict with and frustrate WS' Federal statutory authorities. In a situation requiring a variance from a State of local law or regulations that does not directly and substantively conflict with and frustrate WS Federal statutory authorities, either a State or local authority agrees to carry out the action in cooperation with WS or a written authorization or concurrence must be obtained from the appropriate State or local authority.* (WS Directive 2.210)

2.4.1.2 *APHIS-WS Policies Regarding Capture Devices*

WS Directive 2.450: Traps and Trapping Devices

a.	*All employees whose duties involve animal capture should participate in a WS-approved trapper education course as recommended by Best Management Practices guidelines. State Directors may provide for continuing trapping education for appropriate employees at district state, or regional meetings.*
b.	*Use of all traps, snares (cable device), and other animal capture devices by WS employees will comply with applicable federal, state, and local laws and regulations related to animal capture for managing wildlife damage.* [also WS Directive 2.210 "Compliance with Federal, State, and Local Laws and Regulations." (Appendix C)]
c.	*All traps and trapping devices will be set in a manner which minimizes the chances of capturing non-target species. If possible, non-target animals that are captured will be released.*
d.	*If an animal that appears to be a licensed pet is captured, reasonable efforts will be made to notify the owner, seek veterinary care if necessary, or deliver the animal to appropriate local authorities.*
e.	*Animals targeted for lethal control in direct control projects will be dispatched immediately,*

	removed from capture devices, and properly disposed (also WS Directives 2.205 "Euthanizing Wildlife" [Part A9 below], *2.510 "Fur, Other Animal Parts and Edible Meat", and 2.515 "Disposal of Wildlife Carcasses")* [Section 2.4.1.9 below]
f.	*Captured animals intended for release, relocation, or captivity will be handled and transported appropriately to achieve project objectives* (also WS Directive 2.501 *"Translocation of Wildlife"*) [2.4.1.8 below]
g.	*Foot-hold traps or snares are not to be set closer than 30 feet from any exposed animal carcass or part thereof, having meat or viscera attached, including remains of animals previously removed from traps or snares (cable device) that may attract raptors or other non-target animals. If an animal carcass could be dragged or moved by scavengers to within 30 feet of set foot-hold traps, snares (cable device), the carcass will be secured to restrict movement* (also WS Directive 2.455, *"Scents, Baits, and Attractants"*). *These restrictions do not apply to animal carcasses used to attract bear or mountain lion to approved capture devices.*
h.	*The use of foot-hold traps and spring activated leg snares (cable device) must incorporate pan-tension devices as appropriate to prevent or reduce the capture of non-target animals, unless such use would preclude capture of the intended target animals.*
i.	*Foot-hold traps with inside jaw spread greater than 5 ½ inches, when used in restraining sets, are limited to types with smooth, offset jaws that may or may not be laminated or to padded-type jaws. Foot-hold traps with teeth or spiked jaws are prohibited. WS Regional Director may authorize use of modified jaw protrusions on traps for the purpose of reducing injuries to target animals.*
j.	*If it is necessary to use foot-hold traps or snares (cable device) under fence lines, reasonable efforts to be taken to obtain approval from adjacent landowners where applicable; judgment should be used to avoid capture of livestock and other domestic animals.*
k.	*The use of break-away locks or stops is encouraged when livestock, deer, or other large animals may be exposed to snare (cable device) sets.*
l.	*Capture devices should be set to minimize visibility of captured animals.*
m.	*Foot-hold traps (long-spring or coil spring) will not be used to take bear.*

2.4.1.3 *Use of Firearms*

WS Directive 2.615: WS Firearm Use and Safety

a.	*All WS-Nevada use, storage, and transportation of explosives will be in compliance with applicable Federal, state, and local laws and regulations, employees will be trained and certified per WS Directive 2.615 "Firearms Use and Safety" and WS Directive 2.625 "Pyrotechnics, Rocket Net Charges and Incidental Explosive Materials" and its Attachment 1 for safe and secure storage and transportation of the materials.*
b.	*Shooting a firearm, projectile or pyrotechnic out of a vehicle is permitted as long as the firearm or device is not loaded (a cartridge in the chamber) until the muzzle is safely out of the window of the vehicle and a clear line of fire is established. The muzzle of the firearm or device may not be retrieved back into the vehicle until the device has no live round in the chamber.*
c.	*Whether a firearm is being stored in an office, vehicle, home, camp, or any other location, the maximum level of security available should be employed. Security devices may range from gun safes, vaults, locking gun racks, to cables through the receiver or frame opening locked to an immovable object.* All firearm storage will be per this Directive.
d.	*All WS personnel, regardless of employment status, and official volunteers who are required or requested to use firearms in the conduct of official duties must adhere to all basic rules of*

	firearm safety, and will be provided firearm safety and handling training per the WS Firearms Safety Training Manual. Aerial crewmember training will consist of instruction from the WS Firearm Safety Training Manual as well as additional specialized instruction that may be contained in the WS Aviation Operations Manual, the WS Aviation Safety Program Manual, and the WS Aerial Operation Crew Member Training Manual.

2.4.1.4 *Use of Explosive Materials*

WS Directive 2.625: Pyrotechnics, Rocket Net Charges, and Incidental Explosive Materials

a.	*All WS use, storage, and transportation of explosives will be in compliance with applicable Federal, state, and local laws and regulations. Employees assigned to use pyrotechnic pistols or other launching devices will receive safety training in their use as required by WS Directive 2.615 "Firearms Use and Safety."*
b.	*All storage and transportation of pyrotechnics, rocket net charges and incidental explosive materials will be conducted per the standards in Attachment 1 of WS Directive 2.625.*
c.	*All WS use, storage, and transportation of explosives will be in compliance with applicable Federal, state, and local laws and regulations. Employees assigned to use pyrotechnic pistols or other launching devices will receive safety training in their use as required by WS Directive 2.615 "Firearms Use and Safety."*
d.	*All storage and transportation of pyrotechnics, rocket net charges and incidental explosive materials will be conducted per the standards in Attachment 1 of WS Directive 2.625.*
e.	*All WS use, storage, and transportation of explosives will be in compliance with applicable Federal, state, and local laws and regulations. Employees assigned to use pyrotechnic pistols or other launching devices will receive safety training in their use as required by WS Directive 2.615 "Firearms Use and Safety."*

2.4.1.5 *Use of Hazardous Materials and Pesticides*

WS Directive 2.465: Accountability and Oversight of Hazardous Materials and Pesticide Use

WS Directive 2.401: Pesticide Use

a.	*During the fiscal year, at least one annual physical inventory will be conducted by the hazardous material user and one reviewing official (i.e., District Supervisor, Assistance District Supervisor, collateral duty safety officer) designated by the State Director. All hazardous materials discrepancies will be resolved by the pesticide user and/or the reviewing official at the time of the physical inventory, if possible. All discrepancies will be corrected in the MIS CMITS database within 30 days. Some of the subject matter that will be reviewed regarding hazardous materials is as follows: security, storage, warning signs, inventory, receipt and transfer of documentation, handling, disposal of pesticides, I&E [immobilization and euthanasia] drugs, pyrotechnics, etc.* (WS Directive 2.465)
b.	*WS activities will be in compliance with applicable Federal, State, Tribal, and local laws and regulations pertaining to pesticides, including application, certification, storage, transportation, shipment, disposal, and supervision, or when recommending the use of restricted-use pesticides. Restricted use pesticides used or recommended by WS personnel must be registered by the US Environmental Protection Agency (EPA) and the appropriate State regulatory agency.* (WS Directive 2.401)
c.	*For field applications, where other decontamination equipment of sufficient quantity and type is not readily available, WS personnel must carry a decontamination kit containing at least one quart of water, coveralls, disposal towels, and soap. Incidents and/or accidents resulting from the use of pesticides must be immediately reported to the appropriate supervisor and the WS Safety and Health Council. The WS Safety and Health Council is responsible to investigate*

	and/or coordinate the investigation of any incident or accident related to the use of pesticides. WS personnel are required to report to the State Director, any knowledge of adverse incidents involving APHIS registered products. (WS Directive 2.401)
d.	All storage, transportation, inspections, training, and emergency procedures will be conducted according to WS Directive 2.401 Attachment 1. (WS Directive 2.401)

2.4.1.6 *Use of M-44s*

WS Directive 2.415 M-44 Use and Restrictions
Implementation Guidelines for 26 Use Restrictions

a.	State Directors are responsible for ensuring that WS employees under their supervision are fully aware of all relevant Federal, State, and local laws and regulations, and individual M-44 applicators are responsible for complying with these laws and regulations. Applicable laws will vary from state to state as well as within states. WS M-44 applicators are subject to inspection by EPA or State regulatory enforcement officials to ensure that applicable laws and regulations are being followed. State Directors and subordinate supervisors must ensure that all M-44 use by personnel under their jurisdiction is in compliance with NEPA (National Environmental Policy Act) documents and decisions, agreements, and federal agency work plans. (Use Restriction #1,)
b.	Additional regulations and restrictions prescribed by EPA will be provided by the WS Operational Support Staff through normal supervisory channels. Each State Director is responsible to ensure that all M-44 applicators in the state are properly trained and individual M-44 applicators are responsible for complying with all State and Federal regulations regarding M-44 use. #2)
c.	Applicators of pesticides will be trained and certified by the appropriate state regulatory agency. If the State regulatory agency training includes specific M-44 application that covers use, safety precautions, and record keeping, this training meets WS requirements. However, in those states where generalized pesticide training lacks specific M-44 training, the State Director will be responsible for supplementing the training to meet specific training needs on use, safety precautions, and record keeping requirements. WS State Directors are responsible to assure that all M-44 applicators they supervise are adequately trained and certified as often as the State pesticide agency requires. The "Annual M-44 Sodium Cyanide Training Certification" form (WS Form 40) will be used to document applicator knowledge through the completion of this form by the supervisor during annual field inspections.(Use Restriction #3)
d.	M-44 cyanide capsules and ejectors will be used only by WS program employees who are Certified Applicators, and who have received specific M-44 training as described in Use Restriction #3. This includes both

	cooperatively funded employees and official volunteers who are supervised by WS personnel. WS personnel will transfer M-44 capsules or equipment only to other WS employees who are certified M-44 applicators. When transfer of sodium cyanide is necessary, the capsules shall be tracked using the WS Controlled Materials Inventory Tracking System (CMITS). (Use Restriction #4)
e.	M-44s may not be used to protect wildlife other than Federally designated threatened or endangered species. "Livestock or poultry" includes the species listed in "Livestock" and "Commercial Game Animals (Pen-raised)" subcategories of MIS Resources Protected codes. "Wild canids" for which M-44s may be used include coyote, red fox, gray fox, and wild (feral) dogs (see label and WS Directive 2.340 “Feral, Free Ranging, and Hybrid Dog Damage Management”), subject to further restrictions by State or local regulations. States can restrict but cannot expand the list of approved target species. Additional target species can be designated only with EPA approval. (Use Restriction #5)
f.	This restriction reinforces long-standing WS policy against any taking of animals solely for the value of their fur by M-44 or any other method. However, fur may be salvaged from animals taken by M-44s in compliance with WS Directive 2.510 "Fur, Other Animal Parts, and Edible Meat." (Use Restriction #6)
g.	The 7-mile rule applies only to M-44 use for the protection of livestock or poultry. "Recurrent prior experience of predation on the ranch unit or allotment" means a history of predation that has been documented in MIS records. MIS documentation of reported or confirmed livestock or poultry losses, on a MIS Direct Control Work Task or a MIS Technical Assistance Work Task, constitutes "full documentation of livestock depredations, including evidence that losses were caused by wild canids." WS personnel will place M-44s only on properties identified in "Work Initiation Document for Wildlife Damage Management" (WS Forms 12A, 12B, and 12C) signed by the property owner or manager, or as developed in work plans for work on public lands. M-44 use must be specifically authorized through a signed written agreement or through provisions in work plans with cooperating agencies. Each WS Specialist is responsible for determining the boundaries of properties covered by control agreements, and to place M-44s only where authorized by the agreement. (Use Restriction #7)
h.	Compliance with this rule requires common sense and good judgment as well as input from local sources regarding public use and seasonal variations in such use. Regardless of any other consideration, every effort will be made to avoid areas of heavy public use and unnecessary public exposure. The exclusion of M-44s from prairie dog towns (item 3) is intended to protect black-footed ferrets.

	M-44s may be used on Federal lands except in areas specifically designated for recreational use. M-44 non-use areas on public lands will be identified through interagency consultations at the WS State office or District office level; such non-use areas will include beaches, campgrounds and locations where seasonal use such as hunting occurs. Consultations are not needed for types of lands where M-44s will never be used; see list in Use Restriction #8, item (4). "Wildlife refuge areas" means officially designated Federal or State wildlife refuges or wildlife management areas that are identified as such by appropriate signs and maps. WS will coordinate quarterly with the land management agency to determine where M-44s may or may not be used on public lands in certain areas. These quarterly contacts can be made through work plan meetings, telephone conversations, in person, or email. Within 30 days after each quarterly contact, WS needs to provide written documentation of the land management agency's determination of any identified set aside recreation areas (i.e. projected or current areas). Quarterly contacts will also allow for addressing the use of M-44's and unscheduled events that were not planned or discussed during the annual work plan meetings. For WS offices with no plans for use of M-44s on public lands, quarterly contacts are not necessary. M-44s will not be placed within 0.5 mile of occupied residences except for those belonging to a cooperator who has requested the use of M-44s and has signed a Work Initiation Document. Within properties where its use is authorized, the M-44 device shall not be used in areas where exposure to the public and family and pets is probable per Use Restriction 8(2). WS applicators can use WS Form 205 to request a variance to allow placement of M-44s between 0.25 and 0.5 miles of a neighboring residence. M-44s cannot be placed within 0.25 mile of a residence other than that of the cooperator. WS will notify the owner or lessee occupying any residence between 0.25 and 0.5 miles from an M-44 device of their use in the area. Documentation of the notification will be maintained by the WS State Director. The identity of the Cooperator and of the Cooperator's property, must not be shared directly with the notified individuals unless the Cooperator has authorized disclosure in writing. WS personnel should accurately identify property boundaries where M-44 devices are to be placed. If the property boundaries are not clearly posted, or the landowner or lessor is unable to accurately identify the property boundaries, WS personnel shall use electronic mapping or aerial imagery to identify: a) cooperator property boundaries to ensure devices are placed on the property covered by the agreement; and b) non-cooperator residences, to ensure none are within 0.5 mile of the device and/or residences that may require a variance using WS Form 205. Buildings that

	are obviously abandoned or not actively occupied are not residences for purposes of this interpretation. (Use Restriction #8)
i.	WS personnel will use all control methods including M-44s in ways that minimize adverse impacts to non-target animals and the environment and will conduct Section 7 consultations with U.S. Fish and Wildlife Service as required. In addition to consideration of potential impacts to federally listed threatened and endangered species before placing M-44s (see the label), WS applicators also will consider impacts on state-listed species as well as federal and state species that are candidates for listing. Maps for listed threatened and endangered species or experimental populations will be obtained by each State Director from appropriate FWS Endangered Species personnel if possible. Alternatively, maps may be prepared jointly by WS and FWS personnel. Where FWS personnel are unavailable or unable to cooperate in this activity, the State Director will prepare appropriate maps and will provide copies to FWS Endangered Species and State wildlife agency offices whenever new or updated maps are distributed to M-44 applicators. Also, each applicator must be aware of specific areas closed to M-44 use, as shown in "Endangered Species Considerations" on the label. Endangered species maps are not needed in states or areas where no vulnerable threatened or endangered species exist, as determined by informal consultations between WS and federal and/or state endangered species offices. (Use Restriction #9)
j.	This rule will be met by WS personnel providing copies of the initial placement and any subsequent changes of M-44 GPS locations as soon as possible, but no later than 14 days after placement. This M-44 coordinate information shall be sent to the applicator's supervisor by electronic or hard copy delivery. It is not required that anyone beyond the certified applicator be present during placement or replacement of M-44 devices. (Use Restriction #10)
k.	As a general policy, WS will not use M-44s on any property where persons other than WS personnel are using them. Each exception to this rule will be authorized in writing by the supervisor or State Director before any M-44s are set by WS personnel. In such exceptional cases where WS and other governmental agencies or private individuals are using M-44s concurrently, WS personnel will communicate with other users sufficiently to ensure that the maximum number of M-44s placed by all users does not exceed the totals set forth in Use Restrictions # 15 and #16. (Use Restriction #11)
l.	This rule is designed to protect non-target animals, including humans and their pets, which may be attracted to bodies of water. In addition to avoiding M-44 placements within 200 feet of water bodies, WS personnel will avoid using M-44s where exposure to non-target animals, the public

	and family pets is probable. Dry irrigation ditches and water troughs are not "bodies of water" for purposes of this Use Restriction. Avoidance of hazard to humans and non-target animals may require at times that M-44 sets be more than 200 feet away from water. Wherever uncertainty exists about the suitability of specific placement locations, applicators should consult with their supervisors before placing M-44s. (See Use Restriction #14). (Use Restriction # 12)
m.	In 40 FR 44726-44739 (9/29/75), EPA Administrator Russell Train indicated: "4. ..there was no basis in the record for extending the use of the M-44 to protect "agricultural crops," since that would encompass a rather large, undefined area of use. The purpose of this Restriction #8 is not to protect crops, but to protect people who work in the field and, in some cases, those people who eat food products from the field. This restriction does not prohibit placement in areas adjacent to the field which are less likely to result in human exposure to injury." (Note: The M-44s can be placed in areas only for the purposes identified in Use Restriction #5.) (Use Restriction #13)
n.	"Public road or pathway" generally means a road or trail that is identified as such on maps, is open to unrestricted public access and maintained by a government or public entity. A pickup track or livestock path is not a "public road or pathway" for purposes of this rule. Any uncertainty about specific public roads or pathways on public lands should be resolved through informal consultation with local land management agency personnel. In this regard, WS personnel will avoid placing M-44s in any location where exposure to the public and family pets is probable (Use Restriction #8). The out-of-sight rule means that if a person using only the un-aided eye, that is standing on the road could direct another person in the field directly to the M-44 device; this would not meet the out-of-sight rule. This rule applies to M-44 devices, not warning signs. An applicator who is uncertain as to whether or not a specific road or pathway is considered public will consult with the supervisor before placing M -44s in that area. (Use Restriction #14).
o.	"Pasture land" is fenced land that produces forage for consumption by grazing animals. Fence rows around the pasture are considered as part of the pasture for purposes of this rule. "Open range" is unfenced grazing land, and one (1) square mile contains 640 acres. Application of this standard to field situations requires that WS specialists know property boundaries where M-44s are being placed. In general, WS personnel will use the minimum number of M-44s needed to achieve

	project objectives. This Use Restriction could be interpreted to allow a maximum of 64 M-44s to be placed in one square mile of fenced pasture. However, rarely, if ever, would a WS specialist use so many M-44s. In the unlikely case where WS specialists need to set a number of M-44s, approaching the limits specified in this restriction, specialists will not place more M-44s than are authorized here and in Use Restriction #16. Any apparent contradictions between Use Restrictions #15 and #16 will be resolved by complying with the more restrictive rule. (Use Restriction #15)
p.	This restriction is intended to protect non-target animals that, like target predators, also may be attracted to a carcass. WS applicators will not place M-44s within 30 feet of any livestock or other animal carcass with meat or viscera attached, regardless of whether or not the carcass is intended to be a draw station. M-44s placed more than 30 feet away from livestock carcasses may, over time, come to violate this rule if scavengers drag the carcasses toward M-44 sets. This problem can be minimized by staking carcasses to keep them from moving. M-44 applicators are responsible for taking all reasonable precautions to ensure that no carcass or parts of any carcass are moved to within 30 feet of any M-44 device. The number of M-44 devices used with draw stations will not exceed the number authorized in either Use Restriction #15 or #16. Apparent contradictions between these rules will be resolved by using the limit imposed under the more restrictive rule.(Use Restriction #16)
q.	Required checks will be conducted as part of supervisors' regular oversight, and will be documented on the "Field Inspection Report" (WS Form 82). Additionally, supervisors will complete the "Annual M-44 Sodium Cyanide Training" form (WS Form 40) during annual field inspections to document review of applicator's knowledge of M-44 guidelines and restrictions. Checks may be conducted more often, as necessary in the supervisors' opinion, but each applicator will be checked at least once each year. Inventory and use records of sodium cyanide will be in accordance to the CMITS requirements. (Use Restriction #17)
r.	This restriction means that M-44 devices must be inspected once during each calendar week. Weekly checks will be made and documented by each applicator using regular MIS (or equivalent replacement in the MIS 2000 system) reporting procedures. Each required M-44 check will be recorded on an MIS “Direct Control Work Task” showing the number of M-44s checked and fired (including 0 if none were fired). M-44s may be checked by cooperating ranchers. Cooperator checks will be limited to visual inspection to determine if devices have been disturbed or pulled, followed by verbal report to the applicator who will submit appropriate MIS documentation. Cooperators

	may not reset or handle the device and they should not disturb any animal taken with the device. Each required check that cannot be made due to adverse weather or for any other reason should be documented specifically for each property or agreement in MIS (Use Restriction #18).
s.	Damaged or unserviceable devices (ejector, shell holder, and/or tube) will not be discarded in the field. They will be either removed or replaced by working units, as deemed appropriate by the applicator. Removal or replacement of damaged or nonfunctional M-44 devices requires no special documentation beyond routine reporting in an MIS Direct Work Task of the numbers of units set on the property (Use Restriction # 19).
t.	"Site" in this context means the property described in the work initiation document for wildlife damage management (WS Form 12A, 12B, and 12C). Documentation of predator damage to livestock anywhere on the ranch unit or allotment or other physical evidence of their presence will be regarded as evidence that a target predator has visited the site. M-44s will be removed when they are no longer needed. This decision will be made consistent with Use Restriction #7 (Use Restriction # 20).
u.	M-44 capsules and devices will be stored under lock and key at all times when unattended, including when in transit. WS personnel will use locking metal boxes for this purpose. M-44 capsules may be transported in the cab or passenger compartment of a vehicle when in a locked pesticide storage box. At the end of the day, M-44 capsules will be locked together in a pesticide storage box (Use Restriction # 21).
v.	The State Director shall consult with the local state pesticide authority to determine the proper disposal procedures of spent and/or defective capsules. If state pesticide regulations allow deep burial of defective capsules, the capsule shall be pinched with pliers to break the seal prior to burial. M-44 capsules disposal will be documented using the disposal transaction in CMITS. State-sponsored pesticide collection/container disposal programs qualify as proper disposal of M -44 capsules. Also, assistance for M-44 capsule disposal can be provided by the APHIS Safety Health and Environmental Protection Branch (SHEPB) at 301-436-3114 (Use Restriction # 22).
w.	Most people know nothing about M-44s and their hazards. Warning signs are the first line of defense against accidents. M-44 applicators should use as many warning signs as are needed to adequately post an area. Weekly inspections of proper placement and legibility of all warning signs is necessary to maintain proper signage and public notification requirements. All warning signs shall be removed when M-44 devices are

	taken from the field. Be sure to place individual device signs so that the arrow points toward the device. In addition to placing warning signs, applicators must advise resource/land owners of the dangers of sodium cyanide, and the potential for death or injury to people, pets, and livestock if M-44s are misused. Ranchers and landowners are responsible to inform any persons entering their property of the presence and hazards of M-44 devices. In addition, applicators or cooperating landowners should personally warn neighbors and other persons in the area whose free-roaming pets might encounter M-44 devices. The USDA/APHIS/WS "M-44 Device for Local Predator Control" Fact Sheet can be used for these educational purposes. On properties where no fence lines exist to identify property boundaries or display warning signs, appropriate warning signs shall be erected to indicate that M-44 devices have been placed on the property ("premise sign") per Use Restriction 23(a). A WS authorized elevated sign ("device sign") as required by Use Restriction 23(b), must be securely anchored to a stake, post or wire and positioned vertically above ground level or hung from a low hanging tree limb in a manner that renders it clearly visible and noticeable from the device. One elevated device sign will be required for each M-44 device set. WS requires elevated device signs to be placed within 15 feet of each individual M-44 Device, a more stringent requirement than the Use Restriction (Use Restriction # 23).
x.	The M-44 applicator shall keep the phone number of the poison control center or local medical treatment facility readily available on their person (Use Restriction # 24).
y.	Where local hospitals and medical centers rely on poison control centers for help in treating poisoning cases, notification of the poison control centers will meet this requirement. If hospitals in an applicator's area do not use or have access to a poison control center, hospitals and medical clinics should be notified individually. Such written notifications will be made by State Office personnel, District Supervisors, or the designated field personnel in the local area where M-44s are to be used. Copies of written materials serving as proof that the required notifications were made should be kept at the State Office. Notifications should be made annually or at intervals deemed sufficient by the State Director (Use Restriction # 25).
z.	In general, applicator's records must be detailed enough to account for the whereabouts of all M- 44 equipment and capsules, as well as for all results of M-44 use. Items 26 (a), (c), and (e) will be recorded in MIS "Direct Control Work Task section". For purposes of items (b) and (d), location is defined as the GPS locations and by MIS agreement number, respectively. Each date of inspection (item c) of M-44s set on each property will be recorded on a separate work task. Each required check that cannot be

	made due to adverse weather or for any other reason will be documented, specifically for each property or agreement. If a State pesticide regulatory agency requires M-44 location information to be recorded in a different format, then the applicator must adhere to that requirement unless concurrence to do otherwise has been obtained. The apparent reason for discharge (item d) normally will be recorded only when the applicator can identify the apparent reason. Applicators will not speculate about apparent reason(s) for discharge when evidence is lacking. When the applicator does not report a reason for a discharge, this will be interpreted to mean that the cause was unknown. If the State Director or supervisor determines that reasons for discharge need to be documented in greater detail than is possible in MIS, the supervisor will direct the employee as to what report format to use. Accidents or injuries to humans or non-target domestic animals (item f) will be reported verbally to the supervisor and thereafter in writing on 6(a)(2) Adverse Incident Report (WS Form 160), and as further directed by the supervisor. Accidents or injuries to humans or non-target domestic animals (item f) will be reported verbally to the supervisor and thereafter in writing on 6(a)(2) Adverse Incident Report (WS Form 160), and as further directed by the supervisor. In addition to the records mandated by this Use Restriction, WS applicators are required to provide pesticide application records to each cooperator or landowner within 30 days of applying pesticides. WS M-44 applicators can comply with this regulation by notifying the landowner/cooperator in writing that WS will maintain these records, if the landowner agrees, and will provide copies upon request. The "Agreement for Control" form (WS Form 12A, JUL 09 edition) includes the above notification (Use Restriction # 26).

2.4.1.7 *Denning*

WS Directive 2.425: Denning

a.	Predators removed by denning will be humanely euthanized in accordance with WS Directive 2.505, Lethal Control of Animals. Deviation from this policy must be approved by the Regional Director.

2.4.1.8 *Translocation of Wildlife*

WS Directive 2.501: Translocation of Wildlife

a.	*Translocation of wildlife from one geographic area to another may be conducted by WS personnel as a wildlife damage management activity when: a. Such activities are in accordance with the policies of regulating State and/or Federal wildlife management agencies. b. Such activities are in accordance with all applicable Federal, State, and Local laws and regulations.*

b.	*Primary factors influencing translocation include availability of suitable habitat, impact (competition, predation, etc.), on the animals(s) to be moved as well as other species, the likelihood of animal returning, public attitudes, and potential for creating a damage/conflict situation at the new location.*

2.4.1.9 *Disposal of Carcasses*

WS Directive 2.515: Disposal of Wildlife Carcasses and Furs
WS Directive 2.510: Animal Parts and Edible Meat

a.	*All wildlife carcasses, whether in whole or part, will be disposed of consistent with Federal, State, County, and Local regulations and WS Directive 2.210 "Compliance with Federal, State, and Local Laws and Regulations". Animals euthanized with drugs that may pose secondary hazards to scavengers must be disposed of according to Federal, State, County, and Local regulations, drug label instructions, or lacking such guidelines, by incineration or at a landfill approved for such disposal.* (WS Directive 2.515)
b.	*Wildlife carcasses may be discarded on the property where they were killed or recovered, or deposited on another cooperator's property if approved by the respective property owner. Carcasses may be composted following Federal, State, and local laws. Wildlife carcasses or parts may be disposed of at approved public or private landfills where such facilities are approved for animal disposal. Carcasses shall not be deposited in roadside or commercial business dumpsters unless prior approval to do so has been obtained from the dumpster owner or lessee. Carcasses shall not be disposed of in household trash containers. Wildlife carcasses may be incinerated in approved facilities that comply with Federal, State, and Local regulations. Open burning should be avoided due to potential fire hazards except when this method is required by regulations and can be conducted safely. All disposals will be made in a manner which demonstrates WS' recognition of public sensitivity to the viewing of wildlife carcasses.* (WS Directive 2.515)
c.	*Furs, animal parts, or edible meat may be donated, salvaged, sold, or transferred when authorized by the State Director, in compliance with existing cooperative agreements, Memoranda of Understanding, and all applicable Federal, State, and local laws and regulations. Refer to WS Directive 2.510 "Fur, Other Animal Parts, and Edible Meat" for guidelines.* (WS Directive 2.515)
d.	*Feathers, claws, or other animal parts (except eagle parts and parts from the Federal and State listed threatened or endangered species) may be donated or transferred to Native Americans for ceremonial or religious purposes, or to universities, museums, State wildlife agencies, or other reputable organizations for use in scientific or educational purposes. Donating, transferring or transporting protected species will be coordinated through the State Director and cleared with the State wildlife agency, and in cases involving Federally protected species, with the USFWS. WS employees or family members, close relatives or acquaintances may not benefit from any animal(s), in whole or in part, taken by WS employees while conducting official duties. This includes but is not limited to, edible meats, fur, or valuable animal parts. Animal parts commonly used for making scents, baits, lures, and attractants, are excluded.* (WS Directive 2.510)

2.4.1.10 *Immobilization and Euthanasia*

WS Directive 2.505: Lethal Control of Animals [Euthanasia]
WS Directive 2.430: Chemical Immobilization and Euthanizing Agents [I&E]

a.	*WS personnel will exhibit a high level of respect and professionalism when taking an animal's life, regardless of method. WS personnel will be familiar with the methods described in the current AVMA Guidelines for Euthanasia, and those methods will be used to euthanize captured or restrained animals, whenever practicable. In free-ranging wildlife, the AVMA*

	recommends methods "be as age-, species-, or taxonomic/class-specific as possible." WS personnel will use methods appropriate for the species and conditions. (WS Directive 2.505)
b.	*When euthanizing a captured or restrained animal, death of the animal must be confirmed; death should be confirmed in free-ranging wildlife when carcass recovery is possible. Confirmation can be achieved by the absence of a blinking response when the cornea is touched and by monitoring heart rate and respiration for a period of time long enough to confirm death.* (WS Directive 2.505)
c.	All WS-Nevada personnel requiring use of immobilization and euthanizing drugs must comply with WS Directive 2.430 "Controlled Chemical Immobilization and Euthanizing Agents", including full training and certification. *WS personnel using I&E drugs must receive training approved by the WS I&E Committee prior to independent use of possession of I&E drugs* (Attachment 1). (WS Directive 2.430)
d.	*Only I&E drugs approved by the WS I&E Committee can be used by WS personnel, unless under emergency situations (Attachment 2).* [Note: Attachment 2 of WS Directive 2.430 lists the approved I&E drugs.] *In emergency situations, unapproved I&E drugs can be used on a one-time or limited basis by WS personnel when approved by an attending/consulting veterinarian and the State director or designee, provided that such use is in compliance with all applicable laws.* (WS Directive 2.430)

2.4.1.11 *Wildlife Hazards to Aviation*

WS Directive 2.305: Wildlife Hazards to Aviation

a.	WS-Nevada personnel working at airports with WS agreements will notify the appropriate civil or military airport authorities as soon as practicable when imminent wildlife hazards to aviation are observed.
b.	WS-Nevada managers will ensure that WS employees working at aviation facilities are provided with appropriate training and certifications commensurate with the responsibilities of their positions.

2.4.1.12 *Training for Aerial Operations*

WS Directive 2.620: Required Training for Aerial Operations

a.	All WS' aerial operations and safety activities, including training and maintenance, will be conducted in strict compliance with the WS Aviation Operations and Safety Manual; the Federal Aviation Regulations (FAR), the Fish and Wildlife Act of 1956 (Airborne Hunting), any applicable State and local laws and regulations, individual WS State and WS National Wildlife Research Center program Aviation Safety Plans, Aviation Communication Plan, and Aviation Emergency Response Plans. All pilots, crewmembers, ground crews, and aircraft maintenance personnel will adhere to the WS Aviation Operations and Safety Manual and its amendments, Title 14 Code of Federal Regulations (CFR) and FAR Part 43, 61, 91, 119, 133, 135, and 137. No aircraft shall be used in WS activities (either through contract, agreement, or volunteer) that have not been approved through the office of the WS national Aviation Coordinator (NAC), except for military transport and commercial travel purposes.

2.4.1.13 *Personnel Safety*

WS Directive 2.601: Safety [of WS personnel]
WS Directive 2.635: Zoonotic Diseases and Personal Protective Equipment

a.	WS supervisors will promote a safe working attitude among employees. Supervisors will identify hazards, including wildlife-borne diseases, in advance of work assignments. Supervisors will also provide employees with adequate information, training, and personnel protective equipment to optimize employee safety. (WS Directive 2.601)
b.	WS employees will adhere to safety requirements and use appropriate personal protective

	equipment provided for assigned work. Employees are required to immediately report unsafe working conditions to their supervisor and work cooperatively to minimize hazardous working conditions. (WS Directive 2.601)
c.	WS personnel are advised to alert their physician that they may be exposed to wildlife-borne diseases. Serious diseases including rabies, hantavirus, plague, Lyme disease, psittacosis, *Clamydia psittaci*, or histoplasmosis may be misdiagnosed unless the physician is aware of the possibility of exposure. (WS Directive 2.601)
d.	WS employees will be provided with a Physicians Alert Card (APHIS Form 260 or APHIS Form 260A) which identifies a number of the more significant zoonotic diseases personnel are likely to encounter. Personnel will use the Physician's Alert Card when conferring with their physician about any illnesses or suspicious symptoms. Physical injury events such as animal scratches or bites (including embedded ticks) should be reported to the supervisor as soon as possible and documented within 30 days on a US Department of Labor Form CA-1…If an employee experiences signs or symptoms of a suspected work-related illness, zoonotic disease, or parasitic infection/infestation, the employee should notify their supervisor as soon as possible and seek medical attention for a diagnosis and confirmation from a physician that the condition is in fact work-related. (WS Directive 2.635)
e.	All WS personnel who handle or are exposed to wildlife, biological samples, or equipment used to handle or process animals or biological materials will be provided disease safety, biosecurity, and PPE training as prescribed in the WS Biological Risk Management Training Manual. Specific PPE requirements will vary among positions and the specific duties of personnel. All PPE supplies (e.g. gloves, safety glasses, DEET) will be routinely monitored and supplemented or replaced as necessary. (WS Directive 2.635)

2.4.1.14 *Livestock Guarding Dogs*

WS Directive 2.440: Livestock Guarding Dogs

a.	All WS field personnel will be knowledgeable in the use and application of livestock guarding dogs. WS field personnel will assist producers who may be interested in using livestock guarding dogs by providing information and/or referring them to a WS guarding dog specialist for further assistance. Livestock guarding dogs are generally owned and managed by the livestock producer and are recognized by WS as useful for reducing predation.
b.	WS specialists must be cautious when working near or around guarding dogs to minimize potential hazards from applied management methods.

2.4.1.15 *Use of Trained Dogs*

WS Directive 2.445: Use of Trained Dogs in WS Activities

a.	It is WS policy that trained dogs shall only be used by authorized personnel, including volunteers and contractors, to conduct specific WS functions. It is permissible for WS personnel to use employee-owned or government-owned trained dogs in accomplishing WS missions where it is safe and legal to do so. Government-owned and employee-owned trained dogs should accompany the WS employee/handler on official duty only when there is an operational need.
b.	Use of contract or volunteered dogs (e.g. dogs not directly owned by WS or its employees) will be approved on a case-by-case basis by the applicable State Director. In such instances, the contracted or volunteer dog-handler must sign a form acknowledging that they will abide by WS Directive 2.445. In such instances the dog-handler must follow WS' guidelines and a WS employee must accompany the contract/volunteer dog handler throughout the operation.

c.	Dogs will not be allowed to intentionally kill animals. When the objective is removal, animals will be euthanized as quickly as possible via mortal gunshot. Mortal gunshot is the only approved means of euthanasia.
d.	Functions performed by trained dogs: wildlife hazing away from property or other resources; target animal detection to determine if further action is warranted; animal retrieval; decoying target wildlife into shooting range; trailing target animals to facilitate live capture or lethal removal.
e.	WS personnel shall not allow trained dogs to have physical contact with or in any way attack, bite, or kill animals that are restrained in a trap or any other device. When trained dogs are used, handlers will be at the site of encounters between animals and dogs as soon as possible to minimize stress and reduce potential injury. If WS personnel are unable to prevent a trained dog from repeatedly making contact with a restrained animal, WS personnel must immediately intervene and discontinue use of that dog.
f.	WS personnel shall ensure a dog-in-training is muzzled and controlled on a leash when it is near a restrained animal. If the dog-in-training attacks or attempts to attack a restrained animals, WS personnel must immediately stop the interaction. WS personnel must discontinue use of dogs-in-training that repeatedly attempt to physically contact restrained animals.
g.	WS personnel shall ensure trained dogs used in wildlife damage management activities receive housing, food, water, medical care, and are properly licensed and vaccinated according to state and local laws. WS personnel shall ensure dogs are provided a safe transport box. The box shall provide enough shade and ventilation during warm months to keep dogs cool. During cool months, insulation and/or reduced ventilation shall be used to keep dogs comfortable.
h.	Dog handlers shall control or monitor their trained dogs at all times. A trained dog is considered under control when the dog responds to the command(s) of the dog handler by exhibiting the desired or intended behavior as directed. Dog handlers shall ensure trained dogs to not pose a threat to humans or domestic animals, or cause damage to property. Further, dog handlers (whether WS employees or contractors) shall employ as needed various methods and equipment to monitor and/or control dogs, including but not limited to: muzzles, protective vests and collars, electronic training collars, harnesses, leashes, whistles, voice commands, global positioning system (GPS), telemetry collars, identification collar/contract information.

2.4.1.16 *Feral, Free-Ranging, and Hybrid Dog Management*

Directive 2.340: Feral, Free-Ranging and Hybrid Dog Damage Management WS

a.	Where WS-Nevada personnel determine that a captured dog is a pet, WS-Nevada personnel shall inform the land/resource owner as soon as is practicable.
b.	In urban areas where local animal control officers exist [Note: or the Nevada State Patrol or County Sherriff is available], WS personnel shall collaborate with them to determine if WS action is necessary to solve the property or human health and safety problem associated with feral, free-ranging, or hybrid dogs. If WS action is necessary and requested by the local authority, WS personnel must achieve/conduct the following: (1) Written approval of the WS Regional Director; (2) Notification to the WS Deputy Administrator; and (3) Written request from the State, local or tribal authority with jurisdiction over feral, free-ranging, or hybrid dogs, if such local authorities with jurisdiction exist. WS personnel shall ensure that written requests for assistance include: (1) a statement of the problem; (2) the location and time frame for WS activities; and (3) sufficient details regarding the scope of the assistance requested.

2.4.1.17 *Tribal Government-to-Government Consultations*

WS Directive 1040.3: Tribal Government-to-Government Consultations

a.	This Directive implements Executive Order (EO) 13175 ["Consultation and Coordination with Indian Tribal Governments."] regarding consultation, collaboration, and coordination with Tribes. APHIS will respect the rights of sovereign tribal governments and provide an opportunity for Tribes to participate in policy and program development. Each Tribe will be provided an opportunity for timely and meaningful government-to-government consultation regarding policy actions that may have tribal implications. This Directive does not preclude APHIS from consulting with a Tribe when the Tribe and the agency agree that consultation may be desirable, even if consultation is not specifically required. To enhance the evolution of working relationships and mutual partnerships between APHIS and Native American governments, the Agency will be flexible. APHIS should accept all requests for consultation; the emphasis must be on accepting opportunities rather than declining. Consultation does not require APHIS to do everything a tribal representative requests, but rather requires the agency to take the Tribes' views, information, rights, and interests into serious deliberative consideration. Consultation should be part of an effort to cooperate and collaborate in good faith with tribal partners.

2.4.1.18 *Federally Threatened and Endangered Species*

WS Directive 2.310: Endangered and Threatened Species

Please see previous sections of 2.4.1 for relevant APHIS-WS Directives related to capture, use of chemicals, carcass disposal, and firearm use and safety that could also reduce the risk of adversely affecting Federally-listed threatened and endangered species.

a.	WS will conduct its activities to minimize impact on any federally listed endangered or threatened species or adversely modifying listed critical habitat.
b.	WS State Directors will assure that all of their WS employees (Federal and non-Federal) are familiar with the requirements of Section 7 of the Endangered Species Act, as amended. WS employees will also be familiar with Section 7 biological opinions on listed species potentially impacted by their wildlife damage management activities.
c.	WS State Directors will initiate consultation with the US Fish and Wildlife Service (FWS) if new damage management programs, new methods, or newly listed species result in the potential for adverse impacts.
d.	During routine work activities, incidents involving impacts on listed species will be reported by WS field personnel within 24 hours to the appropriate WS supervisor.
e.	Unless otherwise authorized, the location of dead or seriously injured listed species will be immediately reported to the appropriate FWS Law Enforcement Office and State wildlife representative.
f.	When endangered species are responsible for causing damage, the WS State Director will work with the FWS to determine if acceptable solutions for controlling damage can be agreed upon and implemented.
g.	When a managing agency (Federal, State, Tribal) requests WS assistance in protecting listed species or controlling damages caused by listed species, the requesting agency will bear responsibility for funding the work. The WS State Director will coordinate with appropriate Federal, State, and local agencies to arrange funding and determine acceptable control procedures.

2.4.2 *Formal and Informal Consultations with the USFWS for Nevada*

WS-Nevada has completed informal and formal consultation with the USFWS under Section 7 of the Endangered Species Act for effects of all WS-Nevada activities on federally-listed threatened and endangered species. The effects analyses and findings pertinent to this EA on federally-listed species based on consultation completed September 25, 2018 and are included in Sections 3.6. WS-Nevada continues to consult with the USFWS as needed to maintain compliance with the ESA for WS-Nevada activities. The following list of measures from the informal and formal ESA consultation documentation addresses only those methods appropriate for PDM activities for target species within the scope of this EA.

2.4.2.1 *Minimization Measures from the 2018 Informal Consultation and Amendment for WS-Nevada Effects on All Federally-listed Species except Desert Tortoise*

a.	WS-Nevada employees are responsible for conducting official duties in compliance with all federal and applicable state and local laws when conducting WDM activities.
b.	Employees will adhere to WS Directives on the safe, legal, and effective use of damage management methods.
c.	Personnel will be trained on the identification and sign of federally-listed T&E species and candidate, proposed, and experimental/nonessential species found in Nevada.
d.	WS-Nevada will maintain communication with U.S. Forest Service (USFS), Bureau of Land Management (BLM), NDOW, and Service personnel, as appropriate, to keep updated on new and existing information on the distribution of T&E species.
e.	WS-Nevada will provide maps to each employee indicating areas where T&E species are found in Nevada.
f.	WS-Nevada will adhere to the Terms and Conditions outlined in this consultation with the Service.
g.	The WS-Nevada State Director will work with the Service to determine if acceptable solutions for managing damage can be agreed upon and implemented when listed species are responsible for causing damage.
h.	In the unlikely event that a T&E animal is unintentionally captured unharmed, WS-Nevada would take all practical efforts to coordinate with the Service, NDOW, USFS, or BLM, as appropriate, to facilitate marking or radio-collaring the animal prior to release if applicable. If WS-Nevada determines that it would be impractical to arrange for radio-collaring the animal, and if the animal was judged likely to survive on its own, it would be immediately released. Should the animal be judged unlikely to survive on its own, WS-Nevada would coordinate with the Service and take the animal to a veterinarian. If WS-Nevada were to take a T&E species, we would immediately contact the Service to determine whether additional measures might be necessary to reduce the likelihood of any further incidental take.
i.	WS-Nevada will not conduct any activities that might negatively impact established wetlands.
j.	Pan-tension devices will be used on foothold traps and foot snare triggers to reduce the capture of non-target wildlife, including T&E species that weigh less than the target species.

k.	Cage traps will be placed in areas where animals will not be exposed to extreme environmental conditions. Traps will be checked frequently enough to release non-target animals alive and will not be placed in areas with potential to trap T&E species. Nevada state law requires a cage trap be checked at least every 96 hours; however, cage traps are often checked multiple times per day to ensure welfare of trapped animals.
l.	Snares will not be used in areas where T&E species could be expected to be taken. In areas with a T&E species smaller than the target animal, snare stops will be used to preclude their capture.
m.	Quick-kill traps (e.g., Conibears®) will not be used where T&E species are present or would be affected.
n.	WS-Nevada personnel who shoot from the ground or air for WDM will be trained to identify target animals and similar T&E species where both could potentially be present (e.g., coyotes or wolves).
o.	Foot-hold traps or snares (cable devices) are not to be set closer than 30 feet from any exposed animal carcass or part having meat or viscera attached, including remains of animals from previous traps that may attract raptors or other non-target animals (WS Directive 2.455).
p.	WS-Nevada personnel will adhere to all label requirements for toxicants. EPA labels have a section on T&E species and environmental considerations that must be followed for use, and WS-Nevada personnel will abide by these. The restrictions invariably preclude exposure to T&E species.
q.	Within the range of California condor, WS-Nevada personnel will retrieve the carcasses of animals shot with lead bullets as practical and possible and dispose of them where they are not available to scavengers.
r.	**Within Gray Wolf habitat** (May Affect, Not Likely to Adversely Affect; MANLAA): • Nevada will continue to keep its personnel apprised of the status of wolves in Nevada and provide them with information about confirmed wolf presence. • All foothold traps and foothold snares set for WDM will be staked solidly, if soil conditions were such that there was some question about whether the stake might be pulled out of the ground by an adult wolf, then an extended chain with drag should also be attached to the trap/snare. • Aerial crewmembers and personnel that conduct ground WDM north of 1-80 will continue to receive training in wolf recognition and associated wolf sign. • The Service (Reno Office) and NDOW, shall be notified as soon as possible (within 5 days) of wolf or wolf sign sightings, or the finding of any dead or injured gray wolf or in accordance with any future agreements between the agencies regarding communication needs. • WS-Nevada is currently a partner of the Nevada interagency wolf coordination effort; and is well informed of evolving policy and procedures involving wolves as promulgated by NDOW and the Service. **When the presence of a wolf is confirmed by the Service or NDOW:** • All conservation measures for "Within Gray Wolf habitat" • All foothold traps and foothold snares set for WDM will be checked at least once a day. Use of electronic monitoring of traps or snares for daily checks may be used in monitoring traps and/or snares. • Breakaway neck snares will be used exclusively in areas where wolves have been

	verified, as there is no intent to capture a wolf for any purposes. WS-Nevada may be requested to assist with live or lethal wolf capture for the purposes of fitting radio collars, translocating a wolf, or managing livestock or human safety threats. This type of work requires the use of non-breakaway snares to restrain the animal. WS-Nevada would not target wolves for these purposes without further consultation with the Service. • M-44s will not be used within the area where wolves or verified sign has been found and documented. • Aerial shooting and ground shooting in areas where gray wolves have been documented will be limited to those personnel who are trained to distinguish coyotes from wolves. • Thermal imagers or night vision will be used when calling and shooting coyotes at night in areas where wolves are known to occur.
s.	**Within California condor habitat**: • To reduce potential for effects to condors, WS-Nevada will adhere to the below minimization measures. For safety reasons, WS-Nevada uses copper-plated shot or other shot, but will not shoot lead shot from aircraft. In addition, in Clark County, all animals shot on-the-ground by WS-Nevada using lead bullets will be retrieved whenever possible and/or disposed of in a manner that renders them inaccessible to condors. • WS-Nevada will not set foothold traps or snares with visible bait at the set site (except for traps set for mountain lions). If draw stations are used, they will be no closer than 30 feet from the set traps/snares. Double foothold trap sets (more than one trap within 20 feet of each other) will not be used for coyotes or larger predators in Clark County south and east of l-15. • WS-Nevada will not use M-44 devices in Nevada South and East of 1-15. In the remainder of Clark County, WS-Nevada personnel will use M-44 devices in accordance with all label restrictions. If a condor sighting is confirmed within Nevada, North and West ofl-15, M-44 sets in that area will be recessed, covered or placed in single sets (not closer than 1000 feet from one another). • WS Nevada will coordinate with the Service's California Condor Recovery Coordinator in the Ventura Field Office, Ventura, California, at (805) 644-5185, on at least an annual basis. The Service will notify APHIS-WS in Reno, Nevada at (775) 851-4848 of any condors sited in Nevada and WS-Nevada will notify Southern Nevada Fish and Wildlife Service of any dead or injured condors found in Nevada.
t.	**Within Southwestern Willow Flycatcher and Yellow-billed Cuckoo habitat**: • Where activity may be proposed within 0.5 miles of riparian areas with perennial water flow or designated critical habitat, WS-Nevada will avoid activity between May 1 and August 31 (breeding season). • Within 0.5 miles of suitable habitat or designated critical habitat, WS-Nevada personnel will not use pyrotechnics or other noise-making devices during the breeding season (May 1 - August 31).
u.	**Within Yuma Clapper Rail habitat**: • Where activity may be proposed within or near emergent marsh, WS-Nevada will avoid activity between March 1 and June 30 (breeding season).

2.4.2.2 *Reasonable and Prudent Measures and Terms of Conditions from the 2018 Biological Opinion for Desert Tortoise*

The USFWS (2018) Biological Opinion for Desert Tortoise, based on the WS-Nevada Biological Assessment (Wildlife Services 2018), requires use of the following reasonable and prudent measures, terms and conditions, and reporting of agency activities within desert tortoise habitat.

<table>
<tr>
<td>a.</td>
<td>
Reasonable and Prudent Measures
1. APHIS-WS shall implement measures to minimize injury or mortality of desert tortoises due to WDM activities.
2. APHIS-WS shall implement measures to minimize predation on tortoises by predators drawn to carcasses or trash resulting from WDM activities within project areas.
3. APHIS-WS shall implement measures to minimize destruction of desert tortoise habitat, such as soil compaction, erosion, or crushed vegetation, due toWDM activities.
4. APHIS-WS shall implement measures to ensure compliance with the reasonable and prudent measures, terms and conditions, reporting requirements, and reinitiation requirements in this BO.
Terms and Conditions
1. To implement Reasonable and Prudent Measure Number 1, APHIS-WS shall fully implement the following terms and conditions to minimize injury or mortality of desert tortoises due to WDM activities within desert tortoise habitat:

a. Areas proposed for application of sodium and potassium nitrate (predator fumigants) in desert tortoise occupied habitat, including vehicle access routes, shall be inspected for desert tortoises by qualified representatives of APHIS-WS who have been trained to distinguish target from non-target species dens as per EPA label restrictions for desert tortoises. All burrows capable of providing shelter for tortoises shall be inspected with a fiber-optic scope, if necessary, to determine occupancy of each burrow by desert tortoises. Fumigants shall not be applied to burrows if inspections indicate that the burrows are occupied by tortoises.

b. A maximum speed limit of 25 miles per hour shall be required for all vehicles on unpaved secondary roads and 15 miles per hour on unimproved roads.

c. Where accessible by desert tortoises, only leghold traps and foot snares with underpan tension devices set for more than 4 pounds of pressure, will be used. Traps not equipped with underpan tension devices will be set no less than six (6) inches above ground. Neek snares will be placed 6 or more inches from ground level or a stop will be placed on the snare so that it will not entrap a desert tortoise.

d. A qualified desert tortoise biologist will be responsible for informing all APHIS-WS personnel administering WDM programs in desert tortoise habitat about the desert tortoise. This will include information on the life history of the desert tortoise, legal protection for desert tortoises, penalties for violations of Federal and State laws, general tortoise activity patterns, reporting requirements, measures to protect tortoises, and personal measures employees can take to promote the conservation of desert tortoises. The definition of "take" will also be explained.
</td>
</tr>
</table>

In accordance with Procedures for Endangered Species Act Compliance for the Mojave Desert Tortoise, a biologist should possess a bachelor's or graduate degree in biology, ecology, wildlife biology, herpetology, or related fields. The biologist must have demonstrated prior field experience using accepted resource agency techniques to survey for desert tortoises. Field experience may mean a minimum of 60 days field experience searching for desert tortoises and tortoise sign. In addition, the biologist should have the ability to recognize and accurately identify all types of desert tortoise sign. The Service does not endorse any individual or company with respect to their abilities to conduct satisfactory surveys.

e. Fumigants shall be used only by qualified individuals and per EPA label instructions. Such persons shall be limited to qualified wildlife biologists, or to agents of county agricultural commission offices, university extension offices, or representatives of State or Federal wildlife agencies.

f. The agency requesting WDM activities shall be responsible for providing a qualified desert tortoise biologist for the tortoise education program and clearing vehicle routes of tortoises. In addition, the agency shall provide current information to APHIS-WS personnel on the occurrence of desert tortoises in project areas.

g. APHIS-WS personnel shall be instructed to check under vehicles for desert tortoises seeking temporary shelter prior to moving vehicle during the tortoise active season, from March 1 through October 31.

2. To implement Reasonable and Prudent Measure Number 2, APHIS-WS shall fully implement the following term and condition to minimize predation on tortoises by predators drawn to project areas:

a. APHIS-WS shall implement a litter-control program that will include the use of covered, common raven-proof trash receptacles; removal of trash from project sites to the trash receptacles following completion of program activities; removal and appropriate disposal off-site of retrievable animal carcasses resulting from WDM activities.

3. To implement Reasonable and Prudent Measure Number 3, APHIS-WS shall fully implement the following term and condition to minimize destruction of desert tortoise habitat, such as soil compaction, erosion, or crushed vegetation, due to WDM activities:

a. All APHIS-WS vehicles, including ATVs, shall stay on existing roads or trails that have been cleared of tortoises. Cross-country vehicle travel is prohibited. Overnight parking and storage of equipment and materials shall bein previously disturbed areas (i e., lacking vegetation).

4 To implement Reasonable and Prudent Measure Number 4, APHIS-WS shall fully implement the following terms and conditions to ensure compliance with the reasonable and prudent measures, terms and conditions, reporting requirements, and reinitiation requirements in thisBO.

a. APHIS-WS shall submit a report to the Service on or before February 1 following the year in which WDM activities occurred within desert tortoise habitat. The report shall include: (1) number of tortoises taken and circumstances (e.g., crushed by project vehicle or asphyxiated by fumigants), (2) list of all tortoises encountered or

	observed in project areas including exact locations and dates, (3) number of activities abandoned due to the presence of desert tortoise, and (4) recommendations for enhancing the effectiveness of terms and conditions. The first report shall be due to Service's SNFWO on February 1, 2019. The address for the SNFWO is: Field Supervisor U.S. Fish and Wildlife Service 4701 North Torrey Pines Drive Las Vegas, Nevada 89130 Telephone (702) 515-5230 b. APHIS-WS will designate a field contact representative for WDM projects within desert tortoise habitat. The representative will be responsible for overseeing compliance with protective stipulations for the desert tortoise and for coordinating compliance with this BO. The field representative will have authority to halt activities or equipment which may be in violation with the stipulations.

2.4.3 *Additional Measures*

2.4.3.1 *Protection of Human/Pet Health and Safety*

a.	Most PDM activities are conducted away from areas of high human activity except when directly applied on private landowner property to address a specific damage problem. If the risk of people being present exists, then activities are conducted during periods when human activity is low, such as at night or early morning whenever possible.
b.	Although unlikely, in the event that WS-Nevada is requested to immobilize bears by NDOW and in which NDOW is involved either during a period of time when licensed harvest of bears is occurring or during a period of time where the drug withdrawal period could overlap with the start of a harvest season, WS-Nevada would euthanize the bear or mark the animal with ear tags labeled with a "*do not eat*" warning prior to release.
c.	In most cases, cage traps, culvert traps, and snares set for black bears are placed so that captured animals are not readily visible from any designated recreation road or trail or from federal, state or county roads. Sometimes culvert traps are used in and near campgrounds, developments, dumpsters, and other areas which attract bears. Trap warning signs are placed on each end of the trap.
d.	Public safety zones are delineated and defined by location or on Annual Work Plan maps by BLM and USFS, and changed or updated as 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 federally managed 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 of the situation and applicable laws and regulations, WS-Nevada could provide them service. However, the land management agencies would be notified of PDM activities that involve methods of concern such as firearms, dogs, and traps before these methods would be used in a public safety zone, unless specified otherwise in the AWP and as appropriate.

2.4.3.2 *Operating on Public Lands, Including in WAs and WSAs*

a.	All WS-Nevada PDM actions conducted on BLM or US Forest Service lands are conducted per the interagency MOUs and Annual Work Plans (see Section 1.9.2).

b.	PDM conducted within BLM and Forest Service WSAs and WAs is closely coordinated with the land management agency and performed in accordance with the BLM and APHIS-WS MOU, the Forest Service and APHIS-WS MOU, the Federal Land Policy Management Act, the Wilderness Act (16 U.S.C. 1131-1136), BLM policies 6330 (BLM 2012a), 6340 (BLM 2012b) and USFS manual (FSM) 2323 (USFS 2007).
c.	Outside of WAs and WSAs, any unanticipated work not included in the Annual Work Plan will be coordinated with the authorizing federal officer and approved on a case-by-case basis.

2.4.3.3 *Miscellaneous Measures*

a.	WS-Nevada will use the eagle assessment tool (Feral Swine FEIS 2015, Appendix F (APHIS-WS 2015) to determine appropriate measures for avoiding non-purposeful take.
b.	**Use of Non-lead Ammunition.** WS-Nevada will use non-lead ammunition when required by land management policies and as required by Federal, State, and tribal laws and when and where required by ESA Section 7 consultations.
c.	**Use of Existing Access.** Vehicle use is limited to existing roads and trails unless authorized by the land management agency or landowner for specific actions.
d	**Code of Ethics:** The APHIS-WS Code of Ethics requires that all WS employees maintain high personal and professional standards in support of the WS mission to provide Federal leadership in wildlife damage management solutions that are safe, effective, selective, economically feasible, and environmentally responsible. (WS Directive 1.301**)**.

2.4.4 *Relevant State Laws and Regulations*

Measures included in this section from relevant state laws and regulations are paraphrased.

2.4.4.1 *Categories of Wildlife and Legal Take*

NRS §503.595: Prevention or alleviation of damage caused by wildlife: "*…after the owner or tenant of any land or property has made a report to the Department indicating that such land or property is being damaged or destroyed, or is in danger of being damaged or destroyed, by wildlife, the Department may, after thorough investigation and pursuant to such regulations as the Commission may promulgate, cause such action to be taken as it may deem necessary, desirable and practical to prevent or alleviate such damage or threatened damage to such land or property.*" Under Wildlife Commission policy 25, "*the Director of the Department of Wildlife is authorized to issue wildlife depredation permits. "From Upon receipt of a report from a property owner or the Department indicating that a mountain lion, black bear, or bobcat is causing or about to cause damage to private property or oppose a threat to human health and safety, the permittee shall conduct an on-site investigation. If the results of the investigation support the complaint, the permittee may kill the animal. If the permittee cannot determine if the complaint is valid, he shall notify a representative of the Department, who shall conduct a joint investigation to make the final determination*".

NAC 503.035: Coyotes, skunks, weasels, badgers, raccoons and ringtails are classified as "unprotected mammals" in Nevada.

NRS §502.010: Allows the take of any unprotected bird or mammal to protect persons or property in the immediate vicinity of homes or ranches affected by such species.

NRS §502.470: allows the take of any fur-bearing mammal doing damage provided a permit is obtained from the division.

NRS §503.470: Allows the take of fur-bearing mammals injuring any property at any time by the owner or occupant of the property or with the permission of the owner or occupant.

NRS §501.376: Allows the take of black bear and mountain lion to protect life or property when a person feels that they are in immediate danger.

NAC 503.149: A person shall not bait big game mammals for the purpose of hunting.

2.4.4.2 *Use of Pursuit Dogs and Artificial Light*

NAC 503.147: Dogs can be used to hunt and pursue black bears and mountain lions during open season provided the person has a valid black bear/mountain lion tag for the area that is being hunted. Dogs may also be used to hunt, chase and pursue any fur-bearing mammal during the open season under the authority of a trapping license.

NAC 503.189: Pursuant to a mountain lion tag, a person may use a dry cell powered flashlight provided while not in or on a motorized vehicle. County law further defines night-time shooting and use of spotlights.

2.4.4.3 *Use of Traps, Snares and Other Capture Devices*

NRS §503.450: Unlawful for any person at any time to hunt any furbearing mammal in any manner other than by trap, gun or bow and arrow.

NRS§ 503.454: Every person who takes fur-bearing mammals by trap, snare or similar device or unprotected mammals by trapping or sells raw furs for profit shall procure a trapping license.

NAC 503.155: This law requires steel foothold traps of size "number 2" or larger or with an outside jaw Spread of 5 ½" or larger to have lugs, spacers or similar permanently installed devices to maintain a minimum trap opening of 3/16".

NRS §503.570: This law establishes a minimum trap check for traps not designed to cause immediate death, of 96 hours for wild mammals. Additionally, this law provides an exemption to Division of Agriculture of the Department of Business and Industry (Nevada Wildlife Services) and USDA (Nevada-WS) when acting in their official capacities.

NAC 503.152: "***Minimum visitation of traps, snares and similar devices. (****NRS 501.105, 501.181, 503.570****)*** *A person who is required pursuant to NRS 503.570 to visit or cause to be visited a trap, snare or similar device shall ensure that the trap, snare or similar device is visited:*

1. At least once every other calendar day in the following units for wildlife, as designated in NAC 504.210, or portions of those units specified in this subsection other than any private property located within those units or if a box or cage trap is used:

(a) All of Unit 194;

(b) The following portions of Unit 195:

(1) West of Lagomarsino Canyon-Lousetown Road from its intersection with Interstate Highway No. 80 to its intersection with State Route No. 341; and

(2) West of State Route No. 341 from its intersection with Lousetown Road to its intersection with U.S. Highway No. 50;

(c) All of Unit 196; and

(d) The portion within the Clark County Illegal Firearms Discharge Area created by the Clark County Geographic Information Systems Management Office on September 11, 2013;

2. At least once each 96 hours in all other units for wildlife, as designated in [NAC 504.210](), or portions of those units not specified in subsection 1, including any private property located within those units;

3. At least once each 96 hours if a box or cage trap is used;

4. By a person who is a holder of a trapping license issued by the Department; and

5. In a manner which ensures that any mammal caught in the trap, snare or similar device is removed from the trap, snare or similar device."

NAC 503.157: Steel leghold (foothold) traps: Use of bait: this law prohibits using exposed bait within 30 feet of a foothold trap and prohibits use of game mammal, game bird, game fish, game amphibian or protected species of wildlife for bait.

NAC 503.165: Trapping within one-half mile of certain residences: "*1. Except as otherwise provided in subsection 2, a person shall not trap, other than with a box or cage trap, within one-half mile of a residence, if the residence is located within a congested area of a county whose population is 100,000 or more.*

2. The provisions of this section do not apply to:

(a) An officer, employee or agent of any state agency, the Federal Government or a local government acting in his or her official capacity for the purpose of animal control or control of depredating wildlife;

(b) A person acting under written authority from a state agency, the Federal Government or a local government for the purpose of animal control or control of depredating wildlife;

(c) A person trapping on private property; or

(d) A person trapping in a waterway that is not within an incorporated city.

3. As used in this section:

(a) "Congested area of a county" means:

(1) An area of a county in which the discharge of firearms is prohibited by a county ordinance; or

(2) The area within the boundaries of an incorporated city in a county.

(b) "Residence" means any house, room, apartment, tenement or other building designed or intended for occupancy as a residence.

(c) "Waterway" means any river, stream, canal or channel that contains water, including, without limitation, the banks and bed of any such river, stream, canal or channel."

NRS 503.580: this law establishes unlawful to set trap larger than No. 1 Newhouse foothold within 200 feet of public road or highway; exception: This law defines "highway" and provides the exception of private property.

NAC 504.340: this law lists areas closed to hunting and trapping and includes permitted exemptions and conditions.

2.4.4.4 *Protecting Human Safety*

NRS 501.376: Allows the take of black bear and mountain lion to protect life or property when a person feels that they are in immediate danger.

NRS 501.3525: Taking of Wildlife by employee of Department. NDOW employees may take any wildlife from any place (excluding private property without lawful authority) and in any manner for any purpose determined by the Director.

2.4.4.5 *Aerial Take*

NAC 503.760: from the Nevada Law Library *"The Department may issue a permit to the owner or tenant of any land or property, or to a governmental agency, to engage in the hunting, killing or nonlethal control of bobcats or coyotes from an aircraft for the purpose of protecting land, wildlife, livestock, domestic animals or human life. The Department may also issue a permit to the State Director of Animal Damage Control of the Animal and Plant Health Inspection Service of the United States Department of Agriculture to engage in the hunting, killing or nonlethal control of ravens from an aircraft. Such permits will not be issued for hunting for sport."*. In regard to NAC 503.760, WS is exempt from the airborne hunting act and as such doesn't request an aerial hunting permit.

2.4.4.6 *Carcass Disposal and Report of Take*

NAC 503.720: Wildlife depredation permit: Contents. Specifies what the permit must contain, including: "*6. That a report of the operation shall be submitted to the Department…*".

NAC 503.730: Wildlife depredation permit: Ownership and disposition of Wildlife Taken. "*1. Except as provided in subsection 2, wildlife taken under such a permit may not be used for any purpose by the permittee or those assisting the permittee. Such wildlife are the property of the State and, if required by the Department, shall be retrieved and maintained in a good manner by the permittee. The Department may dispose of them by:*

(a) Donation to a public scientific or educational institution;
(b) Donation to a charitable or other worthy institution for use as food; or
(c) Sale of animals or pelts of value. The proceeds of a sale shall be deposited as provided in NRS.
2. The Department may donate the hide or pelt of such wildlife to a permittee to defray the cost of handling a depredation complaint.
3. Game species taken under such a permit which are unfit for human consumption or other unsalvable (unsalvageable) *wildlife shall be destroyed by the Department*.".

NAC 503.760: Permits to Control Bobcats, Coyotes or Ravens from Aircraft: States what information the applicant must provide; permittee must comply with terms, conditions and restrictions of the permit; and that on January 10 after the year the permit was issued, that a report of the number of take/month be reported to the Department.

2.5 What IPDM Alternatives and Strategies Are Not Considered for Comparative Analysis?

The CEQ regulations at 40 CFR §1508.14 state that agencies "shall rigorously explore and objectively evaluate all reasonable alternatives, and for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated."

By definition, a "reasonable" alternative must be one that meets the underlying need for action or goal:

- "proposal exists at that stage in the development of an action when an agency…has a goal and is actively preparing to make a decision on one or more alternative means of accomplishing that goal…" (40 CFR §1508.23).
- "The statement shall briefly specify the underlying purpose and need to which the agency is responding in proposing the alternatives including the proposed action." (40 CFR §1502.13)

Guidance in the CEQs "40 Most Asked Questions" states that reasonable alternatives must emphasize what the agency determines "is 'reasonable' rather than on whether the proponent or applicant likes…a particular alternative. Reasonable alternatives include those that are practical or feasible from the technical or economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant."

Consistent with NEPA regulations and CEQ guidance, WS-Nevada reviewed alternatives and ideas proposed in comments to similar APHIS-WS PDM EAs, and, in this section, identify and briefly describe those that are determined by the agency as not reasonable per the CEQ criteria, and provide the agency's rationale for not considering them in detail in this EA.

2.5.1 *Use of Only Technical Assistance by WS-Nevada*

WS-Nevada would only respond to requests for assistance through providing recommendations involving lethal and/or non-lethal methods; WS-Nevada would not conduct any operational assistance. Since this does not allow for any application of non-lethal operational assistance, this alternative is not considered in detail. The effects of a Technical Assistance Only alternative would be very similar to Alternative 5 – No WS-Nevada PDM Activities, as WS-Nevada would have no direct effect on the human environment. Even though technical assistance may be provided by WS-Nevada, requestors are not obligated to use the advice and may choose a different strategy altogether. There is no obligation for any requester to report their actions to WS-Nevada and WS-Nevada is not a regulatory agency.

Therefore, this alternative will not be considered for comparative analysis.

2.5.2 *Use of Only Lethal Methods by WS-Nevada*

Under this alternative, WS-Nevada would only provide technical and operational assistance using lethal predator damage management techniques. Prohibiting WS-Nevada from using or providing technical assistance on effective and practical non-lethal PDM alternatives is not effective, not ethically acceptable to wildlife professionals, and is contrary to agency policy and directives (WS Directive 2.101), in which APHIS-WS gives preference to the use of non-lethal methods before lethal methods when practical and effective.

In some situations, non-lethal methods can supplement, reduce, or eliminate the need for lethal control, and may provide a more effective short-term or long-term solution to PDM problems than lethal methods. For example, the use of guard dogs may be effective at reducing predation rates of livestock, or installing proper fencing when practical can protect resources and exclude some predators from areas. In other circumstances, lethal methods best and most effectively resolve the damage in a timely manner. Also, at times lethal methods may not be available for use due to safety concerns or local ordinances prohibiting the use of some lethal methods.

The option to consider both lethal and non-lethal methods as part of the APHIS-WS Decision Model (Section 2.3.1.1) allows WS-Nevada to use the most effective and practical methods available, while accounting for the many legal, logistical, biological, ethical, and environmental variables in each unique damage situation. Finally, most members of the public that comment on APHIS-WS NEPA documents feel strongly that there be more emphasis on using non-lethal methods to resolve damages, which is already APHIS-WS policy (WS Directive 2.101).

Therefore, this alternative will not be considered for comparative analysis.

2.5.3 *Use of Only Non-lethal PDM Technical Assistance*

WS-Nevada would provide only non-lethal technical assistance and non-lethal operational assistance. WS-Nevada would not implement nor advise others on the use of lethal methods.

Non-lethal technical assistance is included in all Alternatives with the exception of Alternative 5. If the requester has taken all reasonable non-lethal actions and the problem still persists, it is not logical that the WS-Nevada specialist would not also provide professional advice regarding effective lethal methods that are legal for the requester to use in Nevada. Therefore, considering this alternative in detail would be redundant and would not be reasonable, logical, or professional.

Therefore, this alternative will not be considered for comparative analysis.

2.5.4 *WS-Nevada Verifies that All Possible Non-lethal Methods are Exhausted Before Implementing Lethal Operations*

This alternative is similar to Alternative 3. However, in Alternative 3, only reasonable non-lethal methods applicable to the circumstances must be used and shown not to be effective in all cases. This alternative has been requested by various commenters during similar APHIS-WS NEPA processes (USDA-APHIS-WS 2011; 2014; 2016), and requires that all non-lethal methods be used before any lethal operations can be implemented, including non-lethal methods that are not appropriate for the circumstances. This would result in the loss of substantial time, resources, and money for both the requester and WS-Nevada in implementing and monitoring all these non-lethal methods, and potentially result in large financial losses for the requester and/or a high risk of human/pet health or safety risks, and /or major losses to ESA-listed species. Alternatives 3 and 4 considered in detail (Sections 2.3.3 and 2.3.4) provide reasonable and viable approaches for addressing the needs of requesters and concerns of commenters without incurring unreasonable and unacceptable risks and losses.

Therefore, this alternative will not be considered for comparative analysis.

2.5.5 *Use a Bounty System for Reducing Animals Causing Damage*

Bounty systems involve payment of funds (bounties) for killing animals considered "undesirable," and are usually proposed as a means of reducing or eliminating any species that causes damage to human-valued assets, especially predators.
The only state that has an active bounty on predators, in this case coyotes, is Utah, for an experimental program for protection of mule deer, based on Utah Senate Bill 245 (mule deer protection act) which passed in 2012 (UDNR 2018).

APHIS-WS has no authority to establish a bounty system for population control, suppression, or extirpation, which falls to the states. Over half the states have either outlawed bounties, repealed bounty laws, or have no statutory involvement in bounties (Born Free USA 2017).

The circumstances surrounding the removal of animals using bounties are typically arbitrary and unregulated because it is difficult or impossible to ensure animals claimed for bounty are not taken from outside the area where damage is occurring, as most state or local level bounty legislation that exists is regional or state-wide. Bounties can become a costly endeavor, do not effectively provide relief, and may encourage fraudulent claims.

Therefore, this alternative will not be considered for comparative analysis.

2.5.6 *Provide Compensation for Losses*

This option is discussed in Section 1.13.7.2. The State of Nevada provides no compensation for wildlife damage caused by predators. APHIS-WS has no legal authority or jurisdiction to provide for financial compensation for losses. None of the predators included in this EA are covered by compensation allowances under the Agricultural Act of 2014 (aka the 2014 Farm Bill) which is administered by the USDA, Farm Services Agency (FSA) and specifically for livestock losses due to animals reintroduced by the federal government or federally protected species (such as species protected by the ESA).

This alternative is outside the jurisdiction of APHIS-WS, is infeasible, and is likely ineffective.

Therefore, this alternative will not be considered for comparative analysis.

2.5.7 *Livestock Producers Should Exceed a Threshold of Loss Before IPDM Actions are Taken*

As explained in Section 1.12.2, two independent government audits, one conducted at the request of Congress, the other conducted by USDA and based on complaints from the public and animal welfare groups, found that, despite cooperator implementation of non-lethal actions such as fencing and herding, a need exists for APHIS-WS' program of direct and sometimes lethal predator damage management activities. The appropriate level or threshold of tolerance before using non-lethal and lethal methods differs among cooperators, their economic circumstances, and the extent, type, duration, and chronic nature of damage situations (Section 1.4.3). On public lands, a history of loss may be sufficient for determining that preventive work would be appropriate. On private land, the landowner/resource owner determines when the level of tolerance has been reached and may take any lethal and/or non-lethal action determined appropriate that is legal per state and federal law.

The number of variables involved in determining the point at which a private entity or a government wildlife agency, for example, requests assistance from APHIS-WS for PDM preclude the ability or requirement to set a pre-determined threshold before a need is determined to exist and lethal and/or non-lethal action is requested and taken. WS-Nevada is not responsible for or required to assess the economic value of a particular loss or threat of loss before taking a PDM action, and WS-Nevada policy is to respond regardless of the requestor's threshold of loss.

Therefore, this alternative is not considered for comparative analysis.

2.5.8 *Use Regulated Hunting and/or Trapping to Reduce Predator Damage*

NDOW can and has used regulated sport hunting and trapping by private individuals as an effective population management tool in areas where predators are causing damage and/or adversely affecting wildlife populations managed by NDOW. State-sponsored sport hunting and trapping programs can be one of the most efficient and least expensive techniques for managing populations over broad areas, but not necessarily within localized problem spots.

This alternative is not necessarily effective for addressing localized predator damages and threats at the time the problem is occurring. Hunting is usually conducted in the fall and winter, when damage often occurs in the spring and early summer (Ray et al. 2005). In addition, regulated hunting and trapping is often not allowed in urban or suburban areas because of safety concerns and local ordinances (Timm and Baker 2007).

Under the proposed action and the alternatives that allow for technical assistance in lethal methods, WS-Nevada may certainly recommend to NDOW that a hunting or trapping season and an increase in regulated harvests may be helpful in reducing depredation in certain areas, if appropriate.

However, this alternative is not within the authority of APHIS-WS to implement. For all of these reasons, the use of regulated hunting and trapping is not an alternative considered for comparative analysis.

2.5.9 *Live-Trap and Relocate Individual Predators Causing Damage*

Under this alternative, all requests for assistance would be addressed using live-capture methods or the recommendation of live-capture methods. Predators would be live-captured using immobilizing drugs, cage-traps, cages, or nets. All predators live-captured through direct operational assistance by WS-Nevada would be relocated. In accordance with state law, relocation of bears and mountain lions must be approved by NDOW under specific circumstances (Section 1.11.4.7). Therefore, the relocation of bears and mountain lions by WS-Nevada would only occur as directed by NDOW and/or as authorized by state law.

Relocating problem mountain lions or bears, particularly animals that have learned to take advantage of resources and habitats associated with humans, could move the problem from one area to another, or the relocated animal could return to its original trapping site. NDOW generally does not authorize the relocation of problem predators because of the high risk of moving the problem along with the problem animal. NAC 503.110 prohibits importation, transportation or possession of bats, coyotes, foxes, raccoons and skunks unless properly permitted. Many smaller predators causing conflict are relatively abundant, such as coyotes, skunks, raccoons, and badgers or are not native, such as feral cats and dogs. Non relocation policies avoid causing damage problems in the receiving site, reduce the risk that the animal will return to its original home range, and avoid potentially causing the death of the animal due to occupied territories or unfamiliarity with the new location.

However, WS-Nevada could be requested and authorized by NDOW to relocate individual problem bears or mountain lions, as a component of any alternative that includes an active WS-Nevada.

Therefore, this alternative is not considered for comparative analysis.

2.5.10 M*anaging Predator Populations through the Use of Reproductive Inhibitors*

Methods for reproductive control for wildlife include sterilization (permanent) or chemical contraception (reversible). Sterilization in the field can be accomplished through surgical sterilization (vasectomy, castration, and tubal ligation) and chemical sterilization. Contraception can be accomplished through: 1) hormone implantation (synthetic steroids such as progestins), 2) immunocontraception (contraceptive vaccines), and 3) oral contraception (progestin administered daily). Contraception requires that each individual animal receive either single, multiple, or even daily treatment to successfully prevent conception.

Research into the use of these techniques consists of laboratory/pen experimentation to determine and develop the sterilization or contraceptive material or procedure, field trials to develop the delivery system, and field experimentation to determine the effectiveness of the technique in achieving population reduction. Prior to implementation, chemical contraception products must be registered and approved by the appropriate federal and state regulatory agencies. Research into reproductive control technologies has been ongoing, and the approach will probably be considered in an increasing variety of wildlife management situations by wildlife management agencies.

Bromley and Gese (2001a,b) conducted studies to determine if surgically-sterilized coyotes would maintain territorially 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 did not have to provision pups and food demands were lower. Therefore, sterilization could be an effective method to reduce lamb predation if enough alpha (breeding) pairs could be captured and sterilized. During Bromley and Gese studies (2001a,b), they captured as many coyotes as possible from all packs on their study area; they controlled coyote exploitation (mortality) on their study area, and survival rates for coyotes were similar to those reported for mostly unexploited coyote populations, unlike most other areas. However, the authors concluded that a more effective and economical method of sterilizing resident coyotes was needed to make this a practical management tool on a larger scale (Bromley and Gese 2001b).

Jaeger (2004), Mitchell et al. (2004), and Shivik (2006) also describe the problems with chemical or physical sterilants for alpha coyotes for reducing livestock depredation during the denning season. The primary problems involve identifying and capturing the alpha pair, which are very difficult to capture, rather than beta and transient animals, which do not perform the depredations within packs with stable social structures. Capturing and sterilizing all animals, hoping that the alpha individuals are included, is extremely expensive and time-consuming.

Currently, no reproductive inhibitors are available for use to manage most large mammal populations (Mitchell et al. 2004). Given:

- The costs associated with live-capturing and performing physical sterilization procedures on large mammals;
- The need for at least one and possibly multiple captures of individual animals for application of chemical contraception;
- The lack of availability of chemical reproductive inhibitors for the management of most mammal populations;
- Lack of research on the environmental effects of chemical sterilants and chemical contraception;
- The level of unknowns and disagreements within the professional wildlife management community regarding practicality of use, effectiveness, and potential impacts;
- The considerable logistic, economic, safety, health, and socio-cultural limitations to the use of fertility control on free-ranging predators.

If a reproductive inhibitor becomes available to manage a large number of mammal populations and has proven effective in reducing localized predator populations, the use of the inhibitor could be evaluated under the proposed action as a method available that could be used in an integrated approach to managing damage. APHIS-WS will monitor new developments and, where practical and appropriate, could incorporate reproductive control techniques into its program after necessary NEPA review is completed.

However, at this point, WS-Nevada would neither use nor recommend the use of reproductive inhibitors to reduce or prevent reproduction in mammals responsible for causing damage. Use and effectiveness of reproductive control as a wildlife population management tool is limited by population dynamic characteristics, such as longevity, age at onset of reproduction, population size, and biological/cultural carrying capacity; habitat and environmental factors such as isolation of target population, cover types, and access to target individuals); socioeconomic; and other factors.

Therefore, this approach is not considered for further analysis in this EA.

2.5.11 *Use Only Non-lead Ammunition*

Effects on various resources from the use of lead ammunition are discussed in Section 3.10.2 of the EA. APHIS-WS' use of lead ammunition is a small fraction of total lead contamination from many sources. WS-Nevada and many other state programs have investigated the availability of effective and accurate non-lead ammunition, and have found that such ammunition is not readily available for the wide variety of firearm types used in Nevada and elsewhere, in the appropriate calibers. Non-lead ammunition is also considerably more expensive.

WS-Nevada continues to review the availability and performance of non-lead ammunition options relative to program safety and ammunition performance needs and, as effective ammunition becomes available, will consider its use where appropriate. If WS-Nevada were to use less lead ammunition, impacts would be less than those evaluated in Section 3.10.2, provided that the lead free ammunition is determined to be safe for use from aircraft by experts.

2.5.12 *Conduct Short-Term Suppression of Populations with Goal of Long-Term Eradication*

An eradication alternative would direct all WS-Nevada's efforts toward long-term elimination of selected predator populations wherever a cooperative agreement has been initiated with WS-Nevada. Eradication of a native predator species is not a desired population management goal of state or federal agencies and is outside the authority of APHIS-WS. WS-Nevada does not consider eradication or suppression of native wildlife populations a responsible or effective strategy for managing predator damage because APHIS-WS policy and authority is to manage offending animals or multiple animals within the area of damage. NDOW has the authority to manage population levels of regulated species of wildlife through hunting and trapping seasons and depredation permits. WS-Nevada may assist NDOW as its agent for meeting specific NDOW management objectives when requested (Section 1.8.1), but that type of activity is generally in small areas for protection of specific subpopulations of selected game animals consistent with NDOW management objectives set with public input (Section 1.11.5).

Therefore, this alternative will not be considered for comparative analysis.

2.5.13 *Conduct Supplemental or Diversionary Feeding*

Supplemental feeding involves providing supplemental acceptable food plots or bait stations either during certain annual periods when damage is occurring or on a year-round basis to lure the animal away from the locations of protected resources. This alternative is inefficient at best, and would most likely lead indirectly to increased damage. Supplemental feeding of carnivores would require a ready and consistent supply of meat, including animal carcasses, and placing those carcasses in areas that predators may be using. These sites could become a public nuisance, inappropriately attract large numbers of predators to a small area, increase intra- and inter-species competition, and require a large and continuous effort. In addition, supplemental feeding may increase predator populations and alter their natural diets (Fedriani et al. 2001, Newsome et al. 2015); decrease survival rates of targeted populations when food subsidy is removed (Bino et al. 2010, Newsome et al. 2015); predator populations no longer cycle with prey populations, changing life history parameters such as reproduction and social structure, size of home ranges, activity, and movements (Newsome et al. 2015); change interactions with other predator species, and create long-term changes in disease transmission (Newsome et al. 2015). Regarding black bear, Lackey et al. (2018) found that not only does little evidence support supplemental feeding as an effective strategy for reducing bear conflict it may inadvertently increase the risk to people. The authors also point out that bears that exploit human-related food cause the most conflict with people.

Therefore, this alternative is not considered for comparative analysis.

2.5.14 *Conduct Biological Control of Predator Populations*

The introduction of a species or disease to control another species has occurred throughout the world. Unfortunately, many of the introduced species become invasive species and pests themselves. For example, in Hawaii, the Indian mongoose (*Herpestes auropunctatus*) was introduced to control rats (*Rattus* spp.), but caused declines in many native Hawaiian species instead, primarily because the target species were nocturnal and mongoose are diurnal. WS-Nevada is not authorized to conduct this type of work and would not use this method for IPDM.

Therefore, this alternative is not considered for comparative analysis.

2.5.15 *Use Lithium Chloride as an Aversion Agent for Coyote Depredating on Sheep*

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 and is highly variable (Conover et al. 1977, Sterner and Shumake 1978, Burns 1980, Burns and Connolly 1980, Burns 1983, Horn 1983, Johnson 1984, Burns and Connolly 1985). Some studies report success using lithium chloride (Gustavson et al. 1974, 1982; Ellins and Martin 1981; Gustavson et al. 1982, Forthman-Quick et al. 1985), while other studies have shown lithium chloride to be ineffective especially in field situations (Conover et al. 1977; Burns 1980, 1983; Burns and Connolly 1985) and controlled experiments (Sterner 1995). The General Accounting Office (GAO) (2001) reported "…while the coyotes learned not to eat lambs, they still killed them."

In addition, lithium chloride is currently not registered by EPA for use by WS-Nevada or NDOW, and therefore cannot be used or recommended for this purpose. If a product containing lithium chloride is registered in Nevada to manage predator damage and if the product is proven effective in reducing predation rates, the use of the lithium chloride could be subsequently evaluated as an available method that could be used to managing damage. If WS-Nevada considers using a product containing lithium chloride, WS-Nevada would update its NEPA analysis accordingly.

Therefore, this alternative is not considered in detail.

2.5.16 *All Losses Confirmed by an Independent Entity (Not WS-Nevada)*

Some commenters on similar APHIS-WS NEPA processes request that all livestock losses be confirmed by an entity independent of WS-Nevada prior to WS-Nevada taking any action, especially lethal action (United States Department of Agriculture – Animal and Health Inspection Service – Wildlife Services 2011;2014;2016).

In order to accurately identify the species, and even the animal(s) that has caused a damage or depredation situation, the on-site verification must occur quickly after that event has occurred before the evidence is degraded or removed/consumed by a returning predator. Action to remove the offending animal must also occur quickly, in order to actually address the specific animal, and not, for example, a scavenger. Waiting for an independent entity to verify a depredation event and the animal(s) creating it may result in the inability to verify at all. An internet search yielded only one commercial enterprise in Nevada advertising the ability to protect livestock and wildlife from coyotes, bobcats and mountain lions, the remaining commercial enterprises focus on predators less than or equal to the size of coyotes.

In addition as coyotes are regulated in Nevada as "unprotected wildlife," private landowners or managers may take unprotected wildlife in protection of property on private or public land. This requirement is also outside the scope of this EA as WS-Nevada has no authority to implement an independent process for verifying livestock losses.

Requiring entities other than WS-Nevada to confirm losses could delay responding to requests for assistance. Such a delay could result in individuals deciding to take action, which may result in more predators taken than the offending animal, such as scavengers or other predators in the area, or the offending species. It could also prevent resolution of the problem because the remaining evidence might be too degraded for anyone to make a reliable determination of the cause.

Therefore, this alternative will not be considered for comparative analysis.

2.5.17 *Producers Should Avoid Grazing Livestock in Areas of Predator Activities and Ensure Herders Constantly Present*

APHIS-WS does not have authority to manage grazing or compel ranchers to conduct any activity. However, WS-Nevada may make reasonable recommendations on animal husbandry methods to reduce risk of depredation.

Producers, to the extent practicable, work to avoid grazing livestock near predator dens and rendezvous sites. However, producers have no control over whether or not predators establish dens or rendezvous sites near their livestock, and with some common predators, such as coyotes, it may be virtually impossible to avoid grazing "near" dens, especially for producers grazing on private lands. Producers may not have the option to move their livestock elsewhere either because they have limited access to substitute grazing lands or because the land management agency establishes the timing and movements for permitted livestock. To reduce environmental concerns on grazing lands, cattle are not maintained in tight herds as it often is with bands of sheep, further limiting options to move livestock. In dry years, in order to reduce risk of adverse effects on range, producers may spend shorter times in any given area but they then need to use all or most portions of their allotments instead of avoiding areas with a history of predator conflicts.

WS-Nevada also does not have authority to require ranchers to hire herders for livestock, although it might recommend that strategy as part of technical assistance using the APHIS-WS Decision Model. Nonetheless, sheep producers routinely use herders with their animals to keep them together in a band and moving through the grazing areas; herders are seldom used for cattle operations on public lands because the risk of predation is lower once calves reach a certain size. Due to the dispersed nature of cattle grazing, herders are not an effective management strategy, but range riders can help reduce risks of predation by moving cattle away from areas of high predation risk and promptly identifying animal health and predation incidents so they can be addressed to reduce livestock losses (Parks and Messmer 2016).

WS-Nevada responds to requests for PDM assistance from producers with large herds/flocks that graze on open range and producers with small herds/flocks in fenced pastures. Use of herders and range riders (Parks and Messmer 2016) represents a substantial financial obligation and may not be cost effective for producers with smaller herds/flocks. For producers with small flocks in fenced pastures, it may be better to incur a one-time investment in installing quality fencing that would last for years than the annual expense of a herder.

This alternative is not considered for further analysis because it mandates a specific set of management alternatives for all producers, which is impractical.

2.5.18 *Use Bear Repellents*

Capsaicin (concentrated red pepper spray) has been tested and used effectively on black bears, primarily as an emergency personal protective repellent primarily by recreationists in the backcountry. The spray range on most products is less than 30 feet, so capsaicin is only effective in close encounters and is not appropriate for long-term management of bear damage or threats to public and pet safety. The use of capsaicin pepper spray is not an effective PDM tool and, since it must be used at close range to the depredating animal, may be extremely dangerous.

Therefore, this alternative is not considered in detail.

2.5.19 *Livestock Producers Pay 100% of WS-Nevada Assistance Involving Lethal Removal*

This is discussed in Section 1.13.7.3. The intent of this alternative is to ensure that lethal removal is not subsidized by federal taxpayer funds, thereby encouraging livestock producers to decide whether their funds are more effective if applied to non-lethal methods.

Under all alternatives in which WS-Nevada provides lethal and/or non-lethal assistance, preference is already given to non-lethal methods in accordance with WS Directive 2.101. In many instances, WS-Nevada is contacted after entities have unsuccessfully attempted to resolve their damage or threats on their own with non-lethal and/or lethal methods. APHIS-WS is authorized by federal law and funded by both Congressional appropriations and funds provided by entities that enter into cooperative agreements with APHIS-WS state offices for assistance.

WS-Nevada already provides technical support to all requesters and operational support (Alternative 1), including lethal assistance to some degree under all alternatives as determined appropriate, except Alternative 5.

Therefore, this alternative is contrary to agency policy and will not be considered for comparative analysis.

2.5.20 *WS-Nevada Prohibited from Operating on Federal Lands*

The USFS and BLM recognize the importance of effective PDM actions on lands under their jurisdiction. USFS and BLM maintain MOUs with APHIS-WS at the national level (Section 1.8.2). These MOUs provide for direct requests from livestock permittees or state agencies to the respective APHIS-WS state agency for preventive and corrective assistance.

Per the national interagency MOUs, the agencies meet annually to cooperatively develop work plans, including designating appropriate restrictions to ensure that PDM actions do not conflict with land use plans.

Producers leasing grazing allotments on federally managed lands, natural resource managers working to protect sensitive or ESA-listed species, and federal agency officials responding to threats to human/pet health or safety associated with predators on federally managed lands that they manage have legal access to the same types of damage management methods as would be used by WS-Nevada, with the exception of M-44s (NDA DAI Nevada Wildlife Services has legal access to DRC-1339). In the last 5 fiscal years, only 5% of all coyote take by WS-Nevada in the state has occurred with M-44s because of limited application. M-44s are primarily used to capture coyotes that have proven difficult to capture using other methods.

IPDM can and is being conducted on federally managed lands by entities other than WS-Nevada Public hunting and trapping as regulated by NDOW legally occurs on public lands unless otherwise restricted (such as in national parks).

Some predator species, such as coyotes, may be taken by the public, permittees, or other agencies experiencing depredation in the same manner as actions by WS-Nevada (except for the use of M-44s) without any requirement to report take to NDOW, unless they are taken under an aerial shooting permit issued by NDOW. Depending on the training and experience of the individuals conducting the work, selectivity of these actions for target species and target animals, especially older territorial adult coyotes that are typically more difficult to capture than younger individuals, may be lower than for a program conducted by trained personnel from WS-Nevada (Sacks et al. 1999a, Larson 2006).

This issue is outside the scope of APHIS-WS authority. Therefore, this alternative is not considered for comparative analysis.

2.5.21 *No IPDM within any Designated WAs or WSAs*

This is evaluated under Alternative 1 (Sections 2.3.1 and 3.11).

2.5.22 *WS-Nevada Contracts PDM Activities to the Commercial Sector or Defers All PDM Activities to NDOW*

This alternative requires WS-Nevada to award and oversee contracts for predator damage management activities to the commercial/private sector; WS-Nevada would not conduct any technical or direct lethal or non-lethal assistance. All legally authorized methods would also be authorized in such contracts. WS-Nevada would retain contracting responsibilities, provide oversight to ensure that PDM is implemented according to the statement of work, and document target and non-target take as reported by the contractor. As the authorized federal agency, WS-Nevada would continue to be responsible for environmental and NEPA compliance. Private contractors would not be contracted to use M-44s or DRC-1339.

NDOW maintains a list of licensed commercial companies and provides their contact information and qualifications on its website (Section 1.7). However, none of these companies have advertised such expertise or equipment for larger predators such as bears and mountain lions. NDOW is often the first to be requested and to respond to damage caused by bears and occasionally mountain lions, and can either do the work itself, hire commercial companies/guides/outfitters (as it has done in the past for mountain lion removal) , enter into an agreement with WS-Nevada, and/or train and certify volunteers with pursuit dogs. Any PDM work not conducted or authorized by WS-Nevada or by another federal agency would not require compliance with NEPA.

WS-Nevada does not contract its authorized activities to other entities, including commercial entities (with the exception of contract helicopters). NDOW and its agents may already be hired directly by requesters to conduct PDM activities. WS-Nevada would not assume any responsibility or liability for actions conducted by any other entity.

Therefore, this alternative will not be considered for comparative analysis.

2.5.23 *Modify Habitats to Reduce Predation*

WS-Nevada may recommend habitat modification as part of its technical assistance activities (WS-Nevada does not conduct this type of activity itself) in all alternatives having WS-Nevada involvement. The land/resource owner is responsible for ensuring that any necessary permits are acquired prior to taking any such action on their private land. Also, federal and state land management agencies have the authority to conduct habitat management.

As this strategy is already included in all the alternatives considered in detail, except the "No Program" alternative (Alternative 5), this alternative will not be considered further as an independent alternative.

2.5.24 *Make Supplemental Payments to Livestock Producers Livestock Protection Program*

Under the current Marin County Livestock Protection Program, qualified ranchers are provided cost-share funding to assist in the implementation of non-lethal management methods to reduce depredation such as through new fence construction or improvements to existing fences, guard animals, scare devices, or changes in animal husbandry. The most commonly used methods by producers are guard dogs and fencing (Larson 2006). To qualify for the program, ranchers must have at least 25 head of livestock and must use 2 non-lethal methods to deter predation, as verified by the Marin County Agricultural Commissioner. The program is described in more detail under Section 1.13.5.

Animal advocates have referred to the Marin County program as a model program that has successfully addressed and embraced ethical concerns, as well as the differing values of the ranching and animal protection communities (Fox 2001, Fox 2006). However, this positive opinion of the County program is not necessarily shared by Marin County or the greater California livestock community (Larson 2006). Although Marin County's program is championed by some groups as a non-lethal approach and appears to be less lethal on its surface, a study evaluating the effectiveness of the Marin County program (Larson 2006) indicated that more coyotes have been killed during the implementation of the Marin County Program compared to the standard APHIS-WS cooperative program. This is due, in part, to the fact that landowners are not prohibited from killing coyotes on their land or hiring others to do so while also participating in the County's program. Individual producers and others working on their behalf routinely practiced snaring, calling and shooting, and denning in an effort to kill damage-causing coyotes. Larson (2006) also indicated that it is likely that some ranchers are taking more coyotes than when the WS-California program was in place, because WS-California personnel target the more difficult to remove dominant, offending coyote while efforts by untrained individuals often remove more juvenile and subordinate coyotes which are less likely to cause lamb losses (Sacks et al. 1999a).

Research conducted in nearby Mendocino County, California, and elsewhere indicates that territorial, dominant (alpha) coyote pairs, the most difficult to capture by snaring or trapping, cause the majority of livestock losses, especially when adults are raising pups (multiple authors cited in: Jaeger 2004, Sacks et al. 1999a). Experienced field specialists from APHIS-WS are likely to be more effective at targeting specific problem coyotes than less experienced members of the public who are more likely to remove less problematic, but easier to capture or kill, juvenile and subordinate coyotes (Larson 2006). In addition, landowners are rarely trained, experienced experts in professional trapping techniques and are more likely to capture non-target species during their efforts (Larson 2006). Because the Marin County program requires no records to be kept or submitted from landowners on use of lethal methods or take numbers, there is no way to quantify the take of target and non-target animals nor evaluate the environmental impacts of such take. The APHIS-WS program uses the MIS database to effectively track the equipment, and target and non-target take associated with all operational IPDM projects.

A review of Marin County's budget over the first 5 years of the non-lethal program's implementation found that on average the program cost Marin County 1.3 times the amount that the cooperative APHIS-WS IPDM program cost the county in its highest year (Larson et al. 2016). This budget evaluation only recorded the county's cost for implementation, and do not capture the additional landowner costs associated with this program. The discontinuation of the indemnity compensation program and the limited scope of producers served for this amount are also noteworthy.

The scope of the Marin County program is limited to providing financial compensation assistance for non-lethal predator damage management to protect livestock and poultry operations larger than a certain size. It does not provide trained personnel to apply this cost-shared equipment in the field or address several of the needs for action that WS-Nevada work on as identified in Chapter 1, including protecting smaller herds of livestock, property protection, work at airports, for public/pet health or safety, or to protect natural resources, including ESA-listed species (Sections 1.11.2 through 1.11.5), nor do non-lethal methods always resolve the predator management problem, even for operations that do qualify for cost-share assistance. Unlike Nevada, Marin County does not have prevalent mountain lion populations or conflicts with this species and livestock. Between 2001 and 2016, only 2 depredation permits were issued for mountain lion in Marin County and none were taken (CDFW 2016). Similarly, between 2006 and 2014, no permits were issued for black bears in Marin County (CDFW 2015b). In contrast, NDOW averaged about 111 complaints per year for black bears (NDOW data for CYs 2012-2015 (P.Jackson, NDOW, personal communication 10/12/2017) and 22.5 for mountain lions (NDOW data from November and December 2015 and CY 2016 (P.Jackson, NDOW, personal communication 10/16/17)) across the state, with the numbers slightly increasing for black bear and undetermined for mountain lions (only 14 months of data). WS-Nevada recorded an annual average take of 24 mountain lions and 1.4 bears statewide between FY 2012 and 2016.

Based on the limitations of the Marin County program summarized above, the failure of the program to address all needs for action presented in Chapter 1, and the fact that APHIS-WS has no control over the authorities, decisions, and budget of state, county, and local governments, WS-Nevada has determined that detailed analysis of this alternative would not provide substantive new information to aid decision-making and will not be conducted at this time.

2.5.25 *WS-Nevada Should Subsidize Non-Lethal Methods Implemented by Resource Owners*

Under the current program (Alternative 1), WS-Nevada provides some subsidies for some non-lethal IPDM methods in the form of loaning or distributing equipment, under very limited circumstances. For example, propane cannons, pyrotechnics, and cage traps have been loaned or distributed by WS-Nevada to livestock producers on rare occasions. This activity is also incorporated into Alternatives 2 and 3. The "subsidy for non-lethal methods" alternative could include covering the cost of livestock guarding animals, purchasing materials for non-lethal methods (e.g., fencing or fladry), staffing range riders to protect livestock at night, and loaning or permanently provisioning frightening devices (e.g., pyrotechnics or electronic guards).

Although we recognize the appeal of this alternative, unfortunately it has some limitations. Cooperators rely on WS-Nevada for IPDM, which includes both non-lethal and lethal methods. At present, cooperators often purchase and already use non-lethal methods prior to contacting WS-Nevada to address IPDM needs (Appendix B). Subsidies for non-lethal methods that cooperators can and are already implementing would not be an efficient and cost effective use of public resources when there is a need for WS-Nevada's assistance with lethal methods.

Additionally, non-lethal IPDM methods are extremely limited for some applications (e.g., predation on range herds of cattle), and, in some cases, predation persists despite implementation of practical and effective non-lethal methods. Most often, WS-Nevada's assistance is requested once predation has reached the cooperator's threshold of losses and non-lethal methods have been proven ineffective.

In Nevada, for the FY 2014-FY 2018 time frame, 45% of this funding was from WS-Nevada's federal allocation and 55% cooperative funding (USDA APHIS 2019). Cooperators provide the direction to WS-Nevada on the types of services they want delivered with the funding they provide and it is implemented in accordance with program policies. Although WS-Nevada does occasionally loan some harassment equipment, cooperators request that WS-Nevada focus its efforts on those services that the public is less skilled or proficient in doing. Cooperators rely on WS-Nevada to provide technical assistance needed for individuals (including individuals supplementing WS-Nevada efforts) to use their own resources and efforts. Use of appropriated dollars to subsidize the purchase of non-lethal methods would impact the support infrastructure which enables other entities to cooperate with WS-Nevada. The State of Nevada also provides no subsidies for non-lethal methods to resolve damages from the predator species covered in this EA. Subsidies for purchase of non-lethal methods to selected types of livestock producers is currently offered in Marin County, California by the County to some degree, but the costs and effectiveness are not clearly known (Shwiff et al. 2005, Shwiff et al. 2006; Sections 1.13.5 and 2.5.24).

Given that WS-Nevada does not have the anticipated resources needed to fully implement this alternative statewide and that WS-Nevada would not be able to adequately meet the full purpose and need for action, a "subsidy for non-lethal methods" alternative will not be considered for comparative analysis.

3 Environmental Consequences

WS-Nevada conducts IPDM on many land classes (Sections 1.9.4 and 2.3, Table 2.2, 2.3, 2.4 and 2.5) using a variety of lethal and non-lethal methods (Section 2.3.1, Appendix A) when requested to assist with damage and threats caused by predators. Chapter 3 first identifies the types of impacts (effects) that will be evaluated, environmental resources that will be studied, and what would occur if WS-Nevada were less available to provide IPDM assistance. Each issue section addresses a separate environmental resource, and includes background information, an evaluation of the impacts on that resources, and a conclusion. The alternatives are compared with the environmental consequences of the proposed action at the end of each issue section. Determination of significance of the impacts predicted in this chapter does not occur in this EA, but is made by the APHIS-WS decision maker documented in the appropriate decision document.

3.1 What Kinds of Effects are Evaluated in this Chapter?

Chapter 3 examines the direct, indirect, and cumulative impacts of each of the alternatives on the biological, physical, and sociocultural aspects of the human environment (issues). Direct effects are caused by the action and occur at the same time and place. Indirect effects, which are caused by the action and are later in time and farther removed in distance (40 CFR §1508.8). A cumulative impact results from the incremental impact of the action when added to other past, present, and reasonably future actions regardless of what agency or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR §1508.7).

The consideration of past actions may be considered in a cumulative impact analysis as the baseline to which the impact associated with the proposed action or alternative is compared and contrasted. It may also provide a context of the trends over time related to direct or indirect effects associated with the proposed action or alternatives or may illuminate or predict future direct or indirect effects of the proposed action based on past experience with similar types of proposed actions (CEQ 2005). Thus, the baseline impacts are those for Alternative 1, the no action alternative, as described in Section 2.3.1.

3.2 What Issues are Analyzed in this Chapter?

Environmental issues are the resources that may be affected by the proposal, or concerns about the risks to humans from implementing IPDM activities. The issues in this section were identified based on APHIS-WS experience, agency and tribal outreach, and/or from public comments on similar APHIS-WS actions. Many of the issues are evaluated in greater detail than the expected effects warranted because they are concerns that have been commonly raised by the public during similar APHIS-WS NEPA processes (USDA 2011; 2014; 2016). The following issues are analyzed in this chapter in the order outlined.

3.2.1 *Effects on Populations of Predator Species Taken Intentionally (Section 3.5)*

This issue drives the analysis of the direct effects of WS-Nevada's intentional lethal IPDM activities, and the cumulative effects that include all other known sources of predator mortality. WS-Nevada, its cooperating agencies, and the public are concerned with the effects of removals on the viability of predator populations. The effects on each species is evaluated using the best available information including the scientific literature and detailed take information from WS-Nevada's MIS database and reported take from NDOW and USFWS databases.

3.2.2 *Effects on Species that May Be Taken Unintentionally*

3.2.2.1 *Effects on ESA-listed Threatened and Endangered Species (Section 3.6)*

WS-Nevada consults with the USFWS when its activities may affect any federally-listed threatened or endangered species. This issue evaluates the potential for effects on such listed species. ESA Section 7 consultations with the USFWS are relied on for evaluating potential effects.

3.2.2.2 *Unintentional Take of Other Species (Section 3.7)*

Analysis of unintentional lethal and non-lethal take of predators and other species, formerly referred to as non-target take, is based on WS-Nevada take data and evaluated within the context of the species population trends.

3.2.3 *Potential for WS-Nevada IPDM Activities to Contribute to or Cause Ecological Trophic Cascades (Section 3.8)*

This issue has been routinely raised by the public during similar APHIS-WS NEPA processes (USDA 2011;2014;2016) and is based on a concern that the removal of predators during IPDM may cause an indirect ecological chain of events to occur within and through different trophic levels (levels of the food chain). Complex interrelationships exist among and between trophic levels, population dynamics, habitat, biodiversity, and the species themselves. This analysis is based on an extensive review of the relevant scientific literature and impact analyses on predator and non-predator species in Nevada.

3.2.4 *Humaneness and Ethics Related to WS-Nevada Use of IPDM methods (Section 3.9)*

WS-Nevada and the public are concerned about the humane treatment of animals, and people hold differing ethical values related to IPDM. The scientific literature related to the ethics of wildlife capture and lethal take in recreational, research, and predator control activities, and the apparent humaneness of the use of mechanical, non-chemical, and chemical lethal and non-lethal take methods are summarized, discussed, and analyzed.

3.2.5 *Potential Effects of IPDM Methods on the Environment and Their Risks to Human/Pet Health and Safety (Section 3.10)*

This issue drives the analysis of the effects of WS-Nevada's use of IPDM methods (mechanical, non-chemical, and chemical methods, Appendix A) on environmental resources including soil, water, air, plants, and invertebrates. It also assesses the risks from using the IPDM methods on human and pet health and safety.

3.2.6 *Effects on WAs and WSAs (Section 3.11)*

Analyses of impacts related to IPDM actions in special management areas in Nevada focuses on understanding the types of activities allowed in special management areas with an emphasis on WSAs and congressionally-designated WAs. The evaluation includes discussion of how proposed IPDM activities in WAs and WSAs would be found to be consistent with the objectives for each special management area.

3.2.7 *Cultural Impacts Including Impacts on Native American Cultural Uses, Hunting, Non-Consumptive Uses, and Aesthetic Impacts (Section 3.12)*

Some members of the public may be concerned that WS-Nevada IPDM activities could conflict with cultural and spiritual values, recreational activities such as hunting and fishing and non-consumptive uses, such as wildlife viewing and photography. There may be some concern that the proposed action or alternatives would result in the loss of aesthetic benefits to the public, resource owners, native tribes, or neighboring residents.

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 IPDM activities would adversely impact aesthetic enjoyment of activities such as hiking on public lands.

Native American cultural practices: Native American tribes in Nevada 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.

3.2.8 *WS-Nevada Objectives for IPDM Activities (Section 3.14)*

This section determines whether the Alternatives meet the goals and objectives of the proposal (as outlined in Section 1.5.2) by referencing the sections of the EA that address each objective. Meeting the objectives of IPDM is not an environmental impact assessment issue, but it is a tool to aid managers in making informed decisions, and to aid the public in understanding how the alternatives compare.

3.3 What Issues Are Not Considered for Comparative Analysis and Why?

The following issues have been raised by the public during similar APHIS-WS NEPA processes (USDA 2011, 2014, 2016) and although they are issues that are considered in the development of this EA, they are not considered in the detailed discussion for the reasons identified. In addition, the following environmental resources are not evaluated in detail because the agency has found that these resources are not significantly impacted by APHIS-WS and WS-Nevada Operations, based on similar APHIS-WS NEPA processes in the Western United States, including Nevada (United States Department of Agriculture – 2011;2014;2016).

3.3.1 *APHIS-WS Activities Could Conflict With Ongoing Wildlife Field Research:*

Concerns that APHIS-WS IPDM activities could interfere with ongoing agency or academic wildlife research have been raised. WS-Nevada coordination with NDOW, tribal, federal, or state agency researchers would typically identify such ongoing research so potential conflicts could be avoided or mitigated. Such research occurring on USFS or BLM lands would also be identified during development of the Annual Work Plan.

3.3.2 *Accuracy of Reporting Intentional and Unintentional Take of Animals:*

Commenters have questioned the accuracy of APHIS-WS recording of the number of animals taken intentionally and unintentionally during field activities (USDA 2011; 2014; 2016). All APHIS-WS personnel are required to accurately report their field activities and technical assistance work in the MIS database, including all animals taken intentionally and unintentionally, whether lethally or released (WS Directive 4.205). Per APHIS-WS policy, supervisors are required to review recorded 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 APHIS-WS actions. The report prepared by the USDA Office of Inspector General (OIG) on its audit of the APHIS-WS IPDM activities reviewed the accuracy of recording field activities, among other issues (Section 1.12.2). The audit concluded that APHIS-WS complied with all applicable federal and state laws and regulations regarding wildlife damage management. However, the audit found that MIS contained inaccurate information, including external party access and data entry errors (of 29,958 entries, 619, or 2.07% were found to have discrepancies. These conditions resulted in an overestimate of APHIS-WS wildlife damage management activities and the transmission of inaccurate data to the public. APHIS-WS is committed to and actively addressing OIG recommendations intended to further reduce discrepancies (Office of the Inspector General 2015).

3.3.3 *Environmental Effects From the Loss of Individual Animals:*

Comments on previous APHIS-WS NEPA processes have urged APHIS-WS to analyze environmental impacts from the loss of individual animals, suggesting that the killing of any wildlife represents irreparable harm (USDA 2011; 2014; 2016). Under the current and proposed alternatives, an individual predator or multiple predators in a specific area may be lethally removed through WS-Nevada IPDM activities. All WS-Nevada IPDM activities are conducted under the authorization of and in compliance with applicable federal and state laws for the protection of wildlife populations. Although we recognize that some people could find the loss of individual animals distressing, analysis in Chapter 3 indicates the current and proposed actions involving the removal of individual animals would not in any way cause direct, indirect, or cumulative irreparable harm or other environmental impacts on any of the wildlife populations involved in WS-Nevada's operations, including ESA-listed species (see Sections 3.5, 3.6, and 3.8). Section 1.4.2 discusses the variety of values that people place on wildlife, including on individual animals. The ethics and humaneness of capture and removal of individual animals are evaluated in detail in Section 3.9.

3.3.4 *Concerns that Projects to Protect one Wildlife Species by using Lethal Methods to Remove Other Species Inappropriately Places Higher Value on Some Species:*

Wildlife species have specific cultural significance to many groups or individuals. The decision to manage predators for the protection of a specific prey species is not a matter of considering one species more important than another. Instead, the decision reflects the difficult choices made by the natural resource management agencies when attempting to sustain viable populations and meet management objectives for wildlife species. Agencies such as NDOW or USFWS have internal policies, management plans, legislative guidance, and/or mandates that construct their decision making process for how natural resources should be managed and protected. When they determine that PDM is necessary to protect one wildlife species, they may request assistance from WS-Nevada. A discussion of those types of requests can be found in Chapter 1.

This issue of cultural significance was not addressed in detail because WS-Nevada does not make the determination of when PDM is necessary to protect other wildlife, and therefor is not issuing a judgement on the value of a species in this context. This is different from how WS-Nevada may act when requested to implement PDM for the protection of livestock, property, or human health and safety. WS-Nevada would only conduct PDM for the protection of another wildlife species (e.g. deer, rabbits, or other prey species) at the request of the land or natural resource management agency. However, it is important to note that PDM actions for this purpose are generally only requested as a supplement to other management actions as part of comprehensive management plans, and that there are other related and ongoing activities to enhance wildlife species survival and success.

3.3.5 *Historical Resources*

PDM methods and activities implemented by WS-Nevada as described in Section 2.3.1 and Appendix A do not cause major ground disturbance and generally do not have the potential to affect historic properties, districts, sites, and objects. WS-Nevada has determined that its activities do not generally have the potential to affect historic properties and other cultural resources and are therefore not "undertakings" as defined by the National Historic Preservation Act (NHPA) (April 10, 2019). This determination is also based on outreach with federally-recognized tribes in Nevada (Section 1.8.3), including compliance with EO 13175 and NAGPRA. In addition, as described in Section 1.8.3, WS-Nevada closely coordinates all activities with land managers, including land management agencies who are responsible for identifying areas of potential conflict and avoidance. Therefore, NHPA consultation requirements have not been triggered based on past WS-Nevada activities. In the unlikely event that an issue with cultural resources is raised during IPDM planning by a tribe or federal agency, or if WS-Nevada were to identify a localized need to excavate soil, or have another potential effect on historic buildings, sites, or objects, NHPA could be triggered and WS-Nevada would review its activities with the SHPO to determine the appropriate consultation needs. However, in these unlikely scenarios, WS-Nevada would likely relocate its site activities to completely avoid any potential effects on cultural resources.

3.3.6 *Environmental Justice (E.O. 12898):*

This executive order relates to the fair treatment of people of all races and income levels with respect to social, health, and environmental impacts. WS-Nevada responds to all requests for assistance, regardless of race or level of income, and the contribution of federal funds can further assist such populations in addressing health and safety threats caused by predators and economic impacts from depredation and damage. Disposal of carcasses, and handling, use, and disposal of hazardous materials and chemicals are conducted per agency policy (Section 2.4) and federal and state law and regulations. Risks to human health and safety are discussed in Section 3.10.

3.3.7 *Floodplains (E.O. 11988):*

WS-Nevada operations do not involve construction of infrastructure and would not impact the ability of floodplains to function for flood abatement, wildlife habitat, navigation, and other functions.

3.3.8 *Visual Quality:*

WS-Nevada operations do not change the visual quality of a public site or area. Although physical structures, such as fencing, may be recommended as part of technical assistance, they are not constructed by WS-Nevada and therefore not under the agency's jurisdiction. WS-Nevada may assist livestock producers with installing temporary fencing or fladry in small quantity as a non-lethal deterrent to predators and would be more likely to occur on private land but could occur on active grazing allotments on public land. These temporary barriers would be for short duration.

3.3.9 *General Soils (except for Issue 3.10.2 - environmental fate of lead in soils):*

WS-Nevada operations do not involve directly placing any materials into the soils or causing major soil disturbance. Soil disturbance is reduced because vehicles are used on existing roads and trails to the extent practicable and as required by land management agencies, landowners, or by law, and there is no construction proposed or major ground disturbance. Setting traps involves only minor surface disturbance, and equipment is set primarily in previously disturbed areas.

3.3.10 *Minerals and Geology:*

WS-Nevada operations do not involve any major excavation, blasting, or contact with minerals or change in the underlying geology of an area.

3.3.11 *Prime and Unique Farmlands:*

WS-Nevada operations do not involve converting the land use of any kind of farmlands.

3.3.12 *Water Resources (except Section 3.10 regarding the use of lead ammunition and effects in wetlands):*

WS-Nevada operations do not involve construction, major digging, dredging or filling, discharge of pollutants into waters of the U.S., or changes to flow of waterways. All chemicals used for IPDM are used, stored and disposed of in accordance with EPA and state requirements for the protection of the environment. WS activities would not cause erosion or sedimentation into water bodies. See also general soils and vegetation in this section. Therefore, IPDM would not affect water resources including water quality and wetlands, streams, ponds, or other waterbodies.

3.3.13 *Air Quality:*

WS-Nevada's emissions are from routine use of vehicles, airplanes, and very limited use of harassment devices using explosives, and therefore constitute a *de minimis* contribution to criteria pollutants regulated under the Clean Air Act.

3.3.14 *Vegetation, Including Timber and Range Plant Communities (except for federally-listed plant species, Section 3.6):*

WS-Nevada operations do not involve modification to any vegetation communities, nor do they involve removal of trees or shrubs. WS-Nevada's activities would have only a small potential for a negligible amount of plant disturbance (see Section 3.6.2 for a discussion of effects on T&E plant species (no effect determinations). WS-Nevada may provide technical assistance in the form of information or advice to land managers/owners to modify vegetation to help deter predators, however actions by the land managers/owners are not a WS-Nevada responsibility.

3.3.15 *Climate Change:*

Greenhouse gases (GHGs) are components of the atmosphere that trap heat relatively near the surface of the earth, and therefore contribute to the greenhouse effect and global warming. Most GHGs occur naturally in the atmosphere, but increases in their concentration result from human activities such as the burning of fossil fuels. Global temperatures are expected to continue to rise as human activities continue to add carbon dioxide, methane, nitrous oxide, and other greenhouse (heat-trapping) gases to the atmosphere.

> The most recent report by the Intergovernmental Panel on Climate Change (IPCC) (2014) states that it is *extremely likely* [emphasis in text] that more than half of the observed increase in global average surface temperature from 1951 to 2010 was caused by the human-caused increase in greenhouse gas (GHG) concentrations and other human-caused contributions together. This report states that climate change impacts are strongest and most comprehensive for natural systems, causing changes in precipitation levels, timing, and extremity; water quality, quantity, and timing; seasonal timing of life cycle activities, migration patterns, geographic ranges abundance, and interactions of terrestrial, aquatic, and marine species; ocean acidification; temperature extremes; and increases in high sea levels. Continued emissions of GHG will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive, and irreversible impacts for people and ecosystems.
>
> In 2016, the President's Council on Environmental Quality (CEQ) advises federal agencies to consider whether analysis of the direct and indirect GHG emissions from their proposed actions may provide meaningful information to decision makers and the public during NEPA analyses (Goldfuss 2016). This guidance has been recently rescinded. However, even if the guidance were in effect, WS-Nevada's impacts on climate change from its greenhouse gas emissions are *de minimus*.
>
> The potential effects of climate change on populations of predators has been considered in Section 3.5.

3.4 How Will Alternatives Be Assessed Where WS-Nevada Activities are Modified or Absent?

Alternative 1 involves continuing the current WS-Nevada IPDM activities/proposed action as described in Sections 2.3.1 and Appendix A. Alternatives 2 through 5 modify the levels of WS-Nevada involvement in IPDM activities in Nevada to differing degrees. A summary of the issues by alternative is presented in Table 3.22 (Section 3.13).

An important part of comparing the environmental impacts and risks to human health and safety of the alternatives is understanding what IPDM may be implemented when WS-

Nevada has limited or reduced abilities to respond to requests for assistance with a full array of legally available methods applied using the APHIS-WS Decision Model. To address this factor, this section provides information on who can and does implement IPDM, and how those activities are likely to compare with Nevada's proposed action, its impacts and risks. Additional information on IPDM work conducted by others is available in Sections 2.3.1.10 and 3.4.

3.4.1 *What Other Entities Could Respond if WS-Nevada IPDM Activities are Restricted or Absent?*

Multiple agencies, other entities, and individuals can conduct IPDM activities (Sections 2.3.1.10 and 3.4):

- NDA-WS would still conduct PDM, but without federal oversight and methods only authorized for use by WS-Nevada (e.g. M-44s);
- NDOW can either conduct IPDM directly for game animals or issue a permit for others to take game animals for reducing damage outside of regular game seasons, all of which are reported to NDOW;
- NDOW can issue permits for aerial shooting of coyotes to private or commercial entities, with each permit issued for specific circumstances and time periods, and reporting of take required;
- Wildlife control operators (WCOs), licensed by NDOW, can provide commercial services to anyone as requested, and their take is reported to NDOW at the end of each year;
- Landowners or authorized agents may take predators causing damage or risks on private land in accordance with state law (Section 2.4.4.1), with NDOW requirement for reporting take dependent on species taken (no reporting is necessary for take of coyotes, for example, unless take involved use of foothold traps/snares as part of a depredation permit); and
- WS-Nevada may provide IPDM services when requested on any land class, either directly or as an agent of NDOW, including technical advice on lethal and non-lethal methods and implementation of lethal methods, and keeps detailed records of take in its MIS database.
- Table 3.1 provides a conservative estimate of lethal take (intentional and unintentional) by WS-Nevada directly taken by or reported to NDOW and USFWS by other entities for each species. The largest lethal take of state managed predators is by non-WS-Nevada entities during NDOW-regulated game and furbearer seasons (Table 3.1). This take, however, does not directly address damage and risk situations caused by predators. The largest lethal take of USFWS managed predators is by WS-Nevada.
- NDOW has a program for licensing commercial wildlife control operators, with each operator identifying their specialties and capabilities at the NDOW website

(http://www.ndow.org/uploadedFiles/ndoworg/Content/Forms_and_Resources/Commercial-Collection-Permitees-List.pdf). Currently, 21 commercial WCOs are identified on NDOW's website. These companies typically operate locally, so some areas may have limited access to wildlife control operators with the capabilities to address the damage or risk concerns, especially for game species and large predators.

- WS-Nevada conducted 39.7% of its activities on private land during FY 2012-FY 2016. WS-Nevada also responds to requests for IPDM activities on federal land (USFS, BLM (56.8%)), and other public lands, including city, county, and state lands (Table 2.2). In the absence of WS-Nevada, government, private entities and landowners could request assistance from any available local commercial WCO and, in the instance of mountain lion and bear depredation, NDOW. NDOW may or may not have the resources available to respond to every request for assistance. Land owners and their agents may also attempt to respond to damage or threat problems caused by predators as provided by state law and regulation (Section 2.4.4.1), but they may not have the necessary effective equipment or proficiency in its humane, safe, and effective use compared to that available from WS-Nevada, NDA-WS and commercial WCOs.

3.4.2 *How do IPDM Activities Conducted by All Entities, Including WS-Nevada, Complement and Compare?*

As discussed in Section 3.9, proficiency and experience of the person using lethal and non-lethal predator damage management methods are critical for ensuring effectiveness, selectivity, and humaneness. NDA-WS is generally as efficient and experienced as WS-Nevada, but would be limited in the PDM strategies it can implement. These strategies would include a reduction in the aerial program, due to the lack of federal oversight, training of aircrew and the availability of aircraft; the use of the M-44 device would not be available to NDA-WS either; NDA-WS does not conduct wildlife hazard management at airports, NDA-WS would also not have utilization of the WS National Wildlife Disease Program, it's labs or expertise for disease sampling.

NDOW has a licensing and annual reporting process for commercial entities (WCOs) that conduct IPDM. NDOW also requires entities requesting a permit for aerial shooting of coyotes to report methods previously used and their effectiveness. Commercial WCOs are licensed and proficient in their methods and activities, but few companies have the capability and/or interest to respond to requests for depredating bear, mountain lion, common raven or some other species in this EA. WCOs not currently covering these species may not be equipped, prepared, or experienced to address conflicts with those species.

Individual landowners may also hire or request other individuals who are not licensed WCOs to address the damage problem, or address the problems themselves. Individual landowners are less likely to have the proficiency, experience, or skill for using traps, snares, harassment equipment, or firearms for lethal take of predators in a humane, selective, and/or effective manner. Landowners and their agents may use traps, snares, and firearms in a manner inconsistent with best practice standards for humaneness and effectiveness. They would also not be required to use the same decision process that WS-Nevada uses (APHIS-WS Decision Process; Section 2.3.1.1).

3.4.2.1 *Small Predators*

Many commercial WCOs with the capabilities to address predator damage or risk situations focus on small predators such as raccoons and skunks. A small number of WCOs include coyotes, badgers, foxes, and bobcats in their services if they are located within or near the natural range of the species. The number of requests to either WCOs, WS-Nevada or NDA-WS for assistance with weasel control is very low. WS-Nevada and NDA-WS average take of these species is generally low compared to those taken by WCOs locally (Table 3.1), though NDA-WS could still provide such assistance.

3.4.2.2 *Common Raven*

Any individual/entity lethally removing common ravens or their eggs must first apply for and be granted a depredation permit from the USFWS (Sections 1.5 and 1.6). The use of non-lethal methods is generally a precondition for USFWS's issuance of a depredation permit, as lethal methods are not allowed to be the sole recourse for raven damage. Common ravens and/or their eggs taken are required to be reported to USFWS. Landowners can take common ravens themselves or have someone else designated as their agent remove them. Landowners or WCOs may use methods authorized by their depredation permit. Those methods may include, but will be specific to each permit, the use of firearms, hand capture, and nest/egg removal. Additional methods may be authorized by USFWS, as appropriate and at the discretion of the USFWS. Aside from WS-Nevada, NDA-WS also has the capability, training, and restricted use pesticide license to address common raven damage. DRC-1339 (EPA Special Local Need No. NV-150001) is currently registered in Nevada for use by WS-Nevada and NDA-WS for addressing common raven damage. WCOs are unlikely to be trained or equipped to address common raven damage as effectively, as they would not be registered to use DRC-1339.

WS-Nevada and NDA-WS average take of these species is currently higher than numbers taken by WCOs locally (Table 3.1), though NDA-WS could still provide such assistance if WS-Nevada did not.

3.4.2.3 *Black Bear and Mountain Lion*

NDA-WS would still be available to provide services related to damage caused by black bear and mountain lion, although services would be mainly for protection of livestock.

As of September 19, 2017, 1 company is listed on the NDOW website (NDOW 2016c) as explicitly providing services for depredating mountain lions. NDOW allows mountain lions and bears causing damage to be lethally taken without a permit if a person feels they are in immediate danger, otherwise take would be permitted. Individuals who request assistance from NDOW may get direct assistance from the agency, NDOW may refer the request to an NDOW agent, such as WS-Nevada, or the landowner may designate their own agent or they may take the black bear or mountain lion themselves (with permit). The average take of black bears and mountain lions reported to NDOW and the average WS-Nevada take are similar (Table 3.1). Therefore, if WS-Nevada was not available to provide for lethal take of depredating or threatening black bear or mountain lion, NDOW and NDA-WS would have to increase their responses and landowners might begin to take lethal action themselves or authorize others as their agents (as permitted).

3.4.2.4 *Coyotes*

Coyotes taken by WCOs, their agents, or under NDOW permit for aerial operations is approximately 20% of the number of coyotes taken by WS-Nevada in response to requests for PDM (Table 3.1). The distribution and availability of commercial WCOs is also an important consideration in a large state like Nevada. Of the NDOW-licensed WCO companies identified on the NDOW website, only 2 state that they respond to requests for coyote assistance, 1 in Clark County and 1 in Elko County. Aerial operators under permit from NDOW are hired and paid for by livestock producers or others (as are WS-Nevada aerial operations (no permit required)), and are restricted to flying only under the purpose, location (federal grazing allotment during periods of active use and applicants private land), and term of the permit, with grazing allotments and ranch names specified (NDOW 2017a). Additionally, landowners can take coyotes themselves or have someone else designated as their agent remove them. Coyotes taken are not required to be reported (except those taken with traps under trapping regulations).

In the state of Nevada, M-44 devices (sodium cyanide) can only be used by WS-Nevada, per the EPA label. They are not commonly used by WS-Nevada staff, taking 5.1% of total WS-Nevada annual coyote take (average 222.8 coyotes per year) by WS-Nevada FY 2012 through FY 2016 with this device (Table 2.1, Appendix E, Table E.1). WS-Nevada conducts 49.6% of its coyote operations on private land and 46.3% of its coyote operations on BLM land (Table 2.2). If WS-Nevada is restricted in its ability to take coyotes lethally under alternatives 1, 3, 4 and 5, it is assumed that producers would request more assistance from NDA-WS, more NDOW permits for aerial operations, commercial operators would have to expand their capabilities and areas of operation, and/or landowners would begin to or increase their lethal take actions themselves or by requesting assistance from WCOs or other individuals.

When taking unprotected mammals outside of trapping regulations or depredation permits, take of coyotes, badger, skunks, and weasel are not required to be reported, therefore are unknown.

Table 3-1. Average Annual Known Predator Take in Nevada by Source, FY 2012-2016[1].

Species[1]	WCO Take[2]	Aerial Shooting Take (non-WS)[3]	Hunting Harvest[4]	Total WS Take[5]
Coyote	62	804	3,412	4,370.2
Badger	--	--	191	47.8
Mountain lion	3	--	150	24
Striped skunk	0	--	81	15.6
Raccoon	--	--	145	11.6
Bobcat	0	--	2,309	4
Red fox	0	--	81	3
Kit fox	--	--	783	1.6
Black bear	6	--	14	1.4
Gray fox	0	--	1,319	0.2
Spotted skunk	0	--	23	0.2
Common[6] raven	94.4	0	0	3,826.2

1 For details see Section 3.5; Tables 3.2 through 3.16. Feral/free-ranging dogs and cats are managed by County/local authorities and their take cannot be estimated.
2 Wildlife Control Operator (WCO) licenses are issued by NDOW (NAC 503.095).
3 Airborne hunting permits are granted by NDOW to private operators for coyote aerial shooting to protect livestock, domesticated animals, or natural resources (NDOW 2017a). Data incomplete; only one permittee provides take information in annual report.
4 Represents the number of predators taken during reported hunting and trapping harvest regulated by NDOW and not related to predators removed for damage management.
5 Intentional and unintentional WS-Nevada take (MIS 2017).
6Take in "WCO" column for Common raven refers to permitted take by sources other than WS-Nevada as Reported to USFWS (Table 3.5).

3.4.2.5 *Summary*

Although there are several types of entities conducting IPDM (NDOW, WCO, WS-Nevada, NDA-WS, permitted individuals, private individuals), those that are currently doing so have evolved over time and often complement one another. There is overlap for some of the species and or situations, and there are some areas of expertise and skill sets that overlap as well. However, there are differences to where and or when these different entities are or would be involved in conducting IPDM. Because there is a difference in the level of efficiency and effectiveness, especially with private individuals, and uncertainty in WCO's readiness to conduct some of these activities, it would be hard to know what the outcome would be in the absence of one or the other. It is possible that given the absence of one or more entities, the others would be able to fill in. It is also possible, that given the limitations discussed, that groups would not be able to fill in behind one or more of the others.

3.4.3 *Benefits of the WS-Nevada IPDM Program*

There are several benefits to using WS-Nevada's and NDA-WS' IPDM services that may not be available when other entities, especially private citizens and NGOs, provide such services. WS-Nevada and NDA-WS' employees are highly trained professionals that adhere to a myriad of measures, such as APHIS-WS Directives (Section 2.4), ESA consultation requirements, and other operating procedures prescribed in this EA that are designed to reduce adverse effects on the environment and reduce risks to humans. WS-Nevada (and NDA-WS) records its activities through the MIS database so that information can be readily available for environmental analysis, partner agency use, and for public scrutiny. For example, all APHIS-WS lethal and non-lethal intentional and unintentional take of all species, regardless of their status, is presented in program data reports for each state and summarized nationally (USDA APHIS 2019). WS-Nevada's use (and NDA-WS use via WS-Nevada's federal leadership) of the APHIS-WS Decision Model helps to ensures that IPDM is performed according to all applicable federal, state, and local laws and agency policies in the most effective, selective, and humane way possible (Section 2.3.1, Section 2.4).

As a federal agency responsible for compliance with NEPA, APHIS-WS documents and analyzes its activities and involves other agencies, tribes, and the public to ensure that it makes informed and transparent decisions about IPDM. It is under the umbrella of NEPA that all of APHIS-WS's IPDM activities are reviewed for their effects on the human environment. The effects of IPDM methods on humans and the environment, results of ESA Section 7 consultations, and Tribal government concerns are among the physical, biological, and sociocultural issues included in a NEPA document. The State of Nevada does not have a NEPA-equivalent law, so public participation in IPDM decision-making based on evaluation of issues and comparisons of alternatives does not occur. Effects of private actions are not generally reportable to the public unless the action is taken under a permit or is required to be reported by state law. Because of the federal NEPA process requiring the agency to evaluate its activities on the human environment, and because APHIS-WS policy is to allow the public to comment on EAs before decisions are made, special interest groups and interested citizens are able to focus their attention on federal agency decision-making where it would be more difficult or even at times not possible to discover the actions, assess and understand the effects, and participate in decision-making of other entities.

3.5 What are the Impacts on Predator Species Populations?

This section includes the direct and cumulative analyses of potential impacts on populations of individual predator species in Nevada. These analyses include all intentional take (direct lethal removal) by WS-Nevada, and all other take reported to state management agencies including hunter and trapper harvest and some take by private citizens for depredation or health and safety reasons.

3.5.1 *What Methodologies and Assumptions Were Used for Population Analyses?*

Estimating wildlife population sizes over large areas can be extremely difficult, labor intensive, and expensive. State and federal wildlife management agencies have limited resources to conduct wildlife population surveys and monitor trends.

States may monitor the status of wildlife populations by assessing sex ratios and age distribution. Indices of relative abundance or data on catch-per-unit effort from hunter surveys also serve as relative measures of population size and status. This EA uses the best available information from jurisdictional agencies and peer-reviewed literature to provide estimates of wildlife population size and status.

The magnitude of the potential impacts on target species is quantified to the greatest extent possible for each of the alternatives considered, based upon population estimates from the literature, USFWS and/or NDOW data. Tables 3.2 through 3.17 provide an overview of the status of the statewide populations and estimated populations for the predator species included in this EA. Population demographic information is included in the description for each species, and information on sources of mortality for each species is provided in the tables incorporated into the analysis for each species (Tables 3.2 through 3.16).

As the state wildlife regulatory agency, NDOW Big Game Status Reports are published annually which provide black bear population estimates and mountain lion population trends. However, for the other predator species in this EA, NDOW does not estimate abundance. In order to estimate population size for these species, conservative estimates are derived from the best available density estimates reported in the literature, with preference given to publications and studies in Nevada or states having similar habitat. The lowest estimate is assumed to be the minimum population. Habitat suitability indices, localized density fluctuations, and immigration/emigration are not factored into these calculations, nor is density in Nevada based on quantity of habitat, as none of this information is available from any source. All population estimates are considered to be conservative, as we have used the lowest population estimate among the ranges of those available in the literature.

As discussed in Section 1.11.2.9, approximately 84% of Nevada is federally administered land, of which 3.5% is landlocked by private land (Theodore Roosevelt Conservation Partnership 2019) and 12% is private land. 57.9% of the WS-Nevada lethal take of predators occurred on federally administered land and 39.5% on private lands. Of importance, WS-Nevada actively works on only a small portion of all the available properties that have signed WIDs at any given time. Of those properties being actively worked, IPDM activities are conducted on only a fraction of the total area which the property encompasses. Thus, the potential impacts from WS-Nevada's IPDM activities on wildlife populations are only in a small portion of the state and for a limited duration.

In order to analyze the level of effects of WS-Nevada on the individual species' populations, available take data is presented annually by species for FY 2012 through FY 2016 (Tables 3.2 through 3.17). WS-Nevada's intentional take is used to analyze the direct effects on species populations.

All sources of WS-Nevada take of predator species are combined with all known sources of non-WS take in Nevada to represent the cumulative take for FY 2012 through 2016. Cumulative take may include measures of:

- WS-Nevada intentional take of a predator species;
- WS-Nevada unintentional take of a predator species;
- NDOW administrative removal (intentional lethal removal conducted by NDOW or its agent);
- Hunting and trapping harvest regulated by NDOW;
- Private Wildlife Control Operators (WCOs) take (reported to NDOW by NDOW-licensed WCOs);
- Aerial take of coyotes by non-WS-Nevada entities, as permitted by NDOW;
- Other allowable take for damage or threats to human health or safety reported to NDOW per NRS §502.010, 502.470 and 501.376;
- Other known mortality sources, such as vehicle collisions or poaching.

To assess whether cumulative take is negatively effecting a predator's population estimate, cumulative take is compared to the maximum sustainable yield (harvest), the amount of mortality from all known sources that can be sustained in perpetuity (Botsford 2016). In this case, the proportion of the estimated species population taken by all sources in the year with the highest take between FY 2012- FY 2016 is compared to the lowest maximum sustainable harvest level from the literature. Since the cumulative take is compared to the conservative statewide population estimate for each species, the cumulative impact analyses in this section adjust for imperfect data and err in favor of overestimating potential impacts on predator populations.

Additionally, similar calculations are made to determine the projected cumulative impacts under the projected WS-Nevada annual maximum take scenario. The WS-Nevada annual maximum take is represented as the most WS-Nevada could take in a given year under the current program (Alternative 1) given the potential for fluctuations in program delivery (Appendix E). The projected annual cumulative take provides a conservative estimate of the highest proportion of the estimated species population that could be taken by all sources, under projected WS-Nevada annual maximum take scenario. The proportion is then compared to the lowest maximum sustainable harvest level from the literature.

Under no circumstances should the projected WS-Nevada annual maximum take be interpreted as the target number of animals WS-Nevada seeks to remove, nor does APHIS-WS have a policy of ever taking the maximum sustainable harvest proportion of the population for any species.

As explained in detail in Chapters 1 and 2, APHIS-WS personnel work to resolve conflicts with wildlife and facilitating human-predator coexistence while minimizing risk of adverse impacts on a case-by-case basis. To this end, efforts focus on removing specific depredating individuals or local groups of predators. Furthermore, APHIS-WS policy gives preference to non-lethal methods where practical and effective (WS Directive 2.101, Section 2.4.1.1). Cumulative impacts rely on data that can be collected. Unknown and unreported mortality can't be calculated (Section 2.3.1.10), however WS-Nevada has used maximum take projections and conservative population estimates to consider potential impacts. These analyses do not incorporate take from IPDM activities conducted in adjacent states. Wildlife management authority resides with the states. WS-Nevada's analysis is on assisting the State of Nevada and other entities that are within Nevada and according to applicable Nevada statutes and rules. The information compiled in the analysis of this EA is sufficient to address the impacts associated with the alternatives for WS-Nevada involvement in PDM in Nevada.

3.5.2 *What is the Relationship of Climate Change to Predator Population Dynamics?*

The Intergovernmental Panel on Climate Change - Summary for Policymakers (IPCC 2014) reports historic warming of 0.85°C during 1880 to 2012, and predicted surface temperature increases of 0.3°C-0.7°C during 2016–2035 with associated ecological impacts. WS-Nevada considers the best available information when assessing program impacts on the environment, thus new information about climate effects on vulnerable resources would be considered appropriately. WS-Nevada sought to consider predicted climate effects on the environment from two perspectives: the potential for climate change to affect IPDM program needs, and the potential for cumulative impacts on wildlife and other issues evaluated in this EA.

WS-Nevada considered predicted climate change effects on coyotes, black bears, mountain lions, raccoons, striped and Western spotted skunks, badgers, bobcats, red, gray and kit foxes and common ravens. Regarding mammals, studies found through literature searches related to climate change effects on these species focused primarily on polar bears (*U. maritimus*) which specialize in hunting from sea ice and are therefore especially vulnerable (Derocher 2004, Regehr et al. 2007, Atwood et al. 2016). Arctic foxes (*Alopex lagopus*), that share in risks related to sea-ice loss, have been studied somewhat less extensively for these effects (Kim et al. 2014). Regarding common ravens, the National Audubon Society came out with "Audubon's Birds and Climate Change Report: A Primer for Practitioners…" in 2015. The projections are based upon 3 data products: Climate Sensitivity Lists; Individual Species Modeled Climatic Suitability; and Climate Prioritizations. The report is intended to provide conservationists and managers with management tools/insight in managing bird species based upon the bird's response to climate related change including varying emission levels. Uncertainties are identified and defined with some approaches to dampen them. Specific to the common raven, the climate model forecasts "little change" in wintering grounds, but large changes in the summer ground (39% remaining stable) with a substantial drift northward of the range. National Audubon Society (2015) point out that the common raven forecast contrasts with the present trend which is expanding slowly southward and to lower elevations, suggesting that the common raven's hardy and adaptable traits may counter the effects of climate change.

No significant body of peer-reviewed science on predicted climate change effects on predator species targeted or taken unintentionally by WS-Nevada appears to exist at this time. Although publications were relatively few, the most frequent results were for red and grey foxes. For example, Teacher et al. (2011) studied historic red fox distribution in Europe relative to climate and concluded that future climate change may not seriously impact their distribution. Mcalpine et al. (2008) documented the first known instance of grey foxes occurrence in New Brunswick, Canada, suggesting possible climate-mediated range expansion as the reason for this occurrence. In addition, concerns have been raised that since red foxes are competent reservoirs for arctic fox variant rabies, increasing temperatures could result in changes to red and arctic fox population dynamics with consequential changes in the occurrence of fox rabies (Kim et al. 2014). While irruptions of fox rabies in red foxes have occurred historically at lower latitudes, impacts to IPDM in Oregon would likely be low to non-existent given relatively recent successes at control (MacInnes et al. 2001, Rosatte et al. 2007, Slate et al. 2014). Rabies in grey foxes is likewise under control (Sidwa et al. 2005). Finally, Mugaas et al. (1993) studied the distribution of raccoons and related species and suggests a high level of climate adaption by raccoons as an explanation for their wide distribution and success.

Evidence for effects from global climate change from or to current or proposed IPDM activities in Nevada is lacking. Consequently, WS-Nevada expects no climate-related impacts to or from its proposed activities. WS-Nevada remains committed to monitoring program effects on target species and on other environmental resources, in coordination with the appropriate resource management agencies. Finally, by keeping ESA Section 7 consultations with the USFWS up-to-date (Section 3.6), WS-Nevada ensures that its IPDM activities would not jeopardize even the most vulnerable species.

3.5.3 *What are the Direct and Cumulative Impacts on Coyote Populations?*

3.5.3.1 *Coyote Life History Information*

The coyote resembles a medium-sized dog, with adults weighing an average of 22 to 30 pounds. Coyotes were once found primarily in the prairies and deserts of Mexico and central United States, but have expanded their range to include much of North America since the 1700s. Coyotes are widely distributed and common in Nevada. In the wild, they typically feed on small mammals, birds, reptiles, fruits, seeds, and carrion. In urban and suburban areas, they also feed on rabbits and pets, including cats. Coyotes can also feed on larger mammals, such as deer, antelope, and livestock, and scavenge when opportunity arises.

Coyotes have strong ability to adapt to a wide variety of conditions, including those created by humans and their resource-rich subsidized environments (Section 3.8). Coyotes are highly mobile animals with home ranges that may vary seasonally and with the sex and age of the animal (Pyrah 1984, Servin and Huxley 1995, Gese 2001). Alpha pairs have stable territories that they defend (Gese 1998, Wallach et al. 2009b), while single transient coyotes may travel long distances until they become established within a territory. They normally hunt during the evening and night (except for those habituated to human presence), singly or in pairs, but in late summer or early fall may hunt with the family group (Section 1.12.3.2).

Coyote populations are generally comprised of residents (70-90%) and transients (range from 10-30%), with the transients nonbreeders. Generally for an exploited population of coyotes, 25-50% of the residents are breeders while the remaining 25-50% are offspring (nonbreeders). Proportion of population classified as breeders depends on pack size (Knowlton et al. 1999). Coyote pairs annually produce 1 litter of 4 to 8 pups in April and May (Knowlton et al. 1999). The young disperse at about 6 to 9 months (Bekoff and Wells 1980). Only the alpha pair breed and only 10% of the young from a given pair need to survive and reproduce to replace the pair. The remaining 90% of any subdominant animals may either stay with the breeding pair to assist with raising pups or, more likely disperse and often die before establishment in a new territory (Knowlton et al. 1999).

Coyote spatial organization is complex and can vary between study sites and with seasonal breeding activities (Messier and Barrette 1982, Windberg and Knowlton 1988). Each occupied coyote territory may have several non-breeding helpers at the den during whelping (Bekoff and Wells 1982, Allen et al. 1987). Messier and Barrette (1982) reported that from November through April, 35% of the coyotes were in groups of 3 to 5 animals and Gese et al. (1988) reported that coyote groups of 2, 3, 4, and 5 comprised 40%, 37%, 10% and 6% of the resident population, respectively. The presence of unusual food concentrations and nonbreeding helpers at the den can influence coyote densities and complicate any effort to estimate abundance (Danner and Smith 1980). To that end, a positive relationship was established between coyote densities in mid-late winter and the availability of livestock carcasses (Roy and Dorrance 1985).

3.5.3.2 *Coyote Population Information*

Coyotes are found throughout the continental United States (Gese and Terletzky 2009), including throughout the entire State of Nevada and its urban areas. The coyote's ability to adapt to changing environmental conditions and its opportunistic nature has resulted in its increased abundance and wider distribution during the past several decades (Mastro 2011). Habitat changes caused by human land use and development that have occurred over the last two hundred years often favor this species.

Coyotes are classified by NAC §503.035 as an unprotected mammal in Nevada, and as such may be taken year-round, without a license to protect persons or property in the immediate vicinity of homes or ranches affected by such species. Additionally, as an unprotected mammal, they can also be hunted on public lands. Due to this regulatory classification, NDOW does not track or attempt to estimate coyote population levels or densities, and has minimal information on harvest levels. However, NDOW indicates that statewide coyote populations in Nevada are very healthy (NDOW 2018b).

Coyote population densities vary depending on the time of year, food abundance, and habitat. Many authors have estimated coyote populations throughout the west and elsewhere (e.g., Knowlton 1972, USFWS 1979, Pyrah 1984, Camenzind 1978, Voigt and Berg 1999, Gese and Terletzky 2009, Hurley et al. 2011), reporting densities that ranged from 0.39/mi^2 in Montana pre-whelping to a high of 3.55/mi^2 in Wyoming post-whelping.

In southeastern Oregon (about 30 miles north of Nevada), one study used howling surveys during pre-whelping winter months on Hart Mountain National Antelope Refuge (Dunbar and Giordano 2003). The authors found that there was a 1.04-1.37 coyotes/mi^2 density, but noted that this was likely an underestimate, as not all coyotes in the area respond to howling surveys (Okoniewski and Chambers 1984, Gese and Ruff 1998).

In a study by Gese (2005), approximately 44% to 61% and 51% to 75% of an estimated coyote population was removed from a 131 mi^2 project area using aerial shooting and trapping, respectively. 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 eight 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 denning pairs of coyotes. 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 (Gese 2005). Increased breeding activity as a response to population declines is referred to as compensatory reproduction. Increases in a population after a period of population reduction by non-territorial individuals is called compensatory immigration. Both factors contribute to population recovery after PDM activities.

While there may presently be higher coyote densities in portions or all of Nevada as per Dunbar and Giordano (2003), coyote densities will be estimated conservatively at 0.5/mi^2 (USFWS 1979) since this is the lowest estimate presented in the literature. This estimate was prepared for Oregon but is being used because Oregon neighbors Nevada and there is no Nevada-specific coyote density estimate in the literature. Nevada is about 109,826 mi^2 in size (excluding the area of large water bodies), with much of the state comprised of suitable coyote habitat. Therefore, the conservative population estimate of 54,913 (prewhelping) is used to evaluate the impacts of WS-Nevada actions.

Coyote populations with strong social structure can be resilient in the face of moderate levels of exploitation (Ray et al. 2005, Letnic et al. 2011, Ripple et al. 2013). Pitt et al. (2001) and Pitt et al. (2003) assessed the impact of removing a set proportion of a coyote population during one year and then allowing the population to recover. All populations recovered within one year when <60% of the population was removed. Recovery occurred within 5 years when 60%-90% of the population was removed. Pitt et al. (2001) and Pitt et al. (2003) also evaluated the impact of removing a set proportion of the population every year for 50 years. When the removal rate was <60% of the population, the population size was the same as for an unexploited population. These findings are consistent with an earlier model developed by Connolly and Longhurst (1975) and revisited by Connolly (1995), which indicated that coyote populations could withstand an annual removal of up to 70% of their numbers and still maintain a viable population.

3.5.3.3 *Coyote Population Impact Analysis*

3.5.3.3.1 WS-Nevada Direct Effects on Coyotes

The greatest number of requests for assistance with IPDM made to WS-Nevada were related to coyotes. In response, WS-Nevada has intentionally taken an average of 4,370.2 coyotes per year statewide during FY 2012- FY 2016, including individual coyotes and their dens; Table 3.2) (down from an average of 5,911.3 coyotes per year statewide during the FY 2004-FY 2009 time frame (USDA 2011, Table 7). WS-Nevada unintentionally removed 0.2 coyotes per year during the analysis period.

Included in the reported intentional take numbers is the take of coyotes in dens, estimated at approximately 4 individuals per den. This estimate is based on average den occupancy, with a 50% likelihood of dens conservatively containing 1 adult with 6 pups per litter (Pyrah 1984, Gese et al. 1989, Wapenaar et al. 2012), for a total of 7 coyotes. The other 50% of the time, an estimate of 1 coyote per den is used to account for scenarios where there is 1 lone adult, a den with less than 6 pups due to juvenile mortality or dispersal after maturation, and vacant dens.

Of the take, 59.2% of the coyotes were taken from aerial shooting, 23.7% are taken by traps and snares (not including cage and culvert traps), 8.2% were taken by ground shooting and calling and shooting, 5.1% were taken by M-44s (sodium cyanide), and 3.8% were taken by use of sodium nitrate gas cartridges in dens (Table 2.1, Appendix E, Table E.1). Most coyotes are taken by WS-Nevada on private and BLM lands (49.6% and 46.2% respectively) (Table 2.2, Table 2.4) in agricultural and sagebrush steppe areas of Nevada, north of Clark county, especially in the north and east counties such as Humboldt, Lander, Elko and White Pine for livestock protection (Table 2.3, Table 2.4, Table 2.5).

To estimate a "**WS annual maximum take"** for coyotes, analyzed and anticipated future livestock, natural resource, property and human health and safety protection needs were taken into account as well as adjustment to WS-Nevada's aerial program to better respond to these needs.

During the FY 2012 and FY 2016 analysis period, 2012 had the highest coyote take for livestock protection, totaling 4,700 coyotes (rounded to the next hundred); FY 2016 had the greatest coyote take for natural resource protection, totaling 1,000 coyotes (rounded to the next hundred). Anticipating the potential need to protect additional natural resources/natural resource species from coyotes (e.g. greater sage-grouse), this number is doubled to 2,000 under the proposed action. FY 2013 was the year with the greatest coyote take for human health and safety/property protection, totaling 100 coyotes (rounded to the next hundred). The sum of the above aggregate take is 6,800 coyotes.

During the analysis period, FY 2012 was the only year that WS-Nevada's fixed wing program was fully crewed and operational. This required using other Nevada dedicated aircraft, or aircraft/crews from other programs if/when available, resulting in an inability to respond to resource protection needs, particularly during spring calving/lambing and fawning seasons. As such, WS-Nevada is anticipating the fully crewing of 4 aircraft (including agency/contract helicopter), which would be an increase of 1.75 additional fully crewed aircraft. The highest annual coyote take by aircraft during the analysis period was 1,200 (rounded to the nearest 100), which occurred in FY 2012. Multiplying 1,200 coyotes taken by 1.75 additional crewed aircraft produces 2,100.

Adding the sum of the aggregate take of 6,800 to the additional potential take of 1.75 more aircraft (2,100) results in 8,900. Therefore, we will use a WS-Nevada annual maximum take of 9,000 coyotes.

Note: While the calculations for the WS annual maximum take were broken out by different resources protection categories and a greater focus for aerial take, take can be in any proportion or combination of aerial or ground methods, so long as the combined total from all methods does not exceed the annual maximum take.

3.5.3.3.2 Cumulative Mortality on Nevada Coyote Populations

Per state law, coyotes may legally be taken at any time for any reason. However, it is reasonable to assume that much of the private take of coyotes not associated with damage occurs in the winter period when furs are prime and have monetary value. Recreationalists reported take averaged 3,377 coyotes each year during FY 2012- FY 2016. Coyotes taken by private aerial shooting during FY 2012- FY 2016 add an average of 804 per year to the cumulative take. Coyotes reported to NDOW taken by individuals other than WS-Nevada for damage averaged 62 per year (including NDOW licensed WCOs). Currently, there is no required reporting for coyotes that are trapped for purposes other than fur harvest on private land or for coyotes hunted on both public and private lands. Total non-WS take reported to NDOW averaged 4,243 animals per year; Table 3.2).

The largest cumulative take between FY 2012- FY 2016 was 9,521 coyotes in 2012, approximately 17% of the total estimated population. WS-Nevada's portion of the cumulative take was 9.87% of the annual maximum sustainable harvest of 60% (Table 3.2). If WS-Nevada were to take the proposed annual maximum of 9,000 coyotes, the projected cumulative take would be approximately 25% of the estimated Nevada coyote population, with WS-Nevada contributing 16.39% to the cumulative amount. This level of take is still well below the 60% take threshold that might adversely affect a coyote population.

Table 3-2. Population Impact Analysis of Coyote Take in Nevada, FY 2012-2016.

Mortality source	2012	2013	2014	2015	2016	5-year average	5-year high
WS intentional coyote take[1]	5,191	4,643	3,104	3,067	5,025	4,206	5,191
Estimated WS intentional den take[1,2]	228	132	132	160	168	164	228
WS unintentional take[1]	0	0	0	0	1	0.2	1
WCO take[3]	62	62	62	62	62	62	62
Other damage take[4]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hunting harvest	3,236	3,782	3,561	3,591	2,715	3,377	3,782
Aerial shooting, non-WS take[6]	804	804	804	804	804	804	804
Total WS take	5,419	4,775	3,236	3,227	5,194	4,370.2	5,419
Total non-WS take	4,102	4,648	4,427	4,457	3,581	4,243	4,648
Cumulative take	9,521	9,423	7,663	7,684	8,775	8,613.2	10,067
Statewide population estimate[7]:							54,913 coyotes
Annual maximum sustainable harvest[7]:							60% (32,948 coyotes)
Current total WS take as a % of the population[8]:							9.87% (5,419 coyotes)
Current cumulative take as % of population[9]:							18.33% (10,067 coyotes)
Projected WS annual maximum take[10]:							9,000 coyotes
Projected total WS maximum take as a % of the population[11]:							16.39% (9,000 coyotes)
Projected maximum annual cumulative take as a % of the population[12]:							24.85% (13,648 coyotes)

[1] (MIS 2018).

[2] See section 3.5.3.3.1 WS-Nevada Direct Effects on Coyotes. The estimated number of animals taken, based on the number of dens removed by WS-Nevada (MIS 2017).

[3] Data provided as average for 2012-2016 and are only estimates (P.Jackson, NDOW Pers. Comm 10/23/2017). Wildlife Control Operator (WCO) permits are issued by NDOW (NAC 503.095).

[4] Represents the number of animals taken by landowners, NDOW, or others as a result of damage (NDOW 2017c).

[5] Represents the number of animals taken during hunting/trapping harvest seasons (NDOW 2017c).

[6] Airborne hunting permits are granted by NDOW to private operators for coyote aerial shooting to protect livestock, domesticated animals, or natural resources although only one permittee reports take to NDOW so data is an estimate (P.Jackson, NDOW Pers. Comm 10/23/2017) As only an average was provided, the average will be used for each year.

[7] See Section 3.5.3.2 Coyote Population Information.

[8] The proportion of the estimated species population taken by WS-Nevada in the year with the highest WS-Nevada take between FY 2012- FY 2016.

[9] The proportion of the estimated species population taken by all sources in the year with the highest take between FY 2012- FY 2016.

[10] Represents the maximum WS-Nevada could annually take under the current program (Alternative 1) given the potential for fluctuations in program delivery (Appendix E).

[11] Provides a conservative estimate of the highest proportion of the estimated species population that could be taken by WS-Nevada, under projected WS annual maximum take scenario.

[12] Provides a conservative estimate of the highest proportion of the estimated species population that could be taken by all sources, under projected WS annual maximum take scenario and non-WS 5 year high.

3.5.3.4 *Conclusion: Coyote*

Due to the stable population trend for coyotes in the state, and an annual maximum sustainable harvest level of 60%, cumulative impacts on the coyote population from all causes, including all take by WS-Nevada, have not adversely impacted the size or sustainability of the coyote population in Nevada.

WS-Nevada's recent annual coyote take has averaged 4,206 per year from 2012 through 2016. Based on the possibility for increased requests for assistance, an increase in aerial operations, along with other factors discussed in this section, WS-Nevada has projected a need to take up to 9,000 coyotes per year to meet the need for action. Because WS-Nevada only works where requested, it is not certain that WS-Nevada will take the maximum number of coyotes analyzed. However, WS-Nevada concludes that the cumulative impact of all recorded coyote mortality in Nevada, from recreationalists, WCOs, and other entities, along with the proposed maximum annual WS-Nevada take of up to 9,000 coyotes, will not adversely impact the size or sustainability of the Nevada coyote population. This conclusion is based on the cumulative take of coyotes, by all sources, in Nevada not approaching the 60% threshold established by scientific literature, and is consistent with NDOW coyote population trend information (NDOW 2017c, 2018c).

3.5.4 *What are the Direct and Cumulative Impacts on Common Raven Populations?*

3.5.4.1 *Common Raven Life History Information*

Common ravens are among the most widely distributed bird species in the world and can be found in major portions of North America, Europe, Asia and North Africa (Boarman and Heinrich 1999). The population is estimated to be 20,000,000 globally, 1,700,000 in the U.S., and 190,000 in Nevada (Partners in Flight Science Committee 2013). Adults are between 22-27.2 inches long, weigh 24.3-57.3 ounces with a wingspan of 45.7-46.5 inches. Life span in the wild is generally 10-15 years, with an extreme of 22 years and 7 months documented via USGS banding data (USGS 2017). Sexual maturity is usually reached at 3 years of age, with mating and breeding occurring mid-February through late May (most clutches are started in March/April). Nesting generally occurs in cliffs, though in open country (such as much of Nevada) nesting also occurs on power distribution structures. Typical clutch size is between 3 and 7 eggs. Young leave the nest approximately 5-6 weeks after hatching. Brood size (nestlings/female) is variable (e.g. 3.3 in California, 4.2 in Oregon) (Boarman and Heinrich 1999). Immature birds that have left their parents form flocks with non-breeding adults. These flocks tend to roam and are relatively loose-knit (Goodwin 1986).

Common ravens have few natural predators and predation is rarely observed at any lifestage. Egg predators may include other common ravens and martens (*Martes Americana*). Nestling predators may include other common ravens, martens, great horned owls (*Bulbo virginianus*), golden eagles (*Aquila chrysaetuos*), large hawks and coyotes. Predation of adults likely limited to golden eagles, great horned owls and coyotes (Boarman and Heinrich 1999).

The common raven is an omnivorous species known to feed on live meat, carrion, crops, garbage, eggs and birds, small mammals, amphibians, reptiles, fish and insects (Boarman and Heinrich 1999). In many areas of the West, the common raven is seen as an indicator of human disturbance because of its association with garbage dumps, sewage ponds, highways, agricultural fields, urbanization and other typical signs of human-altered landscapes (Boarman 1993, Kristen and Boarman 2003, Howe et al. 2014). Supplemental food sources such as garbage, crops, road-kills, etc., may give the common raven an advantage over other less opportunistic feeders and appear to have allowed the common raven population to increase precipitously in some areas. In a study by Webb et al. (2004), in the Mojave Desert, increased juvenile raven survival from human augmented landscapes led to increases in local common raven populations. In a study by Howe et al. (2014) in eastern Idaho, common ravens readily used anthropogenic structures for nesting with 58% of the 82 nests located on transmission poles and an additional 14% on other human-made towers. Additionally, structures such as power poles and other towers provide elevated perching and nesting locations in areas where these features were naturally nonexistent or uncommon (Howe et al. 2014).

3.5.4.2 *Common Raven Population Information*

Common ravens are a migratory bird managed under the MBTA by the USFWS, however, they are generally a resident species. Some wandering and local migration occurs with immature and non-breeding birds (Goodwin 1986).

Population trends reflect the cumulative impact of all factors such as habitat change, disease, collisions with vehicles and predation on a wildlife population. One strategy WS-Nevada uses to assess cumulative impact is to compare the anticipated impacts of proposed actions to the current population trend. The best information currently available for monitoring trends in common raven populations is data from the Breeding Bird Survey (BBS). The BBS is a large-scale inventory of North American birds coordinated by the U.S. Geological Survey, Patuxent Wildlife Research Center (Sauer et al. 2017) that is comprised of a set of over 3,500 roadside survey routes primarily covering the continental United States and southern Canada. The effort was started in 1966 and routes are surveyed each June by experienced birders. The primary objective of the BBS is to generate an estimate of population change for songbirds. Populations of birds tend to fluctuate, especially locally, as a result of variable annual local habitat and climatic conditions. Estimates of population trends from BBS data are derived using a hierarchical statistical analysis (Link and Sauer 1994). The BBS analyzes bird population trends at the national, regional, and state levels and for Bird Conservation Areas (based on physiographic characteristics). The breeding bird survey uses a 95% confidence interval as the credible interval for trend estimates.

BBS data will be used to monitor common raven population trends, but it is also possible to use BBS data to develop a general estimate of the size of the common raven population (Partners in Flight Science Committee 2013). The Partners in Flight (PIF) system involves extrapolating the number of birds in the 50 quarter-mile circles (total area/route = 10 mi^2) from the BBS survey to the area of the bird conservation regions in Nevada. Correction factors are applied to the resulting calculations to adjust for the biology of common ravens and the environment in Nevada. The PIF system assumes a BBS detection radius of 0.5 miles for Nevada. The BBS surveys are conducted in the morning, but not all birds are equally visible in the morning. A time-of-day correction factor of 1.3 is applied to the common raven estimate to adjust for daily patterns in common raven activity.

Using BBS data to estimate the size of the common raven population requires making some assumptions regarding the nature of the species in question and the data collection process. The first assumption is that chosen survey routes are totally random and are fully representative of Nevada habitats. Although routes are randomly picked throughout the State, the randomness of the selection is compromised somewhat because the survey routes are subsequently assigned to the nearest available road, which can be at some distance from the randomly selected survey location.

The second key assumption is that common ravens are equally distributed throughout the survey area (i.e., Nevada). If survey routes included stops at common raven congregation sites with excellent food availability, such as a landfill, or if common ravens generally congregate near roads to scavenge road kill, then the data might be biased and would tend to overestimate the population. In the western U.S., common ravens are known to scavenge along roadsides where automobile-killed animals can be found. If a BBS route is along a road that has heavy traffic and an abundance of vehicle-killed animals, more common ravens would be expected to occur in the count area and, thus, the population might be overestimated. However, with the exception of a limited number of freeway and highway routes, the majority of Nevada's roads are not subject to heavy traffic and do not have an abundance of vehicle-killed animals. It would thus not be expected that the BBS counts would tend toward overestimating common raven numbers due to the roadkill bias. In a California study by Kristin and Boarman (2003), proximity to roads was not a significant predictor of the number of common ravens observed. However, based on Howe et al. (2014), common ravens used transmission lines, including smaller low-voltage transmission lines. In areas where transmission lines run adjacent to roadways, there may be potential for overestimation of the common raven population.

In Nevada, BBS data for the period of 1966-2015 indicate a statistically significant increasing trend for common raven populations in Nevada (3.68% per year), the Western Breeding Bird Survey Region (2.49% per year) and Nationwide (2.87% per year; Sauer et al. 2017). WS-Nevada conducts its' common raven damage management operations on a local population level, which are often not adequately represented with large scale area trend analysis. Local population levels can be very high in comparison to a regional level, particularly in areas of human disturbance which tend to attract corvid species. For example, common raven counts along the Falcon-Gondor transmission line corridor in NV (construction completed in spring of 2004) have increased by approximately 200 percent (Atamian et al. 2007). In neighboring Idaho, common raven populations have also been evaluated at the local scale. Monitoring conducted on the grounds of the Idaho National Laboratory indicates that local populations have increased eleven-fold over the period of 1985-2009 (Howe et al. 2014). Partners in Flight Science Committee (2013) estimates the common raven population in the U.S. at 1.7 million birds while the global population is estimated at 20 million and estimates Nevada's population at 190,000 birds (Partners in Flight Science Committee 2013).

In most areas, common ravens are a year-round resident, there is no evidence of migration from radio-tagged or marked populations in North America and Iceland (Boarman and Heinrich 1999); however, the species has been known to move into areas just outside its range during non-breeding season. Furthermore, there is some question as to whether some of the birds in flocks of floaters may be migrants (Boarman and Heinrich 1999).

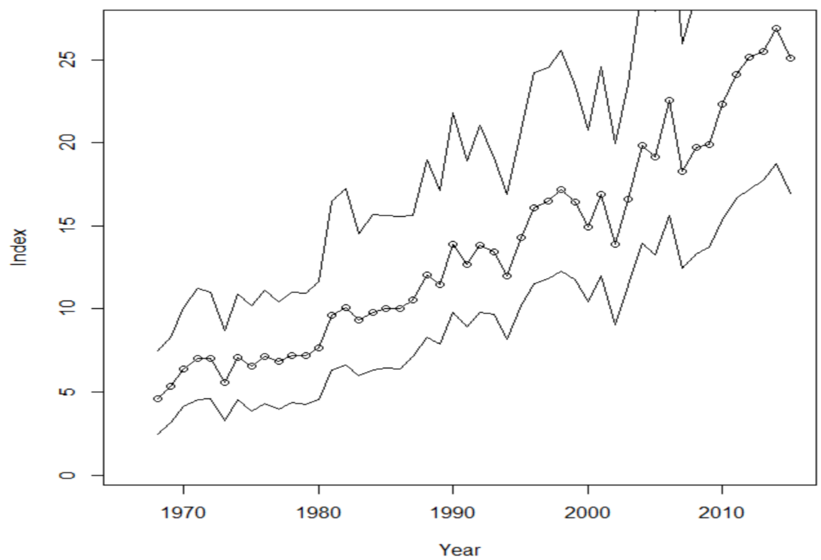


Figure 3.1. Annual Population Indexes and Associated 2.5% and 97.5% Credible Intervals for Common Ravens in Nevada. Indexes Represent the Meancount of Birds on a Typical BBS Route in Nevada for each Year (Sauer et al. 2017).

Common raven nesting numbers are not precisely known over broad areas, and densities in Nevada probably vary throughout the state depending on the availability of food and water and the presence of human disturbance (Boarman and Heinrich 1999). Within Nevada, BBS data and relative abundance maps indicate that densities of common ravens are less in extreme western and southern Nevada (Sauer et al. 2017) as compared to the remainder of the state. Knight and Call (1981) summarized a number of studies on common raven territories and home ranges in the western U.S. Nesting territories ranged in size from one pair/3.62 mi^2 - 15.7 mi^2 in Wyoming and Oregon. In coastal California where an abundant food supply was available, common raven nesting pair density was found to be 1 pair/1.7 mi^2 and 2.0 mi^2 (Linz et al. 1990, 1992). The densities in the Linz et al. (1990, 1992) studies were probably very high as a result of human food "subsidies" and were not representative of all of California. It is likely that Nevada also has sites with similar high nesting densities, although these sites are probably less common than in the more human-populated State of California. Based on nesting pair densities from studies in areas with similar BBS common raven indices as Nevada, the common raven territorial pair density in Nevada could be estimated to be at least 1 pair/3mi^2-6 mi^2 or about 18,500 – 37,000 (median = 27,750) territorial pairs.

Information on common raven age-specific mortality rates and causes of mortality is limited. Data from the Mojave Desert in California indicate 38% fledgling survival, 47% survival in the first year, 81% survival in the second year, 83% survival in the third year and 83% survival for adult birds (Webb et al. 2004). Bedrosian (2005) reports that juvenile common ravens in the Grand Teton National Park had an 82.9% survival rate after departing from their natal territories. Mortality factors for common ravens are not well understood but include predation (including nest predation by other common ravens), weather-related factors, disease and human-induced mortality, such as shooting. Illegal shooting is not likely to be a major contributor to the cumulative mortality because common ravens quickly learn to avoid humans with firearms after witnessing a fellow common raven being shot.

3.5.4.3 *Common Raven Population Impact Analysis*

3.5.4.3.1 WS-Nevada Direct Effects on Common Ravens

In response to requests for assistance with common raven damage, WS-Nevada intentionally removed an average of 3,826.6 common ravens each year between calendar years 2012 and 2016, which includes an average of 2,476.4 common ravens removed each year for protection of greater sage-grouse nests and eggs (Table 3.3). There were no common ravens taken unintentionally during the same time frame. Most of the common ravens were taken in Elko (23.74%), Lincoln (19.78%), White Pine (19.75%) and Humboldt (12.47%) Counties (Table 2.3). Most common ravens are taken on BLM (68.1%) and private lands (27.9%) with the use of DRC-1339 treated eggs (99.3%) (Table 2.1, 2.2 and Appendix E, Table E.1).

Table 3-3. Common Raven take by WS-Nevada for Calendar Years 2012-2016 by Resource (MIS 2019).

Common Raven Take in Nevada for 2012-2016		
RESOURCE PROTECTED	**Max Take per Year**	**Average Take**
Livestock	1,265	961.2
Greater sage-grouse	2,723	2,476.4
Utilities, Landfills, Property	848	389
Total Take	**4,836**	**3,826.6**

WS-Nevada program activities at human-generated food and water sources generally result in a reduction in the number of common ravens present. This reduction is thought to be partially attributable to declines in the local population of common ravens, but is also likely due to the removal of those birds with knowledge of the feeding site. Kristen and Boarman (2003) note that not all human related food and water sources are used by common ravens and that common ravens seem to learn about the location of food and water sources from other common ravens. Birds with knowledge of feeding sites tend to lead other birds to these sites. In a study by Webb (2001), fledgling chicks moved to human-related food sources which already had large flocks of common ravens, even though similar food sources without common raven activity were closer. Removing birds with historical knowledge of the feeding site may reduce the incidence of new birds being attracted to the site.

The majority of WS-Nevada's take of common ravens has been the result of requests for the protection of natural resources, livestock, and power distribution. The majority of common ravens are taken by use of avicide (DRC-1339) treated egg-baits. Treated egg-baits are placed in areas where common ravens depredate on or harass newborn livestock, in areas where ground nesting birds lose eggs or young to common ravens, at sites where damage to agricultural or other resources occurs, and at landfills where common raven foraging and accumulation of common raven feces result in a number of nuisance and health and safety problems. The methodology used by WS-Nevada to place treated egg baits is described in Spencer (2002).

WS-Nevada personnel monitor the common raven numbers at bait sites prior to placing the appropriate number of eggs needed to reduce the local common raven numbers and stop or reduce further damage. At the conclusion of the treatment period, WS-Nevada personnel collect the unconsumed eggs and dispose of them in accordance with label directions. DRC-1339, which causes death primarily due to kidney failure, is relatively slow-acting and birds do not die at the treatment site. This makes it necessary for WS-Nevada personnel to estimate the number of common ravens killed. WS-Nevada personnel monitor the number of common ravens at a site before and after treatment, watch common ravens during treatment, and/or count the number of eggs consumed to estimate the number of common ravens killed.

The number of birds at a site may decrease for reasons not related to the use of DRC-1339 (e.g. a roadkill carcass or spilled food attracts scavenging common ravens), the amount of avicide needed for a lethal dose varies among individual common ravens (each egg contains approximately 1.5 times the amount needed to kill half the birds tested (LD50), and common ravens may consume or cache more than one egg. The number of egg-baits taken per common raven taken varies, ranging from about 1 to 4. The National Wildlife Research Center, using data and input provided by NV and several other western states, conducted computer simulations of baiting efficacy for common raven management using DRC-1339 egg baits. This analysis looked at several scenarios to account for differences in feeding behaviors at the bait site and the resulting dose consumed. The simulations used a bioenergetics model to predict the caloric requirement for corvids for any geographic location in the contiguous United States (Stahl et al. 2008). The development of the model is an effort to provide an alternative to estimate efficacy based on bird feeding behavior at the bait site and the resulting dose consumed. The researchers concluded that "simulations of baiting common ravens with DRC-1339 provide an efficient means of estimating consumption of a lethal dose by a bird" (Stahl et al. 2008). On July 20, 2018 use of this model was mandated for all APHIS-WS employees to calculate their take when using DRC-1339 Concentrate-Bird Control (EPA Reg. No. 56228-63) or Livestock, Nest & Fodder Depredations (EPA Reg. No. 56228-29 and associated 24c Special Local Need labels for the lethal removal of European starlings, common grackles, boat-tailed grackles, great-tailed grackles, brown-headed cowbirds, red-winged blackbirds, yellow-headed blackbirds, or common ravens. WS-Nevada and the National Wildlife Research Center would like to conduct more research on the different variables involved in estimating take using DRC-1339 treated egg baits, such as consumption of treated egg baits by non-target species such as ground squirrels[7]. Research conducted in Nevada using videography indicates that the traditional 1:2 ratio (common ravens to missing eggs) used by managers to estimate common raven take may result in substantial overestimation of common raven numbers, especially if ground squirrels begin consuming egg baits (Coates et al. 2007). This research reinforces WS-Nevada's belief that it may be overestimating common raven take.

In response to requests for assistance with common raven damage, WS-Nevada intentionally removed an average of 3,826.6 common ravens each calendar for 2012 to 2016, which includes an average of 2,476.4 common ravens removed each year for protection of greater sage-grouse nests and eggs (Table 3.3). There were no common ravens taken unintentionally during the same time frame. Most of the common ravens were taken in Elko (23.74%), Lincoln (19.78%), White Pine (19.75%) and Humboldt (12.47%) counties (Table 2.3). Most common ravens are taken on BLM (68.1%) and private lands (27.9%) with the use of DRC-1339 treated eggs (99.3%) (Table 2.1, 2.2 and Appendix E, Table E.1).

3.5.4.3.2 Modeling Efforts

USFWS provided a model (Appendix D) and the following analysis to assess the effects of take on common raven populations. The model uses the Potential Take Limit (PTL) method developed by USFWS – Division of Migratory Birds. The PTL method uses demographic estimates to produce the maximized potential fecundity estimate, and a management goal, to develop a model to estimate different take levels to match management goals (See Appendix). Partners in Flight Science Committee (2013) provides estimates of common raven abundance by state; for this analysis, we are interested modeling effects of take on the number of common ravens in Nevada, which is currently estimated at 190,000. USFWS used a population size of 190,000 common ravens in Nevada, an r_{max} of 0.23 and a management decision of 1 (to maintain a stable population at current level). The results estimate that up to 19,042 common ravens can be removed annually in Nevada, and still maintain a stable population.

3.5.4.3.3 Cumulative Mortality on the Nevada Common Raven Population

The common raven population in Nevada is not isolated, and is likely part of a larger meta-population of common ravens in the western United States. The USFWS

[7] It is unlikely that the ground squirrels that consume the egg baits are affected by DRC-1339 as the LD50 for similar sized small mammals is very high. In fact, the amount needed to kill a fasted female albino rat (1170 mg/kg) is essentially more than would be placed out during an entire project. Conservatively, at the concentration that the DRC-1339 is used for common raven management, a ground squirrel would have to consume 50 treated eggs at one time, which is not physically possible.

authorizes take of common ravens annually throughout the west. In this analysis we consider this proposed take level in Nevada (10,000 birds annually) and its effect on the population when added to the maximum common raven take authorized in the previous 12 years across the 7 states wholly within the Pacific Flyway, excluding Alaska; these are the states of Arizona, California, Idaho, Nevada, Oregon, Utah, and Washington. Table 3.5 provides authorized and actual take for each of these 7 states during the twelve-year period spanning 2006-2017. Using the maximum take authorized for each state during that period, and summing those values for each state, yields a hypothetical upper estimate of the maximum take, 19,361 common ravens, that might be authorized during any single year of the proposed efforts. This is a hypothetical maximum authorized annual common raven take given the permit history within these states from 2006 through 2017; the real maximum take authorized in any given year across that geography occurred in 2014, and was 15,387 common ravens. The estimate of the number of common ravens that were actually taken, is substantially lower than Authorized take each year. The maximum number that were reported taken in any year was 8,007, in 2013 (Table 3.4).

For the purposes of this cumulative effects analysis, we assume the hypothetical maximum take scenario in which 23,361 common ravens are killed per year across these 7 western states (19,361 plus an additional 4,000 to account for potential increases associated with continued growth of the common raven population over time). The estimated size of the common raven population in these states is 1,002,000 (Partner in Flight Science Committee 2013). Thus, the potential annual take of common ravens under this scenario would amount to about 2.33% of the total raven population in these western states (Table 3.4). This percentage is well below the maximum sustainable yield, which is estimated to be 10% for the State of Nevada, and equates to a 'management objective' (Fo) of 1.0 (Appendix D). Further, the populations of common ravens in each of these states has increased significantly over the past 10 years. The estimate of the percent increase per year ranges from 2.06% (in OR) to 6.1% (in Idaho; Partners in Flight Science Committee 2013). These increases have taken place despite the take authorized by the USFWS in these years.

The sum of this authorization with other similar actions across 7 western states suggests that, cumulatively, these authorized common raven mortalities will not affect the long-term viability of common ravens. In contrast, USFWS expects common raven populations to continue to grow coincident with the expanding human population in the west, as it has over the last 50 years.

Table 3-4. Authorized and Actual Common Raven Take in Pacific Flyway States from 2006-2017.

	California		**Nevada**		**Oregon**		**Washington**		**Idaho**		**Arizona**		**Utah**		**Sum**	**Sum**
Year	Auth	Actual	Auth	Actual	Auth	Actual	Auth	Actual	Auth	Actual	Auth	Actual	Auth	Actual	Auth	Actual
2006	1465	877	2620	2384	900	246	281	3	170	114	370	82	17	0	5823	3706
2007	1793	1066	2820	523	900	133	268	2	170	78	370	72	15	0	6336	1874
2008	1897	1007	2170	2201	1195	513	250	1	170	109	510	92	50	1	6242	3924
2009	1906	839	2140	1797	890	360	256	10	170	42	380	90	1400	532	7142	3670
2010	549	492	1810	150	915	265	250	25	25	3	100	88	45	13	3694	1036
2011	2627	1258	4086	3062	2764	281	1199	118	845	103	278	48	2105	1515	13904	6385
2012	1966	755	3810	3287	190	801	250	69	275	193	514	163	2501	2169	9406	7437
2013	3316	724	4540	4209	995	678	232	165	25	9	666	152	2573	2070	12347	8007
2014	4057	967	4383	4184	540	330	474	266	1974	97	455	111	3504	1911	15387	7866
2015	2941	610	4450	3583	415	220	219	47	1775	650	425	169	313	83	10538	5362
2016	2515	852	5150	4189	515	628	1019	106	25	230	199	157	2631	979	12054	7141
2017	1484	511	5197	2148	1,138	353	565	257	575	52	195	173	386	47	9540	3541
Average	2210	830	3598	2643	946	401	439	89	517	140	372	116	1295	777		
Max	**4057**	1258	**5197**	4209	**2764**	801	**1199**	266	**1974**	650	**666**	173	**3504**	2169	15247	7551

Sum of max Authorized (in bold) = **19,361**

1 -- Data from the Service's *Service Permit Issuance and Tracking System* database; includes take of adult common ravens under scientific collecting and depredation permits.

3.5.4.4 *Conclusion: Common Raven*

Given the increasing population trend for common ravens in Nevada and the other 6 states completely within the Pacific Flyway (excludes Alaska) and a maximum sustainable take level well above the authorized or actual take of the species, WS-Nevada has not adversely impacted the size or sustainability of the common raven population while acting under USFWS MBTA permits.

Therefore, WS-Nevada concludes that the cumulative impact of all permitted common raven take in Nevada, including WS-Nevada's proposed maximum from all sources including WS-Nevada, is not adversely impacting the size or sustainability of the Nevada common raven population (Table 3.4). This conclusion is consistent with BBS trend information (Sauer et. al 2017) and aligns with the PTL F_0=1 which has the inherent goal of maintaining a stable population size (Appendix D).

The current/past permitted WS-Nevada take has satisfied the requested need for resource protection, and therefor permitted take of 10,000 common ravens would provide a buffer for annual fluctuations. However, it is possible that WS-Nevada could be requested by resource managers such as the USFWS or the State of Nevada to increase lethal take of common ravens to respond to an increased need for greater sage-grouse and/or the California-Nevada Bi-state population of greater sage-grouse protection. If USFWS was requested to permit an increase in common raven take for greater sage-grouse protection, USFWS concluded that up to 19,042 common ravens (or 10%) could be removed annually from the common raven population in Nevada while still preserving a stable population (Appendix D). Therefore, WS-Nevada has determined that there will be no adverse impacts on common raven populations from the proposed levels of common raven take.

3.5.5 *What are the Direct and Cumulative Impacts on Black Bear Populations?*

3.5.5.1 *Black Bear Life History Information*

Black bears are distributed throughout much of the U.S., Canada, and Mexico. Black bear populations are stable or increasing across most of their range, with an estimated 750,000 to 918,000 black bears in North America (Hristienko and McDonald 2007, Herrero et al. 2011). Black bear generally prefer forested areas and, in Nevada, occupying the extreme western portion of their historic range (NDOW 2004a). In Nevada, relative densities of bears are highest along the extreme western boundary of Nevada (NDOW 2004a).

Black bears are usually sexually mature at 3.5 years of age, but some females may not breed until 4.5 years (Graber 1981, Kohn 1982). Bears in Nevada are reproductively active at age 4-6 years for males and 4-5 years for females (Lindzey and Meslow 1980, Trainer and Golly 1992, NDOW 2004a). Mating occurs in June and July, egg implantation is delayed until late November to early December, and gestation is generally 60 to 70 days (Foresman and Daniel 1983, Tsubota et al. 1987, Eiler et al. 1989, Hellgren et al. 1990). Litter size ranges from one to four; in comparison to black bears in the eastern U.S., black bears in the western U.S. generally have a smaller litters and a later mean first age to reproduction (Kasworm and Thier 1994). Lactating females usually do not breed, which explains alternate year pregnancies (LeCount 1983, Hellgren et al. 1990). Cubs stay with the females 16 to 18 months after birth, typically leaving in late spring prior to the breeding season.

Black bears are relatively long-lived, occasionally reaching 20 years of age or more in the wild (Keay 1995). In Nevada, black bears rarely exceed 20 years of age, with one bear estimated at 23 years old based on mortality data (NDOW P.Jackson NDOW Bear Log 2017). NDOW has kept meticulous black bear data since 1997 as the Nevada black bear population began noticeable increase, from that data NDOW conducted a review of their population assessment, methodology and analysis in 2011 (which includes a description of the population model by Dr. James Sedinger (University of Nevada, Reno) (NDOW Black Bear 2011). From that review of 481 bears: 187 were female, 284 were male; and the average age for females was 8.0 years, 6.5 years for males. As with most species, survival estimates vary by sex, age, in space and time, and to some degree by estimation method. Juvenile black bear annual mortality ranges between 20% and 70%, with orphaned cubs having the highest mortality (Kolenosky and Strathearn 1987). Natural mortality in adult black bears is approximately 10% to 20% per year (Fraser et al. 1982), but can be as high as 42% (LeCount 1987, Elowe and Dodge 1989).

There are few natural predators of adult black bears, but young bears may be killed by mountain lions, bobcats, and coyotes, or by other adult black bears (Larivière 2001). The primary sources of mortality for adult black bears in Nevada since black bear sport hunting began in 2011 include sport hunting (14.2%), vehicle collision (12.8), public safety+3 strike nuisance offenders (5.6%), accidental (2.8%), miscellaneous (2.4%), unknown (1.6%), depredation (1.4%), and illegal (0.4%) (Pat Jackson personal comm. 09/06/2017 and 04/11/2018).

Black bears are omnivores and eat a wide variety of plants and animals, including insects. Diets of black bears change seasonally and are based on food availability (Kolenosky and Strathearn 1987). Depending on availability, foods such as berries, acorns, skunk cabbage, and other herbaceous plants are very important for bears to store fat prior to hibernation. When available, bears will catch and consume deer fawns and elk calves, and feed on carrion (Bull and Heater 2001, Larivière 2001). Invertebrates also provide a consistent source of protein for bears throughout the year (Bull and Heater 2001). In areas near human dwellings, bears may be attracted to garbage, bird feeders, gardens, orchards, livestock and livestock feeds, and beehives as food sources. Some bears will also feed on the cambium of trees.

3.5.5.2 *Black Bear Population Information*

Black bear are protected as a big game animal in Nevada (NRS 501.046 and NAC 503.020) with regulated hunting seasons. Under NRS 501.376 exemption, the killing of black bear is legal if killing the animal is necessary to protect the life or property of any person in imminent danger of being attacked by the animal (Section 2.4.4.1). As listed in Sections 1.7 and 2.4.4.1, a landowner or landowner's agent is allowed to use lethal control to address damage issues related to black bears after obtaining a permit from the department under NRS 503.595. Such takes must be reported to NDOW with carcass/ head/hide (as applicable) surrendered to NDOW (2.4.4.1).

Based on current harvest levels, NDOW harvest data suggest that black bear populations in Nevada are stable (Table 3.6). NDOW uses several methods to monitor black bear populations in Nevada, including sex-age characteristics of harvested bears, ear tag, lip tattoo, Passive Integrated Transponder (microchips) and radio collar mark-recapture approaches, and data from bear damage management activities. NDOW manages black bears with a fall hunting season. As listed above, black bears may also be removed without a permit if in imminent danger of being attacked (Section 2.4.4.1) or with a permit to address damage issues (Section 2.4.4.1).

In 1979, then Director of the Nevada Department of Fish and Game reported at the First Western Black Bear Workshop, that other than for occasional strays from the Sierra's adjacent to Lake Tahoe in California, Nevada had no bear (Lackey 2012). In 2002, the Nevada black bear population was estimated at 150-300 (Beckmann 2002), which was reported to not have changed significantly since J. M. Goodrich 1990 estimate (NDOW 2004a). NDOW estimated the population to be 262±31 in 2008, 456±39 in 2011, 445±14 in 2014 and 600+ in 2015 (NDOW 2015 BGSR). Currently, NDOW estimates there are approximately 550 black bears in the state (NDOW 2017b).

The allowable harvest level for black bears has been estimated at 20% of the population (CDFG 2001). Mace and Chilton-Radandt (2011) reported that black bears in Montana returned to a sustainable population at a mortality rate of approximately 16% when they estimated the reproductive rate of 0.945 and a mean age of first reproduction of 6 years. However, as discussed below (Section 3.5.5.3.2), harvest in Nevada does not generally exceed 12% of the estimated black bear population in the state. According to NDOW (2012a), NDOW manages its black bear population for a long term sustainable yield by gauging its harvest impact and making quota recommendations based on the previous 3 year harvest average (which includes legal and illegal female black bear mortality). Restrictions in hunting opportunities would be imposed when 2 or more of the following occur: more than 40% of the harvested bears are females; less than 45% of the harvested bears are adult females; and/or the mean age of the male harvested black bears is less than 2 years (NDOW 2012a).

3.5.5.3 *Black Bear Population Impact Analysis*

3.5.5.3.1 WS-Nevada Direct Effects on Black Bear

In response to requests for assistance with black bear damage, WS-Nevada removed an average of 1.4 bears each year (including unintentional take) (Table 3.6). Most bears are taken on private land (85.7%; Table 2.2), and mostly with neck snares (42.9%), foot/leg snares (28.6%) and firearms (28.6%) (Table 2.1, Appendix E, Table E.1). The year with the highest WS-Nevada take during this timeframe was FY 2012, with 3 black bears taken.

Based on the number of cooperative service agreements, county, state and federal budgetary constraints, and projected future requests for assistance, WS-Nevada expects that future black bear removals for PDM in Nevada would be similar to take during the last 5 years. However, WS-Nevada must be able to respond to requests for assistance to meet the need for action. While WS-Nevada expects for the need for PDM to stay close to the past, the analysis includes the take of more individuals to accommodate unforeseen needs. Therefore, under Alternative 1 (current program with fluctuations in program delivery) and alternative 2 (modified current program with fluctuations in program delivery), the projected WS-Nevada annual maximum take would be increased to 10 black bears.

3.5.5.3.2 Cumulative Mortality

Various sources of black bear removals contribute to the cumulative take of bears in Nevada (Table 3.6). Recreationalists removed an average of 13.6 black bears per year (or about 2.5% of the total estimated population). An average of 0.2 black bears were taken per year during FY 2012 through 2016 for damage to livestock, agriculture, and property by sources other than WS-Nevada. Additionally, NDOW removed an average of 4 bears per year for health and human safety concerns. Other known types of mortality reported to NDOW include roadkill (averaging 15.25/year), miscellaneous, unknown and illegal kills, and average 20 bears per year (Table 3.5).

Non-WS-Nevada take is approximately 6.95% of the total estimated black bear population in Nevada. Average annual cumulative take of black bears from all known sources is 39.6 bears per year, representing a close estimate of total take given bear take reporting requirements. The largest cumulative take was 53 bears per year, approximately 9.64% of the population, with WS-Nevada contributing 2.73% of the cumulative amount, relative to the annual maximum sustainable harvest of 20% (Table 3.5, Table 3.17). If WS-Nevada were to take the annual maximum take of 10 black bears, the projected cumulative take would be approximately 10.91% of the population, with WS-Nevada contributing 1.82% to the cumulative amount and 11.82% relative to the annual maximum sustainable harvest of 20% (Table 3.5, Table 3.17).

Table 3-5. Population Impact Analysis of Black Bear Take in Nevada, FY 2012-2016.

Mortality source	2012	2013	2014	2015	2016	5-year average	5-year high
WS intentional take[1]	2	2	1	0	1	1.2	2
WS unintentional take[1]	1	0	0	0	0	.2	1
Other damage take[2]	0	0	1	0	0	.2	1
Hunting harvest[3]	11	14	18	14	11	13.6	18
Human health & safety take[4]	5	5	1	9	2	4	9
Other sources of take[5]	13	21	29	27	10	20	29
Total WS take	3	2	1	0	1	1.4	3
Total non-WS take	29	40	49	50	23	38.2	50
Cumulative take	32	42	50	50	24	39.6	53
Statewide population estimate[6]:							550 black bears
Annual maximum sustainable harvest[6]:							20% (110 black bears)
Current total WS take as a % of the population[7]:							.55% (3 black bears)
Current cumulative take as a % of the population[8]:							9.64% (53 black bears)
Projected WS annual maximum take[9]:							10 black bears
Projected total WS take as a % of the population[10]:							1.82% (10 black bears)
Projected annual cumulative take as a % of the population[11]:							10.91% (60 bears)

[1] (MIS 2018).

[2] Represents the number of animals taken by landowners, NDOW, or others as a result of damage (P. Jackson, NDOW, 09/06/2017; NDOW 2017b,).

[3] Represents the number of animals taken during hunter harvest seasons (NDOW 2017b).

[4] Represents the number of animals taken as a result of threats to humans or pets (NDOW 2017b).

[5] Includes roadkill, accidental, found dead, and illegal sources of take (NDOW 2017b).

[6] See Section 3.5.4.2 Black Bear Population Information. All estimates are rounded up.

[7] The proportion of the estimated species population taken by WS-Nevada in the year with the highest WS-Nevada take between FY 2012- FY 2016.

[8] The proportion of the estimated species population taken by all sources in the year with the highest take between FY 2012- FY 2016.

[9] Represents the maximum WS-Nevada could annually take under the current program (Alternative 1) and alternative 2 (modified current program with fluctuations in program delivery)) given the potential for fluctuations in program delivery (Appendix E).

[10] Provides a conservative estimate of the highest proportion of the estimated species population that could be taken by WS-Nevada, under projected WS-Nevada annual maximum take scenario.

[11] Provides a conservative estimate of the highest proportion of the estimated species population that could be taken by all sources, under projected WS-Nevada annual maximum take scenario.

3.5.5.4 *Conclusion: Black Bear*

Based on the stable population trend for black bears in the state and an annual maximum sustainable harvest level of 20%, and after considering cumulative impacts on the black bear population from all causes, WS-Nevada has concluded that the proposed action (removal of up to 10 black bears per year by WS-Nevada) will not adversely impact the size or sustainability of the Nevada black bear population. This conclusion is consistent with NDOW black bear population trend information provided in NDOW Big Game Status Reports (dating back to 2010 prior to NDOW's inaugural black bear) and NDOW management goals.

The proposed take represents an increase over the current average take by WS-Nevada (1.4 bears per year). While WS-Nevada expects the current take level to continue, an increase in requests for assistance with black bear damage may result in take levels approaching the projected annual WS-Nevada maximum take, and cumulative impacts on the statewide black bear population would still be expected to remain low, based on the analysis presented above.

3.5.6 *What are the Direct and Cumulative Impacts on Striped Skunk Populations?*

3.5.6.1 *Striped Skunk Life History Information*

The striped skunk is the most common member of the Mephitidae family, with distributions throughout southern Canada, United States and northern Mexico. They are generally considered abundant throughout their range and have increased their geographical range in North America with extensive clearing of forests. They are not associated with any well-defined habitat type (Rosatte 1987), but are capable of living in a variety of environments including woodland, plains and streamside thickets, rock piles, old buildings, agricultural lands and urban areas.

The diet of striped skunks includes insects, earthworms, beehives, birds, eggs, small mammals, and carrion (Wade-Smith and Verts 1982, Vickery et al. 1992, Lavière and Messer 1997a). Striped skunks often are nocturnal (Larivière and Messier 1997b).

The seasonal availability of prey species can cause seasonal changes in habitat preference for the striped skunk (Crabtree and Wolfe 1988, Crabtree et al. 1989).

The home range of striped skunks is not sharply defined over space and time, but is altered based on seasonal requirements, such as raising young, winter denning, feeding activities, and dispersal (Rosatte 1987). Home ranges reported in the literature averaged 0.85 to 1.9/mi^2 for striped skunks in rural areas (Houseknecht 1971, Storm 1972, Bjorge et al. 1981, Rosaette and Gunson 1984, Bixler and Gittleman 2000).

Striped skunks breed from late January through March (Verts 1967) and produce one litter of 2-10 young between April and June (Maser et al. 1981). Both males and females are sexually mature at 10 months (Wade-Smith and Verts 1982). Winter severity, lack of winter denning sites, disease, and human-caused mortality greatly impact striped skunk populations (Larivière and Messier 1998, Hansen et al. 2004, Gehrt 2005). Skunks primarily cause odor problems around homes, can transmit diseases, such as rabies and leptospirosis (Hass and Dragoo 2006), to humans and domestic animals, and sometimes prey on poultry and eggs.

3.5.6.2 *Striped Skunk Population Information*

Striped skunks are classified as an unprotected mammal in Nevada and as such can be hunted at any time without a hunting license (NAC 503.193), however to take a striped skunk with a trapping device, a trapping license is required (NRS 503.454) unless taken under a state issued depredation permit (NAC 503.193), in which case the take must be reported to NDOW yearly.

Striped skunk densities can be highly variable depending on habitat quality, with densities reported in the literature range from 0.26 to 67/mi^2 (Ferris and Andrews 1967, Verts 1967, Lynch 1972, Bjorge et al. 1981, Broadfoot et al. 2001, Hansen et al. 2004). Additionally, California Department of Fish and Game (1995) calculated striped skunk densities to be between 1.3 and 5.70/mi^2. Many factors may contribute to the widely differing population densities, including type of habitat, food availability, disease, season of the year and geographic area (Storm and Tzilkowski 1982). Specific population density estimates for striped skunks in Nevada are not available because, although managed by NDOW, their population is not sampled. For purposes of this analysis, we will conservatively estimate striped skunk densities at 0.26/mi^2 throughout Nevada, for an estimated population of about 28,747 animals. The annual maximum sustainable harvest for striped skunk is estimated at 60% of the population (Table 3.7; Boddicker 1980) or about 17,248 skunks in Nevada.

3.5.6.3 *Striped Skunk Population Impact Analysis*

3.5.6.3.1 WS-Nevada Direct Effects on Striped Skunks

Striped skunks have the fourth highest lethal take by WS-Nevada during IPDM activities (Tables 3.2 through 3.17). In response to requests for assistance with striped skunk damage, WS-Nevada intentionally removed an average of

15.6 animals per year from FY 2012- FY 2016 (Table 3.6). WS-Nevada did not unintentionally remove striped skunks during the analysis period.

WS-Nevada takes striped skunks primarily in Washoe County. Most striped skunks are taken on private land (70.5%) and city or county land (15.4%; Table 2.2). They are primarily caught using traps, snares, and sodium pentobarbital (Table 2.1, Appendix E, Table E.1).

Based on the number of cooperative service agreements, county, state and federal budgetary constraints, and projected future requests for assistance, WS-Nevada expects that future striped skunk removals for PDM in Nevada would be similar to take during the last 5 years. However, WS-Nevada must be able to respond to requests for assistance to meet the need for action. While WS-Nevada expects for the need for PDM to stay close to the past, the analysis includes the take of more individuals to accommodate unforeseen needs. Therefore, under Alternative 1 (current program with fluctuations in program delivery) and alternative 2 (modified current program with fluctuations in program delivery), the projected WS-Nevada annual maximum take would be 90 striped skunks.

3.5.6.3.2 Cumulative Mortality

Various sources of striped skunk removals contribute to the cumulative take of striped skunks in Nevada (Table 3.6), including recreational harvest, WCO's, landowners and Wildlife Services-Nevada. During 2012 through 2016, the annual number of striped skunks taken by NDOW-licensed WCOs and landowners is not available (P.Jackson Personal comm., 3/29/2018). However, an average of 114.8 were reported taken as recreational harvest.

The average annual cumulative take of striped skunk is 130.4 per year. The largest cumulative take was 183 striped skunks per year, approximately 0.64% of the total estimated population, with WS-Nevada contributing 0.14% of the cumulative amount, relative to the annual maximum sustainable harvest of 60% (Table 3.6). If WS-Nevada were to take the proposed annual maximum take of 90 striped skunks, the projected cumulative take would be approximately 0.87% of the population, with WS-Nevada contributing 0.31% to the cumulative amount.

3.5.6.4 *Conclusion: Striped Skunk*

Given the low level of of take for striped skunk in Nevada (less than 1% of the estimated population), and an annual maximum sustainable harvest level of 60%, cumulative impacts on the striped skunk population from all causes, including take by WS-Nevada, are not adversely impacting the population.

Therefore, WS-Nevada concludes that the proposed action (removing up to 90 per year), cumulative impacts of all reported striped skunk mortality in Nevada, including intentional and unintentional take by WS-Nevada, would not adversely impact the size or sustainability of the Nevada striped skunk population. This conclusion is supported by NDOW (R. Woolstenhulme, NDOW, pers. comm., 06/13/2018).

Should an increase in requests for assistance with striped skunk damage result in the projected annual WS-Nevada maximum take, cumulative impacts on the statewide striped skunk population would still be expected to remain low relative to the annual maximum sustainable harvest level. Given the low proportion of cumulative take, and even lower WS-Nevada take, direct and cumulative impacts from take would not adversely impact the size or sustainability of the Nevada striped skunk population.

Table 3-6. Population Impact Analysis of Striped Skunk Take in Nevada, FY 2012-2016.

Mortality source	2012	2013	2014	2015	2016	5-Year average	5-Year high
WS intentional take[1]	25	12	21	15	5	15.6	25
WS unintentional take[1]	0	0	0	0	0	0	0
WCO take[2]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Other damage take[3]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hunting harvest[4]	158	161	118	112	25	114.8	161
Total WS take	25	12	21	15	5	15.6	25
Total non-WS take	158	161	118	112	25	114.8	161
Cumulative take	183	173	139	127	30	130.4	183
Statewide population estimate[5]:	28,747 striped skunks						
Annual maximum sustainable harvest[5]:	60% (17,248 striped skunks)						
Current total WS take as a % of the population[6]:	.09% (25 striped skunks)						
Current cumulative take as a % of the population[7]:	.64% (183 striped skunks)						
Projected WS annual maximum take[8]:	90 striped skunks						
Projected total WS take as a % of the population[9]:	.31% (90 striped skunks)						
Projected annual cumulative take as a % of the population[10]:	.87% (251 striped skunks)						

[1] (MIS 2018).

[2] Data are not available (P.Jackson Pers comm., 3/29/2018). Wildlife Control Operator (WCO) licenses are issued by NDOW (NAC 503.095).

[3] Represents the number of animals taken by landowners, NDOW, or others as a result of damage. This take is included in Recreation take and fewer than 10 in all years (R. Woolstenhulme Pers. comm., 03/26/2018).

[4] Represents the number of animals taken during hunting and trapping harvest seasons, data derived from post season furbearer harvest questionnaire (avg. return rate of 75%); sources beyond fur harvest are fewer than 10 for any year (R. Woolstenhulme, NDOW, Pers. comm., 04/13/2018).

[5] See Section 3.5.5.2 Striped Skunk Population Information. All estimates are rounded up.

[6] The proportion of the estimated species population taken by WS-Nevada in the year with the highest WS-Nevada take between FY 2012- FY 2016.

[7] The proportion of the estimated species population taken by all sources in the year with the highest take between FY 2012- FY 2016.

[8] Represents the maximum WS-Nevada could annually take under the current program (Alternative 1) and alternative 2 (modified current program with fluctuations in program delivery) given the potential for fluctuations in program delivery (Appendix E).

[9] Provides a conservative estimate of the highest proportion of the estimated species population that could be taken by WS-Nevada, under projected WS annual maximum take scenario.

[10] Provides a conservative estimate of the highest proportion of the estimated species population that could be taken by all sources, under projected WS annual maximum take scenario.

3.5.7 *What are the Direct and Cumulative Impacts on Raccoon Populations?*

3.5.7.1 *Raccoon Life History Information*

Raccoons are highly adaptable and abundant throughout North America. They are typically associated with forested habitats, but are especially common in urban areas with the high diversity of habitats and abundant human food sources.

Raccoons are mostly nocturnal, but may be seen in the daytime, especially in the spring or fall. They frequently inhabit abandoned buildings, culverts, spaces under houses, and attics. Raccoons are omnivorous, and feed 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, including pet food (Sanderson 1987).

Raccoon population densities vary considerably, depending on food availability and habitat suitability, and populations can vary widely between seasons and years due to disease, harvest, and natural mortality (Gehrt 2003). Generally, 60% of females breed their first year, while 90% breed after their first year. Females have one litter per year in late March through May, with three to four young per litter. The young may stay with the females for the first year.

Raccoon damage problems involve predation on domestic fowl, damage to livestock feed, and human health and safety concerns, especially in and near residences.

3.5.7.2 *Raccoon Population Information*

Raccoons are classified as a furbearing mammal by NDOW and as such can be hunted at any time without a hunting license (NAC 503.193), however to take a raccoon with a trapping device, a trapping license is required (NRS 503.454) unless taken under a state issued depredation permit (NAC 503.193), in which case the take must be reported to NDOW yearly

Raccoons generally do well in human-altered areas due to human food subsidies, and the highest reports of raccoon densities usually occur in urban/suburban areas. Typical rural densities run from 1 to 70 raccoons per square mile (Gehrt 2003). Beasley and Rhodes (2012) found raccoon densities of 3.37 to 117.07/mi^2 in northcentral Indiana forest patches. Urban densities in northeastern Illinois can range from 64.8 to 225.3/mi^2, with an average of 121.7/mi^2 (Prange et al. 2003, Gehrt 2004).

NDOW has not estimated raccoon population levels in Nevada. In order to estimate raccoon population densities in Nevada for this EA, the lowest density from the literature of one raccoon/mi^2 is used. Using this density, the conservative population estimate of 110,567 raccoons occur in Nevada. The annual allowable harvest level for raccoons has been estimated to range from 49% to 59% for the long-term maintenance of the species (Sanderson 1987) (Table 3.8), or approximately 54,178 raccoons a year at the more conservative 49% level.

3.5.7.3 *Raccoon Population Impact Analysis*

3.5.7.3.1 WS-Nevada Direct Effects on Raccoons

Raccoons represent the 6th highest lethal take of a predator species by WS-Nevada. In response to requests for assistance with raccoon damage, WS-Nevada intentionally removed an average of 11.4 raccoons per year from 2012 through 2016 (Table 3.7), primarily from Washoe County (Table 2.3). WS-Nevada unintentionally removed an average of 0.2 raccoons per year during the same analysis period. Most raccoons are taken on private lands (93.1%; Table 2.2). Raccoons are primarily taken with foothold traps, cage traps, and neck snares (Table 2.1, Appendix E, Table E.1).

Based on the number of cooperative service agreements, county, state and federal budgetary constraints, and projected future requests for assistance, WS-Nevada expects that future raccoon removals for PDM in Nevada would be similar to take during the last 5 years. However, WS-Nevada must be able to respond to requests for assistance to meet the need for action. While WS-Nevada expects for the need for PDM to stay close to the past, the analysis includes the take of more individuals to accommodate unforeseen needs. Therefore, under Alternative 1 (current program with fluctuations in program delivery) and Alternative 2 (modified current program with fluctuations in program delivery), the projected WS-Nevada annual maximum take would be 80 raccoons.

3.5.7.3.2 Cumulative Mortality on Raccoons

Various sources of raccoon removals contribute to the cumulative take of raccoons in Nevada (Table 3.7). During 2012 through 2016, the annual number of raccoons taken by NDOW-licensed WCOs and landowners is not available (P.Jackson Personal comm., 3/29/2018, and an average of 140.6 were reported taken as recreational harvest, for a total annual average of 140.6 raccoons).

The average annual cumulative take of raccoon is 152.2 per year. The largest cumulative take was 222 raccoons per year, approximately 0.2% of the total estimated population, with WS-Nevada contributing 0.02% of the cumulative amount, relative to the annual maximum sustainable harvest of 49% (Table 3.7). If WS-Nevada were to take the annual maximum take of 80 raccoons, the projected cumulative take would be approximately 0.26% of the population, with WS-Nevada contributing 0.07% to the cumulative amount.

3.5.7.4 *Conclusion: Raccoon*

Given the low level of raccoon take in Nevada (less than 0.5% of the estimated population of 110,567), and an annual maximum sustainable harvest level of 49%, cumulative impacts on the raccoon population from all causes, including take by WS-Nevada, are not adversely impacting the population. Therefore, WS-Nevada concludes that the proposed action (take of up to 80 per year) along with the cumulative impacts of all anticipated raccoon mortality in Nevada, will not adversely impact the size or sustainability of the Nevada raccoon population. This conclusion is supported by NDOW (R. Woolstenhulme, pers. comm., 12/20/2016). WS-Nevada anticipates that the level of raccoon take will remain similar to past years (average of 11.6 per year). However, should an increase in requests for assistance result in the projected annual WS-Nevada maximum take, direct and cumulative impacts from take would not adversely impact the size or sustainability of the Nevada raccoon population.

Table 3-7. Population Impact Analysis of Raccoon Take in Nevada, FY 2012-2016.

Mortality source	2012	2013	2014	2015	2016	5-year average	5-year high
WS intentional take[1]	10	16	13	11	7	11.4	16
WS unintentional take[1]	0	0	0	0	1	.2	1
WCO take[2]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Other damage take[3]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hunting harvest[4]	124	212	204	84	79	140.6	204
Total WS take	10	16	13	11	8	11.6	17
Total non-WS take	124	212	204	84	79	140.6	204
Cumulative take	134	238	217	95	87	152.2	221
Statewide population estimate[5]:							110,567 raccoons
Annual maximum sustainable harvest[5]:							49% (54,178 raccoons)
Current total WS take as a % of the population[6]:							.02% (17 raccoons)
Current cumulative take as a % of the population[7]:							.20% (221 raccoons)
Projected WS annual maximum take[8]:							80 raccoons
Projected total WS take as a % of the population[9]:							0.07% (80 raccoons)
Projected annual cumulative take as a % of the population[10]:							.26% (284 raccoons)

[1] (MIS 2018).

[2] Data are not available (P. Jackson Pers comm. 03/29/2018). Wildlife Control Operator (WCO) licenses are issued by NDOW (NAC 503.095).

[3] Represents the number of animals taken by landowners, NDOW, or others as a result of damage. This take is included in Recreation take and fewer than 10 in all years (R. Woolstenhulme Pers. comm., 03/26/2018).

[4] Represents the number of animals taken during hunting and trapping harvest seasons (R. Woolstenhulme Pers. comm., 03/26/2018).

[5] See Section 3.5.6.2 Raccoon Population Information. All estimates are rounded up.

[6] The proportion of the estimated species population taken by WS-Nevada in the year with the highest WS-Nevada take between FY 2012- FY 2016.

[7] The proportion of the estimated species population taken by all sources in the year with the highest take between FY 2012- FY 2016.

[8] Represents the maximum WS-Nevada could annually take under the current program (Alternative 1) and alternative 2 (modified current program with fluctuations in program delivery) given the potential for fluctuations in program delivery (Appendix E).

[9] Provides a conservative estimate of the highest proportion of the estimated species population that could be taken by WS-Nevada, under projected WS annual maximum take scenario.

[10] Provides a conservative estimate of the highest proportion of the estimated species population that could be taken by all sources, under projected WS annual maximum take scenario.

3.5.8 *What are the Direct and Cumulative Impacts on Mountain Lion Populations?*

3.5.8.1 *Mountain Lion Life History Information*

The range of mountain lions, the largest North American feline, covers an extensive distribution across western North America, including throughout Nevada. However, densities vary across landscapes likely reflecting local distribution of their primary prey (deer and elk), but may also be affected by territorial behaviors. Mountain lions inhabit many habitat types from desert to alpine environments, indicating a wide range of adaptability. In Nevada, mountain lions prey upons species that range in size from woodrats (*Neotoma* spp.) to Elk. The primary mountain lion prey items are mule deer where abundant, bighorn sheep are an important prey species where deer are absent or few. Other prey species include feral horses (*Equus ferus*), beaver (*Castor canadensis*), desert cottontail (*Sylvilagus audubonii*), jackrabbit (*Lepus* spp.), domestic livestock, other carnivores, blue grouse (*Dendragapus obscurus*) and domestic livestock (NDOW 1995).

Mountain lion density is related closely to prey availability and competitive social interactions for other mountain lion. Prey availability is directly related to prey habitat quality, which in turn directly influences mountain lion nutritional health and reproductive and mortality rates. Studies indicate that as available prey increases locally, so do mountain lion densities. As mountain lion population density increases, mortality rates from intra-specific fighting and cannibalism also increase, and/or mountain lions disperse into unoccupied or less densely occupied habitat, if available. These relationships of mountain lion to its prey and to other mountain lions are why densities do not reach levels observed in a number of other wildlife species (ODFW 2006). While densities in Nevada have been variable over time, distribution of mountain lions has been constant (Lansford and Woolstenhulme, 2008). It is also why mountain lions may disperse into atypical mountain lion habitat and cause conflicts there (Bodenchuk and Hayes 2007). 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, in this case deer. Therefore, this allows an artificially high density to be reached in areas where mountain lion territories overlap with livestock production areas.

Variability in home range size between and within sexes is likely a function of social and reproductive status, habitat quantity and quality, and mountain lion population density. Arrangement of home ranges in relation to each other is governed by the mountain lion's mating system, energy requirements, and habitat quality. For females, home range size appears to be based on prey availability for raising young. Male home ranges may be driven primarily by social status and the presence and status of neighboring males (Logan and Sweanor 2000).

Female mountain lions typically breed for the first time between 22 and 29 months of age, but initial breeding may be delayed, especially if the female has not established a territory (ODFW 2006). Mountain lions may breed and give birth year round but most births occur during late spring and summer following a 90-day gestation. One to 6 offspring per litter is possible, with an average of 2 to 3 young per litter. Based on 435 female mountain lions examined by ODFW from 1995 through 2003, a few female mountain lions may breed their first year, increasing to half the 2 year olds age group breeding, and almost all older females (ODFW 2006).

Most males recruited into a population are immigrants, and immigration may constitute as much as 50% of the recruitment into a population (Logan and Sweanor 2000). Not all males that established an independent territory after dispersal were adjacent to the natal home range, while 78% of the females that established independent territories after dispersal were adjacent to or overlapped natal home ranges.

3.5.8.2 *Mountain Lion Population Information*

Mountain lions inhabit many habitat types and are closely associated with deer, wild sheep and elk as primary prey. Mountain lions are distributed throughout Nevada and mountain lion harvest is reported from counties across the state.

Mountain lions are managed by NDOW as a big game animal. The Nevada Mountain Lion Species Management Plan (NDOW 1995) sets guidelines for mountain lion management and provides strategies for resolution of human conflicts with mountain lions (Section 1.11.4.6).

Changes in legal take methods and statutory classifications of mountain lions have influenced mountain lion populations in Nevada. In 1965, mountain lion's legal classification changed from unprotected (predator) to game animal, requiring a hunting license and restriction in take method. Legal take was restricted to sunrise to sunset with use of shotgun, rifle, bow and arrow. Hunting season was year-round and either sex with no limit set or tag required. In 1968, a tag requirement was instituted, allowing for recording of sport hunter harvest. In 1970, a tag limit of one mountain lion per person was established, along with a 6 month long season and requirement of harvest validation by NDOW (allowing for collection of biological data), resulting in the harvest of 76 mountain lions in 1971. In 1976, 26 mountain lion management areas were described with harvest quotas for each (Controlled

Quota Hunt), resulting in the harvest of 21 mountain lions in 1976 and 26 in 1977. In 1978, the Controlled Quota Hunt was changed to a 6 management area system with a predetermined harvest objective for each area, wherein one permit per person could be issued for one management area, resulting in the harvest of 47 mountain lions in 1978 and 38 in 1979. In 1994, this system was further modified to allow a hunter to hunt in two management areas until the harvest objective was reached in the desired management area(s), resulting in the harvest of 134 mountain lions in 1994 and 143 in 1995 (NDOW 1995 and 2004). In 2001, the Wildlife Commission adopted a year-long season, resulting in the harvest of 167 mountain lions in 2001 and 128 in 2002. In 2003, hunt areas boundaries and quotas were based upon NDOW regional boundaries vice unit boundaries, resulting in the harvest of 192 mountain lions in 2003 (NDOW 2005). The mountain lion population in Nevada was at near-record highs in the late 1980's following unusually high deer densities (NDOW 1995 unpublished data in Lansford and Woolstenhulme 2008). Various factors including drought caused deer populations to decline but mountain lions did not appear to decrease proportionately, probably due to the abundance of alternative prey including domestic livestock, elk, feral horses, and bighorn sheep (NDOW unpublished data 2007 and NDOW 2007). Mountain lion numbers remained high until the mid-1990s when data indicated that the population was stable to slightly decreasing from the historically high levels (NDOW, letter to WS, January 21, 2004). NDOW determined that the mountain lion population was stable in 2010(NDOW 2010b) and continues to be stable in 2016 (NDOW 2017b).

Mountain lion density is influenced by prey availability and territoriality behaviors (Seidensticker et al. 1973, Hemker et al. 1984). Territoriality can be an important mortality factor (Maehr 1997, Logan and Sweanor 2001). Estimating population densities for mountain lions is difficult because of the animal's solitary and elusive behavior (Davidson et al. 2014). Mountain lion density estimates range from 0.01/mi^2 to 0.24/mi^2, with an average density estimate for the western states of 0.075/mi^2 (Johnson and Strickland 1992).

Several recent studies have been conducted in Oregon to estimate mountain lion population densities. A 2005 study on yearling and adult mountain lions in Wenaha and Sled Springs Wildlife Management Units (WMUs) in northeast Oregon found a mountain lion density of 0.08 to 0.16/mi^2 (unpublished data, cited in ODFW 2006). In the same year, a study area in southwest Oregon recorded a mountain lion density of 0.11/mi^2 (unpublished study, cited in ODFW 2006). Davidson et al. (2014, 2015) collected and genetically analyzed scat samples to identify individual mountain lions in 2 sections of the Mt. Emily WMU in northeastern Oregon. The studies estimated mountain lion densities in each WMU to be 0.14/mi^2 and 0.15/mi^2, respectively (Davidson et al. 2014, 2015).

In order to estimate the statewide mountain lion population in Nevada, NDOW uses a life table model (retrospective harvest/mortality) which uses known harvest/mortality rates and recruitment rates (Greenly 1988, Stiver 1995) to calculate a retrospective estimate of minimum viable population size needed to sustain know harvest rates over the same time frame, incorporating prey availability as a parameter (Lansford and Woolstenhulme 2008). NDOW reruns the model annually and, as of the end of 2016, estimated a population of 2,500-3,500 mountain lions (P. Jackson Pers Comm 4/19/2018), which are considered stable (NDOW 2017b).

Mountain lion populations can sustain relatively moderate to heavy losses of adults and still maintain viable populations. Robinette et al. (1977) reported a sustained annual mortality of 32% in Utah, while Ashman et al. (1983) noted a sustained annual mortality of at least 30% in Nevada. Ashman et al. (1983) believed that under "moderate to heavy exploitation (30% to 50%)" mountain lion populations in their study area had the recruitment (reproduction and immigration) capability to rapidly replace annual losses.

Average estimated annual harvest rate reported during the 1987 to 2002 study by Laundré et al. (2007) was 23.7% of the estimated harvestable population with maximum annual harvest rate of 47.6%. Human-caused mortality was greater for male mountain lions (average = 36.6%) than for female mountain lions (10.8%). Based on comparisons with areas with low or no hunting, Laundré et al. (2007) concluded that mortality from hunter harvest appeared to be additive to other sources of mortality (harvest removed individuals in addition to the number that died from other causes) in male mountain lions. In females, hunter harvest appeared to be compensatory to other sources of mortality (harvest removed a portion of the population that would have died from other causes), particularly during the period when the population was increasing. Similarly, during the period of population decline, losses of females from natural mortality appeared to be the main cause for population decline and the low rate of hunter harvest during the first year of the decline seemed to have only a limited role. A study by Lindzey et al. (1992) in Utah found that mountain lion population recovery after hunting removal was slow, with hunting losses apparently additive to other mortality. In this study, resilience of mountain lion populations to hunting appears to depend on the rate of immigration into the population and the availability of females of breeding age recruited.

Because mountain lion populations are connected and readily subject to immigration, and that more than 10% of Nevada contains unhunted mountain lion populations (e.g. Nellis Air Force base, the Nevada Test Site, Desert and Sheldon National Wildlife Refuges and Great Basin National Park) (Lansford and Woolstenhulme 2008), the level of annual maximum sustainable harvest used is 30% as reported by Ashman et al. (1983) and Robinette et al (1977), respectively, for sustaining a viable mountain lion population, and consistent with the average annual mortality rate reported by Laundré et al. (2007).

In 2017, Nevada Wildlife Commission Regulation "21-CR-17-04" was adopted which guided NDOW to base its mountain lion management strategy on Andreasen et al. (2012). Andreasen et al. (2012) found that there were 5 unique genetic subpopulations of mountain lions living in Nevada, consisting of 3 source and 2 sink populations. The largest sink population is the "West" population (Sierra

Nevada range) which is separated from the rest of the genetic subpopulations by a "Transient" population. The second sink population is the "North" population, east of the Transient population, north of the "Central" and "East" unique genetic subpopulations. The final unique genetic subpopulation is the "South" population, which includes a refugium (area isolated from human activities such as hunting). Generally, the "sink" populations do not provide genetic transfer (through emigration) to other populations, whereas "source" populations do provide genetic transfer to other populations. NDOW manages its mountain lion population for a long term sustainable yield by gauging its harvest impact and making quota recommendations based on the previous 3 year harvest average for each distinct genetic subpopulation and Transient population (6 subpopulation management approach).

3.5.8.3 *Mountain Lion Population Impact Analysis*

3.5.8.3.1 WS-Nevada Direct Effects on Mountain Lions

In response to requests for assistance with mountain lion damage, WS-Nevada intentionally removed an average of 23.2 mountain lions each year between 2012 and 2016, which includes an average of 1.4 mountain lions removed each year for the protection of human health and safety (Table 3.8). Most of the mountain lions were taken in Washoe and White Pine Counties (Table 2.3). Most mountain lion are taken on BLM lands (59.2%) and on private and USFS land (20.8% and 15.8% respectively; Table 2.2), using firearms, mostly after pursuing with dogs, neck snares, cage traps and foothold traps (Table 2.1, Table E.1). WS-Nevada unintentionally removed an average of 0.8 mountain lions per year during the analysis period.

Based on the number of cooperative service agreements, county, state and federal budgetary constraints, and projected future requests for assistance, WS-Nevada expects that future mountain lion removals for PDM in Nevada would be similar to take during the last 5 years. However, WS-Nevada must be able to respond to requests for assistance to meet the need for action. While WS-Nevada expects for the need for PDM to stay close to the past, the analysis includes the take of more individuals to accommodate unforeseen needs. Therefore, under Alternative 1 (current program with fluctuations in program delivery) and Alternative 2 (modified current program with fluctuations in program delivery), the projected WS-Nevada annual maximum take would be 50 mountain lions.

3.5.8.3.2 Cumulative Mortality

One of the goals of the Nevada Mountain Lion Species Management Plan (1995) is to protect and manage mountain lions for their intrinsic values and other benefits to residents of Nevada and the U.S. This goal includes protecting mountain lions and their habitats for present and future generations, as well as addressing conflicts between mountain lions, livestock, and human/pet safety (Section 1.11.2.8 and 1.11.5). All WS-Nevada take of mountain lions is reported to NDOW for their needs and as part of this monitoring process, but cumulative take of mountain lions in Nevada is attributable to several sources (Table 3.8).

The 2018-2019 statewide mountain lion harvest limit is 247 (including a 2 mountain lion harvest limit for a Nevada-Utah interstate hunt unit (NDOW 2019)). If during a 3 year period, the adult female harvest averages 35%, or the overall female harvest averages 50% for any of the 6 subpopulations, then harvest restrictions will be imposed. NDOW statewide quotas were never exceeded between FY 2012 through 2016.

Hunters harvested an annual average of 135 mountain lions in Nevada during 2012-2016. This included an annual average of 3 in response to damage. As all take of mountain lions must be reported to NDOW, this is assumed to be a close estimate of total non-WS-Nevada take.

The average cumulative take of mountain lions in Nevada for the reporting period was 162 per year. The largest cumulative take was 227 mountain lions per year, 9.08% of the total estimated population, with WS-Nevada contributing 4.27% of the cumulative amount, relative to the annual maximum sustainable harvest of 30% (Table 3.8). If WS-Nevada were to take the WS-Nevada annual maximum take of 50 mountain lions, the projected cumulative take would be approximately 9.80% of the population, with WS-Nevada contributing 2% to the cumulative amount.

Table 3-8. Population Impact Analysis of Mountain Lion Take in Nevada, FY 2012-2016.

Mortality source	2012	2013	2014	2015	2016	5-year average	5-year high
WS intentional take[1]	30	26	18	21	21	23.2	30
WS unintentional take[1]	2	2	0	0	0	.8	2
Other damage take[2]	0	0	2	0	13	3	13
Hunting harvest[3]	103	182	118	99	173	135	182
Human health & safety take[4]	2	1	0	0	4	1.4	4
NDOW administrative take[5]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Other known sources of take[6]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total WS take	32	28	18	21	21	24	32
Total non-WS take	103	182	120	99	186	138	195
Cumulative take	135	210	138	120	207	162	227
Statewide population estimate[7]:							2,500 mountain lions
Annual maximum sustainable harvest[7]:							30% (750 mountain lions)
Current total WS take as a % of the population[8]:							1.28% (32 mountain lions)
Current cumulative take as a % of the population[9]:							9.08% (227 mountain lions)
Projected WS annual maximum take[10]:							50 mountain lions
Projected total WS take as a % of the population[11]:							2% (50 mountain lions)
Projected annual cumulative take as a % of the population[12]:							9.80% (245 mountain lions)

[1] (MIS 2018).

[2] Represents the number of animals taken by landowners, NDOW, or others as a result of damage (NDOW 2017b).

[3] Represents the number of animals taken during hunting and trapping harvest seasons (NDOW 2017b).

[4] Represents the number of animals taken by WS-Nevada (also included in "WS intentional take") as a result of threats to humans or pets (MIS 2018).

[5] Represents administrative removals in mountain lion target areas to meet the management objectives of the NDOW Predator Plan (NDOW 2017c, 2017d).

[6] Includes roadkill, accidental, found dead, and illegal sources of take (NDOW 2017b).

[7] See Section 3.5.7.2 Mountain Lion Population Information. All estimates are rounded up.

[8] The proportion of the estimated species population taken by WS-Nevada in the year with the highest WS-Nevada take between FY 2012- FY 2016.

[9] The proportion of the estimated species population taken by all sources in the year with the highest take between FY 2012- FY 2016.

[10] Represents the maximum WS-Nevada could annually take under the current program (Alternative 1) given the potential for fluctuations in program delivery and alternative 2 (modified current program with fluctuations in program delivery) (Appendix E).

[11] Provides a conservative estimate of the highest proportion of the estimated species population that could be taken by WS-Nevada, under projected WS-Nevada annual maximum take scenario.

[12] Provides a conservative estimate of the highest proportion of the estimated species population that could be taken by all sources, under projected WS-Nevada annual maximum take scenario.

3.5.8.4 *Conclusion: Mountain Lion*

Based on the stable population trend for mountain lion in the state and an annual maximum sustainable harvest level of 30%, cumulative impacts on the mountain lion population from all causes, including take by WS-Nevada, has not adversely impacted the population.

Therefore, WS-Nevada concludes that the cumulative impact of all known mountain lion mortality in Nevada, including take by recreationist, WCOs, and other agencies, and the maximum annual take of 50 mountain lions proposed by WS-Nevada would not adversely impact the size or sustainability of the Nevada mountain lion population. This conclusion is consistent with NDOW mountain lion population trend information (NDOW Big game status reports FY 2012 through FY 2016) and NDOW management goals.

Should an increase in requests for assistance with mountain lions result in the projected annual WS-Nevada maximum take, cumulative impacts on the statewide mountain lion population would still be expected to remain low relative to the annual maximum sustainable harvest level. Given the low proportion of cumulative take, and even lower WS-Nevada take, direct and cumulative impacts from take would not adversely impact the size or sustainability of the Nevada mountain lion population.

3.5.9 *What are the Direct and Cumulative Impacts on Red Fox Populations?*

3.5.9.1 *Red Fox Life History Information*

Red foxes are found throughout much of North America, Europe, Asia and North Africa, and were introduced into Australia in the nineteenth century.

They primarily hunt small rodents, insects, rabbits, ground-nesting birds, turtles, frogs, snakes, small pets, or livestock such as chickens or lambs, at night. Foxes are regarded as nuisance predators in many regions, preying on wildlife and livestock, especially poultry (Ables 1969, Andrews et al. 1973, Tabel et al. 1974, Tullar et al. 1976, Pils and Martin 1978, Sargeant 1978, Voigt 1987, Allen and Sargeant 1993).

Fox pups are born in dens between March and May, and are weaned at 8 to 10 weeks. Rowlands and Parkes (1935) and Creed (1960) reported that male red foxes breed in their first year. Storm et al. (1976) stated that 95% of the females (43.6% were less than one year old) bred successfully in populations in Illinois and Iowa. Litter sizes averaged about 4.7 offspring and litters with as many as 14 and 17 offspring have been reported (Storm et al. 1976, Voigt 1987). Ables (1969) and Sheldon (1950) reported that more than one female was observed at the den and suggested that red foxes have "helpers," a phenomena observed in coyotes and other canids.

3.5.9.2 *Red Fox Population Information*

Red foxes are classified as a furbearing mammal by NDOW. This invasive species' range and population has expanded in Nevada in the last decade. The first reported take of a red fox in Nevada was during the 2001-2002 furbearer harvest season, which increased to 166 during the 2012-2013 furbearer harvest season (NDOW 2017c). A furtaker or hunting license is required to take red foxes on public or private lands, which may be recreationally harvested with no bag limit. Red foxes can be taken during furbearer hunting season (e.g. October 01, 2017 through February 28, 2018) with the exception of those areas closed to hunting and trapping as listed in NAC 504.340 (Section 2.4.4.3). Under NRS §503.470 (Section 2.4.4.1), landowners and commercial wildlife control operators can also conduct red fox removal work on private land to mitigate damage, public health risks, or public nuisances with a depredation permit. Under NRS 503.470, fur-bearing mammals injuring any property can be taken at any time with any method by the owner or occupant of the property or with the permission of the owner or occupant. All take by a landowner, furtaker, or WCO must be reported to NDOW annually.

Reported red fox population densities have been as high as over 50/mi^2 where food was abundant (Harris 1977, MacDonald and Newdick 1982, Harris and Rayner 1986). Sargeant (1972) reported one den per 3 mi^2, or about 1.3 red fox/mi^2, conservatively estimating 4 fox per den. Population densities have been found to be 2.6 red fox/mi^2 in Ontario, Canada (Voigt 1987). For purposes of this analysis, we will conservatively estimate red fox densities at 2/mi^2 in pockets covering only 1,100 mi^2 or 1% of Nevada. Therefore, there are approximately 2,200 red foxes in Nevada.

Red fox dispersal and immigration serves to replace and equalize fox densities over large areas and over a wide range of population densities. Annual harvests in localized areas in one or more years will likely have little impact on overall population in subsequent years, but may reduce localized predation (Allen and Sargeant 1993). Phillips and Mech (1970) stated that fox populations are resilient and in order for fox control operations by trapping to be successful, pressure on the population must be almost continuous. Phillips and Mech (1970) and Voigt (1987) further stated that habitat destruction that reduces prey numbers, water, and cover will affect fox populations to a greater extent than a short-term over harvest. Red fox social structure and population dynamics are similar to that for coyote and red fox populations are likely to exhibit the same resilience to harvest as that modeled for coyotes above (Pitt et al. 2001), which is 70% annually.

Therefore, red fox populations can sustain an annual harvest rate of 70% annually, or about 1,540 red fox per year in Nevada (Table 3.9). WS-Nevada expects the annual lethal removal of red foxes to remain similar to previous activities, including unintentional removal, and does not expect annual removal to increase substantially.

3.5.9.3 *Red Fox Population Impact Analysis*

3.5.9.3.1 WS-Nevada Direct Effects on Red Foxes

In response to requests for assistance for red fox damage between FY 2012 and 2016, WS-Nevada intentionally removed an annual average of 2.8 red foxes, during PDM activities. In addition, WS-Nevada unintentionally removed an average of 0.2 red foxes per year during the analysis period.

Red foxes were taken primarily from BLM (53.3%), Forest Service (40%), as well as municipal or county lands (6.7%), in north eastern Nevada (60% from Elko County), (Tables 2.2 and 2.3). Red foxes are captured primarily using foothold traps, neck snares, or firearms (Table 2.1, Appendix E, Table E.1).

Based on the number of cooperative service agreements, county, state and federal budgetary constraints, and projected future requests for assistance, WS-Nevada expects that future red fox removals for PDM in Nevada would be similar to take during the last 5 years. However, WS-Nevada must be able to respond to requests for assistance to meet the need for action. While WS-Nevada expects for the need for PDM to stay close to the past, the analysis includes the take of more individuals to accommodate unforeseen needs. Therefore, under Alternative 1 (current program with fluctuations in program delivery) and Alternative 2 (modified current program with fluctuations in program delivery), the projected WS-Nevada annual maximum take would be 40 red foxes.

3.5.9.3.2 Cumulative Mortality

Various sources of red fox removal contribute to the cumulative take in Nevada (Table 3.9). During 2012 through 2016, recreational harvesters reported an average of 75.4 red foxes taken per year to NDOW.

Cumulative take of red foxes from all known sources (recreational harvest and WS-Nevada activities) averages 78.4 per year. The highest cumulative take was 175 red foxes per year, approximately 7.95% of the total estimated population, with WS-Nevada contributing 0.58% of the statewide cumulative amount, relative to the annual maximum sustainable harvest of 70% (Table 3.9, Table

3.16). If WS-Nevada were to take the annual maximum take of 40 red foxes, the projected cumulative take would be approximately 9.36% of the population, with WS-Nevada contributing 1.82% to the cumulative amount.

Table 3-9. Population Impact Analysis of Red Fox Take in Nevada, FY 2012-2016.

Mortality source	2012	2013	2014	2015	2016	5-year average	5-year high
WS intentional red fox take[1]	8	4	1	0	1	2.8	8
Estimated WS intentional den take[1,2]	0	0	0	0	0	0	0
WS unintentional take[1]	0	0	0	1	0	.2	1
WCO take[3]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Other damage take[4]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hunting harvest[5]	44	106	166	43	18	75.4	166
Total WS take	8	4	0	1	1	3	9
Total non-WS take	44	106	166	43	18	75.4	166
Cumulative take	52	110	166	44	19	78.4	175
Statewide population estimate[6]:							2,200 red foxes
Annual maximum sustainable harvest[6]:							70% (1,540 red foxes)
Current total WS take as a % of the population[7]:							0.41% (9 red foxes)
Current cumulative take as a % of the population[8]:							7.95% (175 red foxes)
Projected WS annual maximum take[9]:							40 red foxes
Projected total WS take as a % of the population[10]:							1.82% (40 red foxes)
Projected annual cumulative take as a % of the population[11]:							9.36% (206 red foxes)

[1] (MIS 2018).

[2] See Section 3.5.9.3.1 WS-Nevada Direct Effects on Red Foxes. The estimated number of animals taken, based on the number of dens removed by WS-Nevada (MIS 2018).

[3] Data are not available (P. Jackson Pers. comm. 03/29/2018). Wildlife Control Operator (WCO) licenses are issued by NDOW (NAC 503.095).

[4] Represents the number of animals taken by landowners, NDOW, or others as a result of damage. This take is included in Recreation take and fewer than 10 in all years (R. Woolstenhulme Pers. comm., 03/26/2018).

[5] Represents the number of animals taken during hunting and trapping harvest seasons (R. Woolstenhulme Pers. comm. 03/26/2018).

[6] See Section 3.5.9.2 Red Fox Population Information. All estimates are rounded up.

[7] The proportion of the estimated species population taken by WS-Nevada in the year with the highest WS-Nevada take between FY 2012- FY 2016.

[8] The proportion of the estimated species population taken by all sources in the year with the highest take between FY 2012- FY 2016.

[9] Represents the maximum WS-Nevada could annually take under the current program (Alternative 1) given the potential for fluctuations in program delivery and the modified current program (Alternative 2), given the potential for fluctuations in program delivery (Appendix E).

[10] Provides a conservative estimate of the highest proportion of the estimated species population that could be taken by WS-Nevada, under projected WS annual maximum take scenario.

[11] Provides a conservative estimate of the highest proportion of the estimated species population that could be taken by all sources, under projected WS-Nevada annual maximum take scenario.

3.5.9.4 *Conclusion: Red Fox*

Given the low level of red fox take in the state and an annual maximum sustainable harvest level of 70%, cumulative impacts on the red fox population from all causes, including take by WS-Nevada, are not adversely impacting the population.

Therefore, WS-Nevada concludes that the cumulative impact of all recorded red fox mortality in Nevada, including intentional and unintentional take by WS-Nevada, would not adversely impact the size or sustainability of the Nevada red fox population. Population trends are not estimated by NDOW for red fox in Nevada because the amount of take is insignificant to the population (less than 8% in comparison to a 70% maximum sustainable harvest level) (Russell Woolstenhulme, NDOW, pers. comm., 06/13/2018).

Should an increase in requests for assistance with red fox result in the projected annual WS maximum take, cumulative impacts on the statewide red fox population would still be expected to remain low relative to the annual maximum sustainable harvest level. Given the low proportion of cumulative take, and even lower WS-Nevada take, direct and cumulative impacts from take would not adversely impact the size or sustainability of the Nevada red fox population.

3.5.10 *What are the Direct and Cumulative Impacts on Badger Populations?*

3.5.10.1 *Badger Life History Information*

Badgers are found throughout most of the western U.S. In Nevada, badgers are found in plain, desert, foothill, and mountain meadow habitats at moderate densities. Home range sizes of adult badgers averaged 0.6 and 0.9 mi^2 for females and males in Idaho (Messick and Hornocker 1981) and ranged from 0.5 to 2.4 mi^2 in Utah (Lindzey 1978).

Badgers breed in late summer, with implantation delayed until February and the birth of 1 to 5 cubs in March or April. Family groups begin to break up in mid-summer. Females with a litter frequently remain near the den sites. Badgers are mostly nocturnal, opportunistically feeding on burrowing animals, rodents, birds, reptiles, and insects.

WS-Nevada occasionally receives requests for assistance to resolve damages from badgers for the protection of greater sage-grouse nests and eggs, rangeland, pasture, and cropland.

3.5.10.2 *Badger Population Information*

Badgers are classified as an unprotected mammal in Nevada. A furbearer's license is only required to take badgers if taking with traps/snare or if selling fur. NRS §502.010 allows the take of any unprotected mammal to protect persons or property in the immediate vicinity of homes or ranches affected by such species.

Badgers are under the management authority of NDOW. Population trends are not estimated by NDOW for badgers in Nevada because the amount of take is insignificant to the population (less than 1%) (Russell Woolstenhulme, NDOW, pers. comm., 06/13/2018). It has been estimated that the Curlew Valley on the Utah-Idaho border supported 1 badger/mi^2 (Lindzey 1971). Messick and Hornocker (1981) found 13/mi^2 in southwestern Idaho and noted that densities may be higher during periods when juveniles are dispersing.

A study by Hein and Andelt (1995) in Colorado estimated a minimum population density of 0.7 badgers/mi^2 by comparing scent-station visitations, spotlight surveys, headlight surveys, road mortality, and a trapping index. Clark and Andrews (1982) found a higher density of 4.74 badgers/mi^2 in New Mexico, Colorado, and Utah. Densities of 5 badgers/mi^2 were recorded in the National Elk Refuge in northwestern Wyoming (Lindzey 2003).

The lowest density estimate from the literature of 0.7 badgers/mi^2 was applied to generate a conservative statewide population estimate of 77,397 badgers. Annual maximum sustainable harvest for badger populations has been estimated at 30 to 40% (Boddicker 1980) or conservatively about 23,219 badgers in Nevada (Table 3.10).

3.5.10.3 *Badger Population Impact Analysis*

3.5.10.3.1WS-Nevada Direct Effects on Badgers

In response to requests for assistance with badger damage between FY 2012 and 2016, WS-Nevada intentionally removed an average of 47.2 badgers each year, primarily from eastern Nevada, mostly from BLM and private lands (83.3% and 12.6% respectively) Tables 2.2 and 2.3). WS-Nevada unintentionally removed an average of 0.6 badgers per year during the analysis period. Badgers are taken primarily using foothold traps, neck snares, or firearms (Table 2.1, Appendix E, Table E.1).

Based on the number of cooperative service agreements, county, state and federal budgetary constraints, and projected future requests for assistance, WS-Nevada expects that future badger removals for PDM in Nevada would be similar to take during the last 5 years. However, WS-Nevada must be able to respond to requests for assistance to meet the need for action. While WS-Nevada expects for the need for PDM to stay close to the past, the analysis includes the take of more individuals to accommodate unforeseen needs. Under Alternative 1 (current program with fluctuations in program delivery) and Alternative 2 (modified current program with fluctuations in program delivery), the projected WS-Nevada annual maximum take would be 250 badgers (Table 3.10, Appendix E).

3.5.10.3.2 Cumulative Mortality

Various sources of badger removals contribute to the cumulative take of badgers in Nevada (Table 3.10). Badgers reported to NDOW taken as recreational harvest averaged 188 per year (Table 3.10).

The average annual cumulative take of badgers is 235.8 per year. The highest cumulative take was 376 badgers per year, approximately 0.49% of the total estimated population. WS-Nevada contributed 0.40% of that cumulative amount, relative to the annual maximum sustainable harvest of 30% (Table 3.10). If WS-Nevada were to take the proposed annual maximum take of 250 badgers, the projected cumulative take would be approximately 0.69% of the population, with WS-Nevada contributing 0.32% to the cumulative amount.

Table 3-10. Population Impact Analysis of Badger Take in Nevada, FY 2012-2016.

Mortality source	2012	2013	2014	2015	2016	5-year average	5-year high
WS intentional take[1]	93	76	27	13	27	47.2	93
WS unintentional take[1]	1	1	1	0	0	0.6	1
WCO take[2]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Other damage take[3]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hunting harvest[4]	175	192	282	212	79	188	282
Total WS take	94	77	28	13	27	47.8	94
Total non-WS take	175	192	282	212	79	188	282
Cumulative take	269	269	310	225	106	235.8	376
Statewide population estimate[5]							77,397 badgers
Annual maximum sustainable harvest[5]							30% (23,219 badgers)
Current total WS-Nevada take as a % of the population[6]							0.12% (94 badgers)
Current high year cumulative take as a % of the population[7]							0.49% (376 badgers)
Projected WS annual maximum take[8]							250 badgers
Projected Annual WS-Nevada Cumulative Take Maximumas % of population[9]							0.32% (250 badgers)
Projected annual cumulative take as a % of the population[10]							0.69% (532 badgers)

[1] (MIS 2018).

[2] Data are not available (P.Jackson Pers. comm. 03/29/2018). Wildlife Control Operator (WCO) licenses are issued by NDOW (NAC 503.095).

[3] Represents the number of animals taken by landowners, NDOW, or others as a result of damage.

[4] Represents the number of animals taken during hunting and trapping harvest seasons (R. Woolstenhulme Pers. comm., 03/26/2018). This take is included in Recreation take and fewer than 10 in all years (R. Woolstenhulme Pers. comm., 03/26/2018).

[5] See Section 3.5.10.2 Badger Population Information.

[6] The proportion of the estimated species population taken by WS-Nevada in the year with the highest WS-Nevada take between FY 2012- FY 2016.

[7] The proportion of the estimated species population taken by all sources in the year with the highest take between FY 2012- FY 2016.

[8] Represents the maximum WS-Nevada could annually take under the current program (Alternative 1) given the potential for fluctuations in program delivery and the modified current program (Alternative 2), given the potential for fluctuations in program delivery (Appendix E).

[9] Provides a conservative estimate of the highest proportion of the estimated species population that could be taken by WS-Nevada, under projected WS annual maximum take scenario.

[10] Provides a conservative estimate of the highest proportion of the estimated species population that could be taken by all sources, under projected WS annual maximum take scenario.

3.5.10.4 *Conclusion: Badger*

Given the stable population trend for badger in the state and an annual maximum sustainable harvest level of 30%, cumulative impacts on the badger population from all causes, including take by WS-Nevada, have not adversely impacted the population. All known badger take in Nevada, in relation to the population size is insignificant (under 1%) (Russel Woolstenhulme, pers. comm., 6/13/2018).

During the analysis period, WS-Nevada removed an average of 47.8 badger per year. WS-Nevada expects this level of need for badger PDM to continue. An increase in WS-Nevada's badger take to 250 per year is predicted to result in cumulative take of 0.69% of the estimated badger populations. This is not close to the 30% take that is necessary to adversely affect the population. Therefore, should an increase in requests for assistance with badger result in the need for increased take, WS-Nevada concludes that the cumulative impact of all recorded badger mortality in Nevada, including the proposed maximum take of 250 badger per year by WS-Nevada, would not adversely impact the size or sustainability of the Nevada badger population.

3.5.11 *What are the Direct and Cumulative Impacts on Bobcat Populations?*

3.5.11.1 *Bobcat Life History Information*

Bobcats are found in much of the United States and southern Canada to most of Mexico, and are very abundant in the western U.S. Bobcats have become more abundant in North America than they were in 1981 (Roberts and Crimmins 2010) and are common statewide in Nevada. They are typically associated with brushy, rocky and wooded areas, and rimrock and chaparral habitat, especially where ledges occur. Prey abundance, protection from severe weather, availability of rest areas, dense cover, and freedom from disturbance are key factors (McCord 1974, Donovan et al. 2011). Bobcats are resilient, and populations are doing well in the United States except in areas of dense human populations and extensive agriculture.

Bobcats reach reproductive maturity at 9 to 12 months and have one to six kittens in early- to mid-summer (Koehler 1987, Crowe 1975). Older male and female bobcats usually have a territory that is fairly well defined but which varies in size depending on prey density, sex, season, presence of kittens, and climate. Transient animals coexist with territorial resident animals by using less-desirable habitats. Dispersal of young bobcats generally occurs in fall or late winter. They may live up to 14 years, but annual mortality is as high as 47% (Rolley 1985).

Bobcats are opportunistic and frequently prey on rabbits, rodents, beavers, and squirrels. Bobcat population health is stable throughout the United States, except in areas of high human population density and extensive agriculture.

3.5.11.2 *Bobcat Population Information*

Bobcats are classified as a furbearing mammal by NDOW. Under NRS §503.470 (Section 2.4.4.1), owners or occupants of property or those with permission of the owner or occupant may take fur-bearing mammals injuring any property at any time. NRS §502.470 allows the take of any fur-bearing mammal doing damage provided a permit is obtained from the division. All take by a landowner, furtaker, or certified WCO must be reported to NDOW annually.

A furbearer or hunter's license is required to take bobcats on public or private lands, during the regulated harvest season set by the Nevada Board of Wildlife and carried out by NDOW. A furtaker or hunter can choose to trap or hunt bobcat without limit during the season. NDOW requires furtakers and hunters to turn in harvest reports before bobcat pelts are sealed and mandibles from all harvested bobcats to assess age structure and monitor population trends (NAC §502.347).

Reported bobcat densities, as summarized by McCord and Cardoza (1982), have ranged from 0.1 to 7 per mi^2. Knick (1990) estimated that bobcat densities in southeastern Idaho ranged from $0.04/mi^2$ to $0.35/mi^2$, depending on jackrabbit densities. Bailey (1974) estimated bobcat densities in the same area to average about $0.14/mi^2$.

NDOW estimates the Nevada statewide bobcat population at 27,000 utilizing USGS GAP analysis data which uses maps that delineate topographical, biological and geological features to identify habitats, the GAP data for the species are paired with habitat suitability models that specify known habitat requirements. With the resulting maps, NDOW has available statewide available habitat/species. This information used in conjunction with biological density and home range data is used to generate the population estimates. Density and home range data are derived from Nevada research if available and nearby states with similar habitat if not (NDOW 2017d). This data is complimented from mandatory furbearer harvest reports information and age/sex composition data from lower mandibles to set furbearer harvest seasons and limits.

A bobcat population model developed by Knick (1990) based on seven years of intensive bobcat research in southeastern Idaho indicated that bobcat populations can sustain harvest levels of up to 20% of the population. Rolley (1985) also estimated that bobcats can sustain a 20% annual harvest (Table 3.11).

3.5.11.3 *Bobcat Population Impact Analysis*

3.5.11.3.1WS-Nevada Direct Effects on Bobcats

Requests for WS-Nevada to assist with bobcats causing damage are relatively low. WS-Nevada intentionally removed an average of 2.2 bobcats per year between FY 2012 and 2016 (Tables 2.3 and 3.11). WS-Nevada unintentionally removed an average of 1.8 bobcats per year during the analysis period. Bobcats are primarily taken in on/along mountain ranges near saddles, rock outcroppings and creek beds and washes, mostly on BLM and private lands (75% and 20% respectively), with a small proportion on Forest Service land (5%) (Table 2.2). Bobcats are primarily taken with foothold traps and neck snares, and firearms (Table 2.1, Table E.1).

Based on the number of cooperative service agreements, county, state and federal budgetary constraints, and projected future requests for assistance, WS-Nevada expects that future bobcat removals for PDM in Nevada would be similar to take during the last 5 years. However, WS-Nevada must be able to respond to requests for assistance to meet the need for action. While WS-Nevada expects for the need for PDM to stay close to the past, the analysis includes the take of more individuals to accommodate unforeseen needs. Therefore, under Alternative 1 (current program with fluctuations in program delivery) and Alternative 2 (modified current program with fluctuations in program delivery), the projected WS annual maximum take is 40 bobcats.

3.5.11.3.2 Cumulative Mortality

Bobcat taken by various entities contributes to cumulative take in Nevada (Table 3.11). NDOW reports that furbearer harvest removed an average of 2,654.2 bobcats per year from FY 2012- FY 2016 (Table 3.11).

The average annual cumulative take of bobcat is 2,658.2 per year. The highest statewide known cumulative take was 4,000 bobcats per year, approximately 14.81% of the total estimated population, with WS-Nevada contributing 0.15% of the cumulative amount, relative to the annual maximum sustainable harvest of 20% (Table 3.11). If WS-Nevada were to take the annual maximum take of 40 bobcats, the projected cumulative take would be approximately 14.93% of the population, with WS-Nevada contributing 0.15% to the cumulative amount.

Table 3-11. Population Impact Analysis of Bobcat Take in Nevada, FY 2012-2016.

Mortality source	2012	2013	2014	2015	2016	5-year average	5-year high
WS intentional take[1]	5	2	3	0	1	2.2	5
WS unintentional take[1]	3	2	1	2	1	1.8	3
Other damage take[2]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hunting harvest[3]	3,992	3,333	3,063	1,641	1,197	2,654.2	3,992
Total WS take	8	4	4	2	2	4	8
Total non-WS take	3,992	3,333	3,063	1,641	1,197	2,654.2	3,992
Cumulative take	4,000	3,337	3,067	1,643	1,199	2,658.2	4,000
Statewide population estimate[4]							27,000 bobcats
Annual maximum sustainable harvest[4]							20% (5,400 bobcats)
Current total WS take as a % of the population[5]							0.03% (8 bobcats)
Current cumulative take as a % of the population[6]							14.81% (4,000 bobcats)
Projected WS annual maximum take[7]							40 bobcats
Projected total WS take as a % of the population[8]							0.15% (40 bobcats)
Projected annual cumulative take as a % of the population[9]							14.93% (4,032 bobcats)

[1] (MIS 2018).

[2] Represents the number of animals taken by landowners, NDOW, or others as a result of damage. This take is included in Recreation take and fewer than 10 in all years (R. Woolstenhulme Pers. comm., 03/26/2018).

[3] Represents the number of animals taken during hunting and trapping harvest seasons (NDOW 2017c).

[4] See Section 3.5.11.2 Bobcat Population Information. All estimates are rounded up.

[5] The proportion of the estimated species population taken by WS-Nevada in the year with the highest WS-Nevada take between FY 2012- FY 2016.

[6] The proportion of the estimated species population that could have been taken by all sources in the year with the highest take between FY 2012- FY 2016.

[7] Represents the maximum WS-Nevada could annually take under the current program (Alternative 1) given the potential for fluctuations in program delivery and the modified current program (Alternative 2), given the potential for fluctuations in program delivery (Appendix E).

[8] Provides a conservative estimate of the highest proportion of the estimated species population that could be taken by WS-Nevada, under projected WS annual maximum take scenario.

[9] Provides a conservative estimate of the highest proportion of the estimated species population that could be taken by all sources, under projected WS annual maximum take scenario.

3.5.11.4 *Conclusion: Bobcat*

Given the stable population trend for bobcat in the state and an annual maximum sustainable harvest level of 20%, cumulative impacts on the bobcat population from all causes, including take by WS-Nevada have not adversely impacted the population. WS-Nevada's average bobcat take during 2011 through 2016 was 4 bobcats per year, compared to an average recreational harvest of 2,654 bobcats, which is regulated by NDOW. WS-Nevada would have little impact on the population compared to other harvest sources, even at the maximum take level of 40 bobcats per year. Therefore, WS-Nevada concludes that the cumulative impact of all recorded bobcat mortality in Nevada, including the proposed take of up to 40 bobcats per year by WS-Nevada, would not adversely impact the size or sustainability of the Nevada bobcat population. This conclusion is based on the calculation that 5,400 bobcats would need to be taken to adversely impact the population, which is consistent with NDOW bobcat population trend information (NDOW 2017d).

3.5.12 *What are the Direct and Cumulative Impacts on Feral and Free-Ranging Cat Populations?*

3.5.12.1 *Feral and Free-ranging Cat Life History*

Feral and free-ranging domestic cats are non-native and common throughout North America and Nevada, and their wildlife prey have little defense against them. Cats are prolific breeders, having up to three litters of 4-8 kittens per year. Unlike many native predators, cats are not territorial and can exist at much higher densities than native predators. Free-roaming cats can transmit deadly diseases (Section 1.11.6) such as rabies, feline leukemia and distemper to wild cats, wildlife, and in some cases humans. The incidence of rabies in cats is higher than in any other domestic animal in the United States (Birhane et al. 2017).

Studies (Mitchell and Beck 1992, Hawkins et al. 1999, Crooks and Soule 1999) of feral cats show that up to 70% of cats' prey is comprised of small mammals, up to 30% are birds, and the remainder of the diet is comprised of amphibians, reptiles, and insects. Birds that nest or feed on the ground are susceptible to cat predation, although cats are capable of catching birds by the wings and in trees. Loss et al. (2013) suggest that free-ranging domestic cats kill 1.3 to 4.0 billion birds and 6.3 to 22.3 billion mammals annually, and likely represent the greatest source of human-caused mortality (by virtue of cat ownership or support) for birds and mammals in the United States. They have been listed among the 100 worst non-native invasive species in the world (Lowe et al. 2000).

3.5.12.2 *Feral and Free-ranging Cat Population Information*

Today, cats may be the most widespread terrestrial carnivore on earth, with 74.1 to 85.8 million cats in the US, making cats the most popular pet in the country (AVMA 2012). However, there may be 60 to 120 million stray, free-ranging, and feral cats in the U.S. (Jessup 2004, Winter 2004, Lebbin et al. 2010). Feral and free-ranging cats are common in certain areas of Nevada. Feral and free-ranging cats are not managed by the State of Nevada, and as such, there are no population estimates for feral and free-ranging cats.

Primary responsibility for cat control rests with county and local authorities or the resource owner/manager. However, because of Nevada's cooperative wildlife damage management responsibilities and the seriousness of the problem, WS-Nevada occasionally removes feral cats during the implementation of wildlife hazard management plans at aviation facilities to protect our Service members and the flying public. Although it is/would be rare, WS-Nevada also would remove feral cats for public health concerns if requested by local authorities and to respond to damage to poultry or natural resources if requested.

3.5.12.3 *Feral and Free-ranging Cat Population Impact Analysis*

3.5.12.3.1WS-Nevada Direct Effects on Feral and Free-ranging Cats

In response to damage and threat occurrences involving feral and free-ranging cats, WS-Nevada intentionally removed an average of 5 feral and free-ranging cats per year between FY 2012 and FY 2016 (Table 3.12). WS-Nevada had no unintentional take of feral and free-ranging cats during the analysis period. Fourteen feral and free ranging cats were captured while protecting aviation safety and transferred to the custody of Washoe County Animal Services during the analysis period.

The lethal removal of feral and free-ranging cats by WS-Nevada is considered to have little impact on the human environment because feral and free-ranging cats are not indigenous to Nevada and the action may benefit native wildlife species. In addition, the annual numbers of feral and free-ranging cats removed by WS-Nevada is low compared to the thousands killed by animal control and humane organizations in Nevada each year. The Humane Society estimates that 30 to 40 million cats are "community cats" (i.e., stray, abandoned, and/or feral, living outdoors) (HSUS 2017).

WS-Nevada addresses feral and free-ranging cats primarily to protect aviation safety, which is minimal. In the absence of involvement by WS-Nevada, Animal control and private companies would likely provide such services in the interest of protecting the flying public. WS-Nevada expects the annual lethal removal of feral and free-ranging cats in Nevada to remain similar to previous years. However, WS-Nevada must be able to respond to requests for assistance to meet the need for action. While WS-Nevada expects for the need for PDM to stay close to the past, the analysis includes the take of more individuals to accommodate unforeseen needs. Therefore, under Alternative 1 (current program with fluctuations in program delivery) and Alternative 2 (modified current program with fluctuations in program delivery), the projected WS annual maximum lethal take is 20 feral and free-ranging cats, with no limit on the number of feral and free-ranging cats that can be transferred to the custody of Animal Services.

3.5.12.3.2 Cumulative Effects

Various non-WS-Nevada sources of feral and free-ranging cat removals contribute to the cumulative take of feral and free-ranging cats in Nevada (Table 3.12). However, while these non-WS sources of take are not recorded or reported, being primarily under the jurisdiction county/municipal governments, it is known to occur.

Table 3-12. Population Impact Analysis of Feral and Free-ranging Cat Take in Nevada, FY 2012-2016.

Mortality source	2012	2013	2014	2015	2016	5-year average	5-year high
WS intentional take[1]	1	0	1	2	1	1	2
WS intentional live transfer of custody to Animal Services	2	9	3	0	0	2.8	9
Total WS lethal take	1	0	1	2	1	1	2
Total Non-WS take	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cumulative lethal take	1	0	1	2	1	1	2
Statewide population estimate[2]:	unknown						
Annual maximum sustainable harvest:	unknown						
Current total WS take as a % of the population:	unknown (2 feral and free-ranging cats lethally removed; 9 feral and free-ranging cats transferred to custody of Animal Services)						
Current cumulative take as a % of the population:	unknown						
Projected WS annual maximum take[3]:	n/a						
Projected total WS take as a % of the population:	n/a						
Projected annual cumulative take as a % of the population:	unknown						

[1] (MIS 2018).

[2] See Section 3.5.12.2 Feral and Free-Ranging Cat Population Information. Feral and free-ranging cats are not managed by NDOW, and as such, there is no population estimate.

[3] See Section 3.5.12.3.1 WS-Direct Effects on Feral and Free-ranging Cats.

3.5.12.4 *Conclusion: Feral and Free-ranging Cats*

Feral and free-ranging cat populations are not monitored or managed in Nevada, however, the low level of take anticipated by WS-Nevada along with the cumulative impacts of all recorded feral and free-ranging cat mortality in Nevada, would not adversely impact the feral and free-ranging cat population.

3.5.13 *What are the Direct and Cumulative Impacts on Kit Fox Populations?*

3.5.13.1 *Kit Fox Life History Information*

Kit foxes occupy desert habitats and occasionally the fringe of agricultural lands. Kit fox prefer areas where soil is loosely textured to easily dig underground dens which are used throughout the year (O'Farrell 1999, Scott-Brown et al. 1999, Schmidly and Bradley 2016). These fox are most common in areas that support large populations of prey such as rodents, particularly black-tailed jackrabbits (*Lepus californicus*) woodrats (*Neotoma lepida*), Desert kangaroo rats (*Dipodomys deserti*), deer mice (*Peromyscus* spp.), birds and insects. Kit fox reach reproductive maturity between 10 and 22 months of age and litters average 3-5 pups.

3.5.13.2 *Kit Fox Population Information*

Kit foxes are classified as a furbearing mammal by NDOW and can be found in 12 counties throughout Nevada. A furtaker's or hunter's license is required to take kit foxes on public or private lands, which may be recreationally harvested with no bag limit. Kit foxes can be taken during furbearer hunting season (e.g. October 01, 2017 through February 28, 2018) with the exception of those areas closed to hunting and trapping as listed in NAC 504.340 (Section 2.4.4.3). Under NRS §502.470 (Section 2.4.4.1), landowners and commercial wildlife control operators can also conduct kit fox removal work on private land to mitigate damage, public health risks, or public nuisances with a depredation permit. Under NRS 503.470, fur-bearing mammals injuring any property can be taken at any time with any method by the owner or occupant of the property or with the permission of the owner or occupant. All take by a landowner, furtaker, or WCO must be reported to NDOW annually. Population density information is poorly understood for this species.

Studies in California and Utah found kit fox densities anywhere from 0.25-6.0/mi^2 (O'Farrell 1999). NDOW estimates the Nevada statewide kit fox population at 83,000 utilizing USGS GAP analysis data which uses maps that delineate topographical, biological and geological features to identify habitats, the GAP data for the species are paired with habitat suitability models that specify known habitat requirements. With the resulting maps, NDOW has available statewide available habitat/species. This information used in conjunction with biological density and home range data is used to generate the population estimates. Density and home range data are derived from Nevada research if available and nearby states with similar habitat if not (NDOW 2017d). This data is complimented from mandatory furbearer harvest reports information to set furbearer harvest seasons and limits.

There are no estimates of the annual maximum sustainable harvest level for kit fox in the scientific literature. However, an annual maximum sustainable harvest level can be estimated by utilizing reproductive data from the literature. With an estimated population of 83,000 kit fox (NDOW 2017d), assuming a 50:50 sex ratio, there are 41,500 breeding females in Nevada. Given the lowest average of 3 young per litter and only one litter per year, a total of 124,500 young are produced every year.

Juvenile mortality rates for kit fox are as high as 75% (O'Farrell 1999). A conservative use of 75% juvenile mortality rate for kit fox yields a recruitment of 31,125 kit fox by the end of year 1, when juvenile kit fox become sexually mature (O'Farrell 1999).

Egoscue (1975) found during a 5 year study in Utah that adult mortality ranged between 10% and 58%. Assuming an average adult mortality rate of 34%, by the end of year 1, 54,780 kit fox would remain from the original population of 83,000, resulting in a new breeding population of 85,905. The population at the end of year one is 3.38% greater than the starting (current) population in Nevada. Therefore, the annual maximum sustainable harvest level for kit fox in Nevada for the purpose of this analysis is 3.38%.

3.5.13.3 *Kit Fox Population Impact Analysis*

3.5.13.3.1 WS-Nevada Direct Effects on Kit Fox

In response to a request for assistance with kit fox damage between FY 2012 and 2016, WS-Nevada intentionally removed an average of 0.2 kit fox per year during PDM activities in Churchill County using a neck snare (MIS 2018) on DoD land (MIS 2018). WS-Nevada unintentionally removed an average of 1.4 kit fox per year during the analysis period, on Private and BLM lands (62.5% and 25% respectively) in Humboldt, Pershing and Lander counties (MIS 2018, Table 2.3 and Appendix E, Table E.1).

Based on the number of cooperative service agreements, county, state and federal budgetary constraints, and projected future requests for assistance, WS-Nevada expects that future kit fox removals for PDM in Nevada would be similar to take during the last 5 years. However, WS-Nevada must be able to respond to requests for assistance to meet the need for action. While WS-Nevada expects for the need for PDM to stay close to the past, the analysis includes the take of more individuals to accommodate unforeseen needs. Therefore, under Alternative 1 (current program with fluctuations in program delivery) and Alternative 2 (modified current program with fluctuations in program delivery), the projected WS annual maximum take is 40 kit fox.

3.5.13.3.2 Cumulative Mortality

Various sources of take contribute to the cumulative take of kit fox in Nevada (Table 3.13). Furbearer harvest reported to NDOW averaged 818.8 kit fox per year (Table 3.13).

The average annual cumulative take of kit fox is 820.4 per year. The largest cumulative take was 1,111 kit fox per year, approximately 1.34% of the population, with WS-Nevada contributing 0.21% of the cumulative amount relative to the annual maximum sustainable harvest of 2,904 (Table 3.13). If WS-Nevada were to take the annual maximum take of 40 kit fox, the projected cumulative take would be approximately 1.38% of the total estimated population, with WS-Nevada contributing 0.05% to the cumulative amount.

Table 3-13. Population Impact Analysis of Kit Fox Take in Nevada, FY 2012-2016.

Mortality source	2012	2013	2014	2015	2016	5-year average	5-year high
WS intentional take[1]	0	0	1	0	0	0.2	1
WS unintentional take[1]	1	1	0	0	5	1.4	5
WCO take[2]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Other damage take[3]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hunting harvest[4]	963	615	1,105	877	534	818.8	1,105
Total WS take	1	1	1	0	5	1.6	6
Total non-WS take	963	615	1,105	877	534	818.8	1,105
Cumulative take	964	616	1,106	877	539	820.4	1,111
Statewide population estimate[5]							83,000 kit foxes
Annual maximum sustainable harvest[5]							3.38% (2,904 kit foxes)
Current total WS take as a % of the population[6]							0.01% (6 kit foxes)
Current cumulative take as a % of the population[7]							1.34% (1,111 kit foxes)
Projected WS annual maximum take[8]							40 kit foxes
Projected total WS take as a % of the population[9]							0.05% (40 kit foxes)
Projected annual cumulative take as a % of the population[10]							1.38% (1,145 kit foxes)

[1] (MIS 2018).

[2] Data are not available (P.Jackson Pers. comm. 03/29/2018). Wildlife Control Operator (WCO) licenses are issued by NDOW (NAC 503.095).

[3] Represents the number of animals taken by landowners, NDOW, or others as a result of damage. This take is included in Recreation take and fewer than 10 in all years (R. Woolstenhulme Pers. comm., 03/26/2018).

[4] Represents the number of animals taken during hunting and trapping harvest seasons (NDOW 2017c).

[5] See Section 3.5.13.2 Kit Fox Population Information. All estimates are rounded.

[6] The proportion of the estimated species population taken by WS-Nevada in the year with the highest WS-Nevada take between FY 2012- FY 2016.

[7] The proportion of the estimated species population taken by all sources in the year with the highest take between FY 2012- FY 2016.

[8] Represents the maximum WS-Nevada could annually take under the current program (Alternative 1) given the potential for fluctuations in program delivery and the modified current program (Alternative 2), given the potential for fluctuations in program delivery (Appendix E).

[9] Provides a conservative estimate of the highest proportion of the estimated species population that could be taken by WS-Nevada, under projected WS annual maximum take scenario.

[10] Provides a conservative estimate of the highest proportion of the estimated species population that could be taken by all sources, under projected WS annual maximum take scenario.

3.5.13.4 *Conclusion: Kit Fox*

Given the stable population trend for kit fox in the state and the low cumulative impacts on the kit fox population from all causes, WS-Nevada has concluded that the proposed action (removal of up to 40 kit fox) will not adversely impacted the size or sustainability of the population. This conclusion is consistent with NDOW kit fox population trend information (NDOW 2017d). The proposed take represents an increase over the current average take by WS-Nevada. While WS-Nevada expects the current take level (average of 1.6 per year) to continue, an increase in requests for assistance where kit foxes may be encountered may result in an increase up to the analyzed maximum take by WS-Nevada. Cumulative impacts on the statewide kit fox population would still be expected to remain low relative to the annual maximum sustainable harvest level. Given the low proportion of cumulative take, and even lower WS-Nevada take, direct and cumulative impacts from analyzed take would not adversely affect the Nevada kit fox population.

3.5.14 *What are the Direct and Cumulative Impacts on Gray Fox Populations?*

3.5.14.1 *Gray Fox Life History Information*

Gray foxes prefer scattered forest, chaparral, and rimrock-dominated landscapes, from southeastern Canada through the central United States to Oregon, and south to western Venezuela. Gray foxes are found throughout Nevada.

Like those of the red foxes, gray fox diets include rodents and other small prey items. Gray foxes are very omnivorous as well and feed on fruit and berries. Gray fox kits are born in dens in April or May, staying nearby until they are about 3 months old.

3.5.14.2 *Gray Fox Population Information*

Gray foxes are classified as a furbearing mammal by NDOW and can be found throughout Nevada. A furtaker's or hunter's license is required to take gray foxes on public or private lands, which may be recreationally harvested with no bag limit. Gray foxes can be taken during furbearer hunting season (e.g. October 01, 2017 through February 28, 2018) with the exception of those areas closed to hunting and trapping as listed in NAC 504.340 (Section 2.4.4.3). Under NRS §502.470 (Section 2.4.4.1), landowners and commercial wildlife control operators can also conduct kit fox removal work on private land to mitigate damage, public health risks, or public nuisances with a depredation permit. Under NRS 503.470, furbearing mammals injuring any property can be taken at any time with any method by the owner or occupant of the property or with the permission of the owner or occupant. All take by a landowner, furtaker, or WCO must be reported to NDOW annually.

Gray fox densities have been difficult to ascertain because gray foxes are elusive and have large home ranges (Cypher 2003), but are considered tied to habitat productivity (Trapp and Hallberg 1975). Trapp and Hallberg (1975) synthesized several studies of gray fox densities to calculate a range of 1 to 27/mi^2 in the United States. Similarly, Fritzell and Haroldson (1982) compiled several studies to conclude a range of 3.1 to 5.4/ mi^2, depending on location, season, and method of estimation. Weston-Glenn et al. (2009) reports gray fox densities to be 2.51/mi^2 in South Carolina, but noted that gray fox populations at this location are high-density, likely due to high-quality habitat.

NDOW estimates the Nevada statewide gray fox population at 88,500 utilizing USGS GAP analysis data which uses maps that delineate topographical, biological and geological features to identify habitats, the GAP data for the species are paired with habitat suitability models that specify known habitat requirements. With the resulting maps, NDOW has available statewide available habitat/species. This information used in conjunction with biological density and home range data is used to generate the population estimates. Density and home range data are derived from Nevada research if available and nearby states with similar habitat if not (NDOW 2017d). This data is complimented from mandatory furbearer harvest reports information to set furbearer harvest seasons and limits. The annual sustainable harvest level for gray foxes has been estimated to be 25% (Fritzell 1987), or about 22,125 gray foxes in Nevada (Table 3.15).

3.5.14.3 *Gray Fox Population Impact Analysis*

3.5.14.3.1WS-Nevada Direct Effects on Gray Foxes

In response to requests for assistance with gray fox damage between FY 2012 and 2016, WS-Nevada intentionally removed 0 gray foxes. WS-Nevada unintentionally removed an average of 0.2 gray foxes per year during the analysis period. Although gray fox are may be taken for PDM in any county, this unintentionally taken gray fox was taken in Lincoln county on BLM land with the use of a foothold trap (MIS 2018, Table 2.3). Gray foxes are generally taken by foothold traps, neck snares, and firearms (Table 2.1, Appendix E, Table E.1).

Based on the number of cooperative service agreements, county, state and federal budgetary constraints, and projected future requests for assistance, WS-Nevada expects that future gray fox removals for PDM in Nevada would be similar to take during the last 5 years. However, WS-Nevada must be able to respond to requests for assistance to meet the need for action. While WS-Nevada expects for the need for PDM to stay close to the past, the analysis includes the take of more individuals to accommodate unforeseen needs. Therefore, under Alternative 1 (current program with fluctuations in program delivery) and Alternative 2 (modified current program with fluctuations in program delivery), the projected WS annual maximum take is 20 gray fox.

3.5.14.3.2 Cumulative Mortality

Various sources of gray fox removal contribute to the cumulative take of gray foxes in Nevada (Table 3.14). Take reported to NDOW included an annual average take of 1,405 gray foxes as recreational harvest (Table 3.14).

The average annual cumulative take of gray fox is 1,405.2 per year. The largest cumulative take was 1,943 gray foxes per year, approximately 2.20% of the population, with WS-Nevada contributing under 0.00% of the cumulative amount, relative to the annual maximum sustainable harvest of 25% (Table 3.14). If WS-Nevada were to take the annual maximum take of 20 gray foxes, the projected cumulative take would be approximately 2.22% of the total estimated population, with WS-Nevada contributing 0.02% to the cumulative amount.

3.5.14.4 *Conclusion: Gray Fox*

Given the stable population trend for gray fox in the state and an annual maximum sustainable harvest level of 25%, and after considering cumulative impacts on the grey fox population from all causes, WS-Nevada has concluded that the proposed action (take of up to 20 grey fox per year) will not adversely impact the size or sustainability of the Nevada gray fox population. This conclusion is consistent with NDOW gray fox population trend information (NDOW 2017d).

The proposed action is an increase over the current average take by WS-Nevada. While WS-Nevada expects the current take level (average of 0.2 grey fox per year) to continue, increases in requests for assistance with gray fox may result in take increases up to the analyzed maximum take by WS-Nevada. Cumulative impacts on the statewide gray fox population would still be expected to remain low relative to the annual maximum sustainable harvest level. Given the low proportion of cumulative take, and even lower WS-Nevada take, direct and cumulative impacts from analyzed take would not adversely affect the Nevada gray fox population.

Table 3-14. Population Impact Analysis of Gray Fox Take in Nevada, FY 2012-2016.

Mortality source	2012	2013	2014	2015	2016	5-year average	5-year high
WS intentional take[1]	0	0	0	0	0	0	0
WS unintentional take[1]	0	1	0	0	0	0.2	1
WCO take[2]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Other damage take[3]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hunting harvest[4]	1,760	1,680	1,942	1,045	598	1,405	1,942
Total WS take	0	1	0	0	0	0.2	1
Total non-WS take	1,760	1,680	1,942	1,045	598	1,405	1,942
Cumulative take	1,760	1,681	1,942	1,045	598	1,405.2	1,943
Statewide population estimate[5]:							88,500 gray foxes
Annual maximum sustainable harvest[5]:							25% (22,125 gray foxes)
Current total WS take as a % of the population[6]:							0.00% (1 gray foxes)
Current cumulative take as a % of the population[7]:							2.20% (1,943 gray foxes)
Projected WS annual maximum take[8]:							20 gray foxes
Projected total WS take as a % of the population[9]:							0.02% (20 gray foxes)
Projected annual cumulative take as a % of the population[10]:							2.22% (1,962 gray foxes)

[1] (MIS 2018).

[2] Data are not available (P.Jackson Pers. comm. 03/29/2018). Wildlife Control Operator (WCO) licenses are issued by NDOW (NAC 503.095).

[3] Represents the number of animals taken by landowners, NDOW, or others as a result of damage. This take is included in Recreation take and fewer than 10 in all years (R. Woolstenhulme Pers. comm., 03/26/2018).

[4] Represents the number of animals taken during hunting and trapping harvest seasons (NDOW 2017d).

[5] See Section 3.5.14.2 Gray Fox Population Information. All estimates are rounded up.

[6] The proportion of the estimated species population taken by WS-Nevada in the year with the highest WS-Nevada take between FY 2012- FY 2016.

[7] The proportion of the estimated species population taken by all sources in the year with the highest take between FY 2012- FY 2016.

[8] Represents the maximum WS-Nevada could annually take under the current program (Alternative 1) given the potential for fluctuations in program delivery and the modified current program (Alternative 2), given the potential for fluctuations in program delivery (Appendix E).

[9] Provides a conservative estimate of the highest proportion of the estimated species population that could be taken by WS-Nevada, under projected WS annual maximum take scenario.

[10] Provides a conservative estimate of the highest proportion of the estimated species population that could be taken by all sources, under projected WS annual maximum take scenario.

3.5.15 *What are the Direct and Cumulative Impacts on Feral and Free-Ranging Dog Populations?*

3.5.15.1 *Feral and Free-ranging Dogs Life History*

Feral and free-ranging dogs are somewhat common in certain areas in Nevada, where they often run in packs and prey on and harass livestock and poultry. Free-ranging dogs may be subsidized by food provided by owners, and depredation and harassment may be recreational. They can also cause safety concerns for people through threats and attacks. Free-ranging and feral dogs are also known to prey on and harass native wildlife such as deer and upland game. Primary responsibility for dog control rests with state, county, and municipal authorities.

Feral and free-ranging dogs are not part of the native environment and when left abandoned in the wild, feral and free-ranging dogs pose ecological problems because they can prey on native wildlife. Feral and free-ranging dogs may also carry and spread diseases, such as rabies and parvovirus (CDC 2016).

3.5.15.2 *Feral and Free-ranging Dog Population Information*

Feral and free-ranging dogs are not managed by the State in Nevada and no population estimates are available. There are an estimated 83.3 million dogs in the United States, but it is unknown how many have become feral or free-ranging (Bergman et al. 2009).

Primary responsibility for dog control rests with state, county, and local authorities or the resource owner/manager. However, because of Nevada's cooperative wildlife damage management responsibilities and the seriousness of the problem, WS-Nevada personnel are authorized to respond to requests for assistance with feral and free-ranging dogs for the protection of livestock, poultry, and human health and safety, primarily on private lands (Table 2.2). Most dogs are taken by foothold traps, neck snares, or M-44 devices (Table 2.1, Appendix E, Table E.1). Efforts to address damage associated with feral and free-ranging dogs would be conducted in accordance with WS Directive 2.340 (Section 2.4 A) for controlling dogs.

WS-Nevada personnel are only authorized to control feral or free-roaming dogs to protect livestock, poultry, and human health and safety when requested by the sheriff or other authority (WS Directive 2.340, Section 2.4.1.15). Consequently, most requests for assistance go to other agencies.

3.5.15.3 *Feral and Free-ranging Dog Population Impact Analysis*

3.5.15.3.1 WS-Nevada Direct Effects on Feral and Free-ranging Dogs

In response to requests for assistance involving dogs, WS-Nevada intentionally removed an average of 2.4 feral and free-ranging dogs per year between FY 2012 and 2016 (Table 3.15). WS-Nevada unintentionally removed an average of 0.2 feral and free-ranging dogs per year during the analysis period.

The lethal removal of feral and free-ranging dogs by WS-Nevada has little impact on the human environment because feral and free-ranging dogs are not an indigenous component of ecosystems in Nevada. WS-Nevada addresses feral and free-ranging dogs at the request of the local authority for animal control and, thus, this action would likely occur in the absence of involvement by WS-Nevada. WS-Nevada expects the annual lethal removal of feral and free-ranging dogs in Nevada to remain similar to previous years. However, WS-Nevada must be able to respond to requests for assistance to meet the need for action. While WS-Nevada expects for the need for PDM to stay close to the past, the analysis includes the take of more individuals to accommodate unforeseen needs. Therefore, under Alternative 1 (current program with fluctuations in program delivery) and Alternative 2 (modified current program with fluctuations in program delivery), the projected WS annual maximum lethal take is 30 feral and free-ranging dogs, with no limit on the number of feral and free-ranging dogs that can be transferred to the custody of Animal Services.

3.5.15.3.2 Cumulative Mortality

Various sources of feral and free-ranging dog removals contribute to the cumulative take of feral and free-ranging dogs in Nevada (Table 3.15). Other non-WS sources of take of feral and free-ranging dogs are not recorded or reported, but are known to occur.

3.5.15.4 *Conclusion: Feral and Free-ranging Dogs*

Feral and free-ranging dogs are not an indigenous component of Nevada ecosystems and are taken under very limited circumstances. Therefore, WS-Nevada concludes that the cumulative impact of all recorded feral and free-ranging dog mortality in Nevada, including intentional and unintentional take by WS-Nevada, would not adversely impact the feral and free-ranging dog population in Nevada.

Table 3-15. Population Impact Analysis of Feral and Free-ranging Dog Take in Nevada, FY 2012-2016.

Mortality source	2012	2013	2014	2015	2016	5-year average	5-year high
WS intentional take[1]	12	0	0	0	0	2.4	12
WS unintentional take[1]	0	0	0	0	1	0.2	1
Total WS take	12	0	0	0	1	2.6	13
Total non-WS take	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Cumulative take	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Statewide population estimate[2]**:**							unknown
Annual maximum sustainable harvest:							unknown
Current total WS take as a % of the population[3]**:**							unknown (13 feral and free-ranging dogs)
Current cumulative take as a % of the population:							unknown
Projected WS annual maximum take[3]**:**							lethal take of 30 feral and free-ranging dogs; any number of feral and free-ranging dogs can be transferred to Animal Services custody
Projected total WS take as a % of the population:							n/a
Projected annual cumulative take as a % of the population:							unknown

[1] (MIS 2018).

[2] See Section 3.5.15.2 Feral and Free-ranging Dog Population Information. Feral and free-ranging dogs are not managed by NDOW, and as such, there is no population estimate.

[3] See Section 3.5.15.3 WS-Nevada-Direct Effects on Feral and Free-ranging Dogs.

3.5.16 *What are the Direct and Cumulative Impacts on Western Spotted Skunk Populations?*

3.5.16.1 *Western Spotted Skunk Life History Information*

The geographic range of the western spotted skunk extends from central Mexico through the western United States to British Columbia, including Nevada.

The western spotted skunk can be found in a wide variety of habitats, but primarily in brushy or sparsely wooded areas and deserts. Spotted skunks prefer open lowlands but are equally at home in mountainous country (Baker and Baker 1975). They are found in a variety of habitats, including farmyards, wasteland, and chaparral. They usually avoid wetlands and timbered areas. Preference is shown for cover along fences, embankments, gullies, hedgerows, and barns (Crabb 1948), as well as rocky areas (Davis 1945). Almost any location will serve as a den for spotted skunks, including buildings around farmyards, underground burrows, hollow trees, and woodpiles to hay and straw stacks or rocky crevices. They can climb well and sometimes shelter in trees (Hall and Kelson 1959, Ewer 1973, Patton 1974). Spotted skunks are more nomadic than striped skunks and usually do not have a permanent den (Howard and Marsh 1982).

The western spotted skunk exhibits delayed implantation of eggs and breeds during late summer. Some juvenile males are sexually mature by September, and both adult and juvenile females breed during September (Howard and Marsh 1982). Mean litter sizes of four have been reported for spotted skunks (Howard and Marsh 1982). Spotted skunks have one litter per year and young are born in April and May (Mead 1968, Maser et al. 1981).

Skunks primarily cause odor problems around homes, can transmit diseases such as rabies to humans, wildlife, and domestic animals, and sometimes prey on poultry and their eggs.

3.5.16.2 *Western Spotted Skunk Population Information*

Western spotted skunks are classified as an unprotected mammal in Nevada and as such can be hunted at any time without a hunting license (NAC 503.193), however to take a western spotted skunk with a trapping device, a trapping license is required (NRS 503.454) unless taken under a state issued depredation permit (NAC 503.193), in which case the take must be reported to NDOW yearly.

Density estimates for the western spotted skunks range from 22.79 to 103.6/mi^2, with an average estimate of 63.2/mi^2 (Crooks and VanVuren 1995, Kinlaw 1995, Nowak 1999, Crooks 2002). Crabb (1948) found the similar prairie spotted skunk (*Spilogale putorius*) had a density of 13/mi^2. Burt and Grossenheider (1980) also reported a density of 13/mi^2 for the spotted skunk. California Department of Fish and Game (1995) reported a range of 1 to 5.7 western spotted skunks/mi^2.

Spotted skunks are less abundant in Nevada than are striped skunks. The most conservative density estimate for western spotted skunk of 1/mi^2 seems too high given the conservative estimate of 0.26/mi^2 for striped skunks (Section 3.5.5). By comparing the ratio of the low density estimates between spotted and striped skunks (1:1.3) by California Department of Fish and Game (1995), the density of western spotted skunks should proportionally be about a quarter less than the density of striped skunks in Nevada. Therefore, the density of 0.2 spotted skunks/mi^2 will yield a conservative breeding population estimate of 22,113 western spotted skunks in Nevada.

There are no estimates of annual maximum sustainable harvest levels for western spotted skunks in the scientific literature. However, an annual maximum sustainable harvest level can be estimated by utilizing reproductive data from the literature. Since several spotted skunk species or sub-species have a slightly higher male to female sex ratio (Crabb 1948, Mead 1968, Crooks 1994), a 1.3:1 male to female sex ration will be used. In a breeding population of 22,113 western spotted skunks, there are 9,614 breeding females in Nevada. Given the average of 4 young per litter and only one litter per year, a total of 38,456 young are produced statewide each year.

Annual juvenile and adult mortality rates for western spotted skunk are not available from the peer-reviewed literature. Therefore, the number of juveniles surviving one full year to become sexually mature and recruited into the adult breeding population is unknown. Additionally, the number of adults in the original breeding population surviving to breed again the following year is unknown.

Population trends are not estimated by NDOW for spotted skunks in Nevada because the amount of take is insignificant to the population (less than 1%) (Russell Woolstenhulme, NDOW, pers. comm., 06/13/2018). Assuming the original population of 22,113 died by the end of year 1 (which is highly unlikely), the new 22,113 juvenile spotted skunks would need to survive to adulthood in order to maintain a stable population level. The minimum number of juvenile spotted skunks (22,113) is 57.5% of the total number of spotted skunks born each year (38,456). Therefore, the annual juvenile mortality rate can be estimated as 42.5% (Table 3.16).

Since the juvenile mortality rate is not verified by scientific study, the annual maximum sustainable harvest level for the western spotted skunk in Nevada cannot be estimated. However, spotted skunk take in Nevada, in relation to the population size is insignificant (under 1%) (R. Woolstenhulme, NDOW, Pers. Comm., 6/13/2018).

3.5.16.3 *Western Spotted Skunk Population Impact Analysis*

3.5.16.3.1WS-Nevada Direct Effects on Spotted Skunks

In response to requests for assistance for spotted skunk damage between FY 2012 and 2016, WS-Nevada intentionally removed an average of 0.2 spotted skunks per year, all on county/city lands (Table 2.2), in Washoe County (Table 2.3), captured primarily with cage traps and euthanized with sodium pentobarbital (Table 2.1, Appendix E, Table E.1). WS-Nevada did not unintentionally remove any spotted skunks during the analysis period.

Based on the number of cooperative service agreements, county, state and federal budgetary constraints, and projected future requests for assistance, WS-Nevada expects that future spotted skunk removals for PDM would be similar to take during the last 5 years. However, WS-Nevada must be able to respond to requests for assistance to meet the need for action. While WS-Nevada expects for the need for PDM to stay close to the past, the analysis includes the take of more individuals to accommodate unforeseen needs. Therefore, under Alternative 1 (current program with fluctuations in program delivery) and Alternative 2 (modified current program with fluctuations in program delivery), the projected WS annual maximum lethal take would be 20 spotted skunks.

3.5.16.3.2 Cumulative Mortality

Various sources of spotted skunk removals contribute to the cumulative take of spotted skunks in Nevada (Table 3.16). During 2012 through 2016, an annual average of 29.8 spotted skunks were taken as recreational harvest (Table 3.16).

The average annual cumulative take of spotted skunks is 30 per year. The largest cumulative take was 49 spotted skunks per year, approximately 0.22% of the population, with WS-Nevada contributing 0.00% of the cumulative amount (Table 3.16). If WS-Nevada were to take the annual maximum take of 20 spotted skunks, the projected cumulative take would be approximately 1.91% of the total estimated population, with WS-Nevada contributing 0.09% to the cumulative amount.

3.5.16.4 *Conclusion: Spotted Skunk*

Based on the low level of take in relation to the population size for spotted skunk in the state and the low unintentional take, cumulative impacts on the spotted skunk population from all causes, including take by WS-Nevada, is not adversely impacting the population.

Therefore, WS-Nevada concludes that the cumulative impact of all recorded spotted skunk mortality in Nevada, including the proposed take by WS-Nevada (up to 20 per year), would not adversely impact the size or sustainability of the Nevada spotted skunk population, this conclusion is supported by NDOW (R. Woolstenhulme, NDOW, pers. comm., 06/13/18).

Should an increase in requests for assistance with spotted skunk result in the projected annual WS maximum take, cumulative impacts on the statewide spotted skunk population would still be expected to remain low relative to the annual maximum sustainable harvest level. Given the low proportion of cumulative take, and even lower WS-Nevada take, direct and cumulative impacts from take would not adversely impact the size or sustainability of the Nevada spotted skunk population.

Table 3-16. Population Impact Analysis of Western Spotted Skunk Take in Nevada, FY 2012-2016.

Mortality source	2012	2013	2014	2015	2016	5-year average	5-year high
WS intentional take[1]	1	0	0	0	0	0.2	1
WS unintentional take[1]	0	0	0	0	0	0	0
WCO take[2]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Hunting harvest[3]	48	27	39	32	3	29.8	48
Total WS take	1	0	0	0	0	0.2	1
Total non-WS take	48	27	39	32	3	29.8	48
Cumulative take	49	27	39	32	3	30	49
Statewide population estimate[4]:						22,113 spotted skunks	
Annual maximum sustainable harvest[4]:						unknown	
Current total WS take as a % of the population[5]:						0.00% (1 spotted skunks)	
Current cumulative take as a % of the population[6]:						0.22% (49 spotted skunks)	
Projected WS annual maximum take[7]:						20 spotted skunks	
Projected total WS take as a % of the population[8]:						0.09% (20 spotted skunks)	
Projected annual cumulative take as a % of the population[9]:						1.91% (423 spotted skunks)	

[1] (MIS 2018).

Data are not available (P.Jackson, NDOW, Pers. comm. 03/29/2018). Wildlife Control Operator (WCO) licenses are issued by NDOW (NAC 503.095).

[3] Represents the number of animals taken during hunting and trapping harvest seasons (NDOW 2017c).

[4] See Section 3.5.16.2 Western Spotted Skunk Population Information. All estimates are rounded up.

[5] The proportion of the estimated species population taken by WS-Nevada in the year with the highest WS-Nevada take between FY 2012- FY 2016.

[6] The proportion of the estimated species population that could have been taken by all sources in the year with the highest take between FY 2012- FY 2016.

[7] Represents the maximum WS-Nevada could annually take under the current program (Alternative 1) given the potential for fluctuations in program delivery and the modified current program (Alternative 2), given the potential for fluctuations in program delivery (Appendix E).

[8] Provides a conservative estimate of the highest proportion of the estimated species population that could be taken by WS-Nevada, under projected WS annual maximum take scenario.

[9] Provides a conservative estimate of the highest proportion of the estimated species population that could be taken by all sources, under projected WS annual maximum take scenario.

3.5.17 *What are the Direct and Cumulative Impacts on Other Predator Species?*

3.5.17.1 *Other Predator Species Population Impact Analysis*

3.5.17.1.1WS-Nevada Direct Effects on Minks, Weasels and Ring-tailed Cats

WS-Nevada had no intentional or unintentional take of minks, weasels or ring-tailed cats during FY2012 through FY2016. WS-Nevada receives rare infrequent complaints involving these species and may conduct operational control in the future to take depredating animals. Unless equipment is specifically set to capture them, the PDM methods mostly used by WS-Nevada exclude these species because of their size and weight. These species are found at moderate levels locally within their range in the state.

During FY2012-2016, fur harvesters took 124, 212, 204, 84 and 70 minks, 19, 11, 2, 0 and 7 weasels, and 36, 33, 49, 15 and 19 ring-tailed cats, respectively. Take for these species by other sources such as Wildlife Control Operators (WCO's) is not available (P.Jackson, NDOW, Pers. comm. 03/29/2018). Wildlife Control Operator (WCO) licenses are issued by NDOW (NAC 503.095).

Based on the number of cooperative service agreements, county, state and federal budgetary constraints, and projected future requests for assistance, WS-Nevada expects that future mink, weasel, and ring-tailed cat removals for PDM would be similar to take during the last 5 years. Since WS-Nevada did not take any of these species in the past 5 years but could be asked to assist with mink, weasels and ring-tailed cats it is reasonably foreseeable that WS-Nevada could have minimal levels of take. However, even with minimal take by WS-Nevada, these populations are highly unlikely to be cumulatively negatively affected by WS-Nevada PDM efforts. Therefore, under Alternative 1 (current program with fluctuations in program delivery) and Alternative 2 (modified current program with fluctuations in program delivery), unless a substantive project is proposed that may involve the annual take of more than 15 mink, 5 weasels or 15 ring-tailed cats, WS-Nevada will not analyze population impacts further.

3.5.17.2 *Conclusion: Other Predator Species*

Mink, weasel and ring-tailed cat take in Nevada, in relation to the population size is insignificant (under 1%) (R. Woolstenhulme, NDOW, Pers. comm., 6/13/2018). As such, take by WS-Nevada and other known take on the mink, weasel and ring-tailed cat populations from all causes, is not adversely impacting the population.

Therefore, WS-Nevada concludes that the cumulative impact of all recorded mink, weasel and ring-tailed cat mortality in Nevada, including the proposed levels of take by WS-Nevada , would not adversely impact the size or sustainability of the Nevada mink, weasel or ring-tailed cat population. This conclusion is supported by NDOW (R. Woolstenhulme, NDOW, pers. comm., 06/13/2018).

Should an increase in requests for assistance with mink, weasel or ring-tailed cat result in the projected annual WS-Nevada maximum take (15 mink, 5 weasels and 15 ring-tailed cats), cumulative impacts on the statewide weasel population would still be expected to remain low relative to the annual maximum sustainable harvest level. Given the low number of cumulative take, and even lower WS-Nevada annual maximum take, direct and cumulative impacts from take would not adversely impact the size or sustainability of the Nevada mink, weasel or ring-tailed cat populations.

3.5.18 *What are the Comparative Impacts of the Alternatives on Predator Populations?*

3.5.18.1 *Alternative 1. No Action Alternative: Continue WS-Nevada PDM Assistance Outside of Wilderness Areas and Wilderness Study Areas*

The take for all target predator species killed by WS-Nevada on all land classes is presented for each species as a yearly total and 5 year average for FY 2012- FY 2016 (Tables 3.2 through 3.16) and summarized in Table 3.17. Between FY 2012 and FY 2016, the target species with the greatest average yearly take by WS-Nevada for IPDM were coyotes (*n*=4,370.2), common ravens (*n*=3,826.2), badgers (*n*=47.8) and mountain lions (*n*=24). All other predator species intentionally taken by WS-Nevada are at an average of less than 17 per year. Table 2.2 provides intentional lethal take proportions for the top 99.5% of predators as: Coyotes (52.7%), common ravens (45.9%), badgers (0.6%), mountain lions (0.3%).

Virtually all resource owners have used or attempted one or more non-lethal methods on their own prior to non-lethal and/or lethal assistance from WS-Nevada (Appendix C). Environmental factors that may impact the extent to which animals are attracted to human-related food sources; fluctuations in livestock markets and herd population dynamics; predator population dynamics; range expansion by predators, humans, pets, and livestock; ability to crew aircraft; and IPDM funding fluctuations affect WS-Nevada's capability to respond to requests for assistance. Regardless, WS-Nevada expects that intentional take of predators in the foreseeable future will be similar to levels recorded from FY 2012 through FY 2016.

For all predator species in Nevada included within the scope of this EA, the annual statewide known cumulative take is substantially below the annual maximum sustainable harvest level (Tables 3.2 through 3.17) as determined by a review of the available scientific literature. As indicated in the summary Table 3.18, the current cumulative take as a percentage of the population is below 10% of the annual maximum sustainable harvest level for all predator species, except for mountain lions, bobcats, black bears, kit fox, red fox and coyotes. Annual cumulative take of mountain lions is 30.27% of the annual maximum sustainable harvest level, 74.07% for bobcats, 48.18% for black bears, 38.28% for kit fox, 11.36% for red fox and 18.33% for coyotes, indicating that cumulative take of all species is sufficiently far below the level of take that could adversely affect the statewide populations of all predator species.

The proportion of take by WS-Nevada compared to the highest cumulative take shows that WS-Nevada has substantially lower total and proportional take of all species (except coyotes and common ravens) compared to non-WS-Nevada sources. WS-Nevada only takes 9.87% of the cumulative take of coyotes compared to 8.46% for other sources of known mortality, 2.26% of the cumulative take of common ravens compared to 0.07% for other sources of mortality, 1.28% of the cumulative take of mountain lions compared to 7.8% for other sources of mortality, 0.55% of the cumulative take of black bears compared to 9.09% for other sources of mortality, and 0.03% of the cumulative take of bobcat compared to 14.78% for other sources of mortality. Even considering the projected WS annual maximum take, WS-Nevada take for every species is below the annual maximum sustainable harvest level to ensure healthy and stable or increasing predator populations.

All predator species populations targeted by WS-Nevada are stable as determined by NDOW (NDOW, unpublished reports) or Partners in Flight Science Committee (2013) for common ravens (Amedee Brickey, pers. Comm., 01/11/2018). Populations of free-ranging/feral cat and feral/free ranging dog populations are unknown, and many free-ranging cats and dogs live with and are subsidized by their owners. Cumulative take and WS-Nevada's direct incremental contribution to that cumulative take are substantially below the maximum sustainable harvest levels for all species. Even with unknown take, all predator populations continue to be healthy and sustainable as determined by NDOW and these analyses. WS-Nevada is not and would not adversely impact any native predator populations.

Table 3-17. Summary of WS-Nevada Intentional Take and Known Cumulative Take, FY 2012-2016[1].

Species	Current total WS take as a % of the population[2]	Current cumulative take as a % of the population[3]	Projected annual cumulative take as a % of the population[4]	Annual maximum sustainable harvest[1]
Coyote	9.87%	18.33%	24.85%	60%
Common raven	2.26%	2.33%	10%	10%[5]
Black bear	0.55%	9.64%	10.91%	20%
Striped skunk	0.09%	0.64%	0.87%	60%
Raccoon	0.02%	0.20%	0.26%	49%
Mountain lion	1.28%	9.08%	9.80%	30%
Red fox	0.41%	7.95%	9.36%	70%
Badger	0.12%	0.49%	0.69%	30%
Bobcat	0.03%	14.81%	14.93%	20%
Feral and free-ranging cat	--	--	--	unknown
Kit fox	0.01%	1.34%	1.38%	3.38%
Gray fox	0.00%	2.20%	2.22%	25%
Feral and free-ranging dog	--	--	--	unknown
Western spotted skunk	0.00%	0.22%	1.91%	unknown[6]
Weasel	0%	<0.1%	<0.1%	20%

[1] These data are from Tables 3.2 through 3.16. All percentages rounded to nearest 0.01%.

[2] The proportion of the estimated species population taken by WS-Nevada in the year with the highest WS-Nevada take between FY 2012- FY 2016.

[3] The proportion of the estimated species population taken by all sources in the year with the highest take between FY 2012- FY 2016.

[4] Provides a conservative estimate of the highest proportion of the estimates species population that could be taken by all sources, under projected WS annual maximum take scenario.

[5] Appendix D.

[6] Western spotted skunk population trends are estimated by NDOW to be stable.

3.5.18.2 *Alternative 2. Proposed Action/Modified Current Program*

Under this alternative, WS-Nevada would continue the current program as modified to include PDM in WAs and WSAs to protect livestock, human health and safety, federally threatened and endangered species and conduct disease surveillance. Impacts of this alternative on predator species would be similar to those evaluated in Alternative 1. Although there would likely be an increase in the number of predators taken due to the inclusion of WAs and WSAs, WS-Nevada would not exceed the maximum take analyzed for alternative 1 for any species. Additionally, it is likely that unreported take of unprotected coyotes was already occurring in WAs and WSAs by herders, tenders, and possibly hired hands for sheep protection.

Predator take is likely also occurring by sportsmen in WAs and WSAs (e.g. take by fur harvesters, sport take of mountain lions). This would likely be a form of compensatory take. Cumulative take would not likely approach the annual maximum sustainable harvest levels established for the predator species, even with reasonably foreseeable levels of increased take by WS-Nevada.

3.5.18.3 *Alternative 3. Non-lethal PDM Required Before Applying Lethal Assistance (No Preventive Lethal PDM)*

Under Alternative 3, WS-Nevada would not conduct preventive lethal PDM and would use non-lethal methods first, and until proven ineffective, in response to each request for assistance regardless of severity, intensity, and immediacy of the damage or threat or the results of application of the APHIS-WS Decision Model. Lethal methods applied by WS-Nevada would have similar impacts on predator populations as those analyzed under Alternatives 1 and 2 as cooperators already apply reasonable non-lethal methods (Appendix B). Non-lethal methods would not likely contribute substantially to direct or cumulative impacts on predator species. The APHIS-WS Decision Model may not be fully effective because if they are deemed necessary, lethal actions could not be used by WS-Nevada during the time that non-lethal methods are attempted to address the immediate problems. Other commercial, governmental, and private entities and landowners would be likely to continue to conduct PDM activities as described in Section 3.4.

Other entities would likely increase lethal PDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada. During (or instead of) WS-Nevada's non-lethal assistance, landowners/resource owners could still choose to address the problem themselves. If landowners/resource owners determined that lethal PDM is immediately necessary, they may implement lethal methods before applying all reasonable non-lethal methods. Landowners/resource owners could use trained and experienced WCOs or may implement lethal methods themselves. However, entities requesting lethal assistance would have to determine if a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Additionally, private individuals are not likely to have the consistent training with lethal methods, the experience to confirm the cause of damage, or the level of selectivity possessed by WS-Nevada employees. Take of unprotected mammals by private individuals or their agent is not required to be reported to NDOW, potentially resulting in under reporting, compared to WS-Nevada's reporting under Alternatives 1 and 2.

Cumulative levels of take would be expected to be similar to Alternative 1 and would not be expected to near the maximum sustainable harvest levels for predator species. Therefore, predator populations are expected to be stable with similar levels of impacts as under Alternative 1.

3.5.18.4 *Alternative 4. WS-Nevada Provides IPDM Lethal Assistance Only for Cases of Human/Pet Health*

Under Alternative 4, WS-Nevada would provide full IPDM technical and operational assistance (Appendix A), but lethal control could only be included as an option when responding to requests to protect human/pet health or safety. WS-Nevada could not use lethal methods as part of IPDM to respond to other types of requests (e.g., agriculture, property, and game species). For threats to human and pet health or safety, the primary predator species of concern would be black bears, mountain lions, or coyotes in residential areas, or disease vector species. hen WS-Nevada responds with lethal control under the limited circumstances allowable under this alternative, the impacts on predator populations from WS-Nevada would be less than those described for Alternatives 1, 2 and 3, because fewer predators are removed by WS-Nevada under this alternative. Other commercial, governmental, and private entities and landowners would continue to conduct IPDM activities as described in Section 3.4. Other entities would likely increase IPDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada.

However, since WS-Nevada would not be able to respond with lethal methods to damage or threats to any other resources or situations. Entities requesting lethal assistance would have to determine if a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Additionally, private individuals are not likely to have the consistent training with lethal methods, the experience to confirm the cause of damage, or the level of selectivity possessed by WS-Nevada employees. Take of unprotected mammals by private individuals or their agent is not required to be reported to NDOW, potentially resulting in underreporting, compared to WS-Nevada's reporting under Alternatives 1 and 2.

Cumulative levels of take would be expected to be less than Alternative 1 and would not be expected to near the maximum sustainable harvest levels for predator species. Therefore, predator populations are expected to be stable with similar levels of impacts as under Alternative 1.

3.5.18.5 *Alternative 5. No WS-Nevada IPDM Activities*

Under this alternative, WS-Nevada would have no effect on predator populations. PDM would still be implemented by other legally-authorized entities, such as NDA-Wildlife Services (including use of DRC-1339 for common raven damage/removal). Landowners and resource owners experiencing damage or threats would depend on advice and responses from NDA-Wildlife Services, NDOW, commercial WCOs, or other entities. Entities requesting lethal assistance would have to determine if a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Other entities would likely increase IPDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada.

Without WS-Nevada's resources, technical and operational assistance, other entities may be less efficient and effective, potentially resulting in more predators being taken. Additionally, private individuals are not likely to have the consistent training with lethal methods, the experience to confirm the cause of damage, or the level of selectivity possessed by WS-Nevada supervised employees. Take of unprotected mammals by private individuals or their agent is not required to be reported to NDOW, potentially resulting in underreporting, compared to WS-Nevada's reporting under Alternatives 1 and 2.

In the absence of WS-Nevada's assistance, the effects on predator species populations would likely be less than Alternatives 1 and 2 and higher than under Alternatives 3 and 4.

3.6 What are the Effects of WS-Nevada IPDM on Threatened and Endangered Species?

WS-Nevada is responsible for ensuring its actions are in compliance with the federal Endangered Species Act (ESA) which is the focus of this section.

The State of Nevada has a wildlife classification system that includes sensitive, threatened and endangered species (NAC 503.030, 503.050, 503.065 and NRS 503.584 thru NRS 503.589). Many of the Nevada classified threatened and endangered species are also included on the federal list and therefore have been considered in this EA. Federal ESA always supersedes State threatened and endangered species laws if the protections are more stringent.

3.6.1 *How Has WS-Nevada Considered Potential Impacts on Threatened and Endangered Species?*

As a federal agency, WS-Nevada reviews its proposed activities for the potential to affect federally-listed threatened and endangered (T&E) species. When WS-Nevada determines a listed species may potentially be affected by its activities in any way, it consults with the USFWS pursuant to Section 7 of the ESA. WS-Nevada has completed informal and formal consultation with the USFWS for effects from all of its activities on federally-listed T&E species. The effects analyses and findings pertinent to this EA are based on consultations completed on August 27, 2018: informal consultation on all species that may be affected, except desert tortoise; formal consultation and Biological Opinion on desert tortoise. The pertinent descriptions of WS-Nevada IPDM activities that are incorporated into the Biological Opinion and in the informal consultation are included in Section 2.3.1 for Alternative 1 and detailed in Appendix A.

Except for effects on desert tortoise, WS-Nevada determined that proposed IPDM activities, either would have no effect or may affect, but were not likely to adversely affect (NLAA) federally-listed T&E species. The USFWS defines NLAA as any effects are beneficial, insignificant, or discountable. Beneficial effects have contemporaneous positive effects without any adverse effects on the species or habitat. Insignificant effects relate to the size of the impact and include those impacts that are undetectable, not measurable, or cannot be evaluated.

Discountable effects are those that are extremely unlikely to occur (USFWS and NOAA 1998).

3.6.2 *Which T&E Species Would Not be Affected by WS-Nevada PDM Activities?*

WS-Nevada has determined that its IPDM activities would have no effect on some T&E species because WS-Nevada does not conduct IPDM in areas where or in a manner that would affect these species. Species that would not be affected by WS-Nevada PDM activities are listed below.

- **Species of fish:** Ash Meadows Amargosa pupfish (*Cyprinodon nevadensis mionectes*), Ash Meadows speckled dace (*Rhinichthys osculus nevadensis*), Big Springs spinedace (*Lepidomeda mollispinis pratensis*), bonytail chub (*Gila elegans*), bull trout (*Salvelinus confluentus*), Clover Valley speckled dace (*Rhinichthys osculus oligoporus*), cui-ui (*Chasmistes cujus*), desert dace (*Eremichthys acros*), Devil's Hole pupfish (*Cyprinodon diabolis*), Hiko White River springfish (*Crenichthys baileyi grandis*), Lahontan cutthroat (*Oncorhynchus clarkii henshawi*), Moapa dace (*Moapa coriacea*), Pahranagat roundtail chub (*Gila robusta jordani*), Pahrump poolfish (*Empetrichthys latos*), Railroad Valley springfish (*Crenichthys nevadae*), razorback sucker (*Xyrauchen texanus*), Virgin River chub (*Gila seminude*), Warm Springs pupfish (*Cyprinodon nevadensis pectoralis*), Warner sucker (*Catostomus warnerensis*), White River spinedace (*Lepidomeda albivallis*), White River springfish (*Crenichthys baileyi baileyi*), woundfin (*Plagopterus agrentissimus*)
- **Species of mammals:** Wolverine[8] (*Gulo gulo luscus*)
- **Species of invertebrates:** Ash Meadows naucorid (*Ambrysus amargosus*), Carson Wandering skipper (*Pseudocopaeodes eunus obscurus*), Mount Charleston blue butterfly (*Icaricia shasta charlestonensis*)
- **Species of reptiles and amphibians:** Sierra Nevada yellow-legged frog (*Rana sierra*)
- **Species of plants:** Amargosa niterwort (*Nitrophila mohavensis*), Ash Meadows blazing star (*Mentzelia leucophylla*), Ash Meadows gumplant (*Grindelia fraxinipratensis*), Ash Meadows ivesia (*Ivesia kingie var. eremica*), Ash Meadows sunray (*Enceliopsis nudicaulis var. corrugata*), Ash Meadows milk-vetch (*Astragalus phoenix*), Spring-Loving centaury (*Centaurium namophilum*), Steamboat buckwheat (*Eriogonum ovalifolium var.*

[8] According to USFWS species assessment form, only one record of a wolverine in the Sierra Nevada Range since 1930 is when a male wolverine was discovered in 2008, based on genetic testing, this species was not from the extirpated Sierra Nevada wolverine population (believed to have gone extinct in the first half of the 1900's) (Moriarty et al. 2009 as cited by USFWS species assessment form). According to USFWS ECOS (undated), areas that wolverines are known or believed to have occurred in Nevada, include the far western edges of Washoe, Storey, Douglas, Lyon, Carson City, Mineral and Esmeralda Counties. Based on that only one wolverine account has occurred in the last 80+ years in the entire Sierra Nevada's, and the limited amount of livestock protection that would even occur in potential wolverine habitat, WS-Nevada determined that PDM activities will have no effect on wolverine.

williamsiae), Ute Ladies'-tresses (*Spiranthes diluvialis*), Webber's ivesia (*Ivesia webberi*)

3.6.3 *Which T&E Species May Be Affected by IPDM Activities?*

WS-Nevada has determined that some animal species may be affected by some aspects of IPDM, although all but the desert tortoise were not likely to be adversely affected (NLAA). The effects analysis for each of these species, based on USFWS consultations, is summarized in Table 3.18.

Table 3-18. Federally-listed Threatened and Endangered Species Potentially Affected by IPDM Activities in Nevada.

Species	Federal ESA Status	Effects Determination
Gray Wolf (*Canis lupus*)	Endangered	NLAA
California Condor (*Gymnogyps californianus*)	Experimental	NLAA
California Condor (*Gymnogyps californianus*)	Endangered	NLAA
Southwestern Willow Flycatcher (*Emidonax traillii extimus*)	Endangered	NLAA
Yellow-billed Cuckoo (*Coccyzus americanus*	Threatened	NLAA
Yuma Clapper Rail (*Rallus longirostris yumanensis*)	Threatened	NLAA
Desert Tortoise (*Gopherus agassizii*)	Threatened	LAA

3.6.4 *What are the Potential Effects on Specific Threatened and Endangered Animal Species?*

3.6.4.1 *Gray Wolf*

The first confirmed gray wolf detection in Nevada since 1922 occurred in November 2016 with the sighting of a wolf in Washoe County, later identified through DNA analysis of droppings as a young male from the Shasta Pack of Northern California. It is believed that the wolf was exhibiting normal dispersal behavior for a young male searching for a mate or an existing wolf pack to join ("First wolf sighting in Nevada", NevadaAppeal Pers Comm. 2017). This wolf is uncollared and has not been seen in Nevada since its initial sighting and is thought to have left the state. While there is no way to predict whether this wolf will return to Nevada, it is likely that it is a matter of time before other transient wolves disperse/wander into Nevada as California and Oregon wolf population grow.

It is unknown if a pack(s) will become established in Nevada in the near future. Gray wolves are highly mobile and incursions into Nevada from California, or Oregon, are expected from transient or dispersing wolves. Gray wolf dispersal is characteristically done by 2 to 3-year-old males and females because of social strife within the pack, size of prey, prey density, or to find a mate and establish a territory. Average dispersal distances from natal home ranges are 68 miles for males and 47 miles for females with some dispersal exceeding 360 miles (Boyd et. al. 1995). From the western population, gray wolves have dispersed into Washington, Oregon, Utah, and 30 miles west of Denver, Colorado, as well as into the Canadian Provinces of British Columbia and Alberta. The longest documented dispersal distance is 504 miles from Montana into Canada (Boyd et. al. 1995). As the wolf population increases in adjacent states, an increase in the number and dispersal of wolves into new unoccupied areas (e.g., Nevada) may increase the potential for transient gray wolf encounters with APHIS-WS PDM activities and related tools in Nevada.

The gray wolf is a native species that was likely extirpated from California in the 1920s. The gray wolf is now returning to California on its own by dispersal of individuals from populations in other states. Two known recent, breeding incidents have occurred in California (Shasta pack 2015 & Lassen pack 2017.) No evidence of the Shasta pack has been confirmed since 2017. It is unknown if the Lassen pack has pups this year. The California Department of Fish and Wildlife (CDFW) is working to monitor this recovering endangered species.

We have reviewed the level of APHIS-WS program non-target take of wolves in other western states where wolf populations are relatively high. The level of APHIS-WS non-target gray wolf take per year in both the NRM DPS, and Great Lakes areas totals 1.5 wolves per year on average (FY2005-FY2016), of that, lethal take averaged 1.08 wolves per year and non-lethal take averaged 0.42 wolves per year. Wolves were captured by neck snare; foothold trap and M-44. The estimate for the total Northern Rocky Mountain gray wolf population in 2015 was ≥1,704 wolves in ≥282 packs and ≥95 breeding pairs (USFWS et al. 2016). The Wisconsin gray wolf population was estimated at 925 to 952 in 2017 (WDNR 2017). APHIS-WS program operations in those states (particularly Idaho, Montana and Wyoming) are similar to the WS-Nevada program. WS-Nevada PDM activities are similar to those in areas with established wolf populations, but the lack of wolves in Nevada means the chance of WS-Nevada taking a wolf is extremely unlikely.

Managing predation on livestock, natural resources, and human health and safety involve some methods that may have the potential to affect wolves. Predator damage management methods that may be used by WS-Nevada that have the potential to adversely affect wolves include foothold traps, neck and foot-snares, and M-44 devices (sodium cyanide). WS-Nevada has determined that other PDM methods used by the program do not have the potential to negatively affect wolves. This includes quick-kill traps and shooting (aerial and ground). Quick-kill traps will not be used in wolf habitat, or areas where wolves are likely to be found. Shooting is conducted only after positive identification of the target is made, and WS-Nevada personnel the work north of I-80 are trained in wolf identification. For more information on the PDM methods and their implementation, please see Appendix A.

WS-Nevada is not aware of any take of gray wolf in Nevada despite an active IPDM program. Based on the reasons describe above and in the consultation with USFWS, including the implementation of the minimization measures (Section 2.4.2.1 a-r), the USFWS concurred with WS-Nevada's determination that such activities are not likely to adversely affect the gray wolf in Nevada.

3.6.4.2 *California Condor*

The condor is the largest flying land bird in North America. The California condor was extirpated over most of its range by the late 1970s and all wild condors were taken into captivity in the 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. The designated condor experimental area is located in Arizona, Utah, and Nevada, and is bounded on the southern border by Interstate 40, north by Interstate 70, east by Arizona and Utah Highway 191, and west by Interstate 15.

At the 5-year review of this reintroduction program, 47 condors had been released. Of those 47, 18 birds died and 4 were returned to captivity. After 5 years, there were 25 free-flying condors in northern Arizona. In March 2001, a reintroduced bird produced the first confirmed condor egg laid in the wild since 1986. Management of the reintroduced population is governed by the October 16, 1996 Final Rule. This rule allows for unavoidable and unintentional take of California condors when such take is incidental to a legal activity such as hunting, driving, or recreational activities and does not result from negligence. The final rulemaking further applies this standard to construction activities, road building and farming and stated that lawful activities on private land should not be restricted. It is this flexibility in an experimental designation that will contribute to the long-term conservation of condors.

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, outside the NEP zone in Nevada, they are treated as endangered until they are returned to the NEP or the NEP area is expanded.

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 (Cade 2007, Fisher et al. 2006). Lead poisoning is a common cause of condor mortality, however, lead ingestion also causes sublethal damage, such as damage to organs, immune systems, reproductions, neurological functions (Rattner et al. 2008). As a result of this finding, WS-Nevada has worked towards the use of nontoxic shot (bismuth, steel, tungsten, nickel, and combinations thereof) nationally in aerial hunting, and nontoxic bullets (copper) 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-Nevada operating procedure in Clark County to retrieve carcasses shot with lead ammunition to reduce lead exposure, thus minimizing the potential risk to raptors, including condors. It is important to note that WS-Nevada does not conduct aerial shooting in Clark County and very little PDM in Clark County (occasional coyote removal to protect public safety (averaging under one incident/year) and recently one WS-Nevada personnel stationed in Clark County dedicated to the protection of aviation safety at a military installation).

Given the low probability of California condor presence in Nevada and the history of no captures, it is extremely unlikely that the proposed IPDM activities would result in a capture. Based on the reasons describe above and in the consultation with USFWS, including the implementation of the minimization measures (Section 2.4.2.1 a-q, s), the USFWS concurred with WS-Nevada's determination that such activities are not likely to adversely affect the California condor in Nevada.

3.6.4.3 *Southwestern Willow Flycatcher*

Southwestern willow flycatchers breed in dense riparian habitats. Flycatchers primarily use Geyer willow (Salix geyeriana), coyote willow (Salix exigua), Goodding's willow (Salix gooddingii), boxelder (Acer negundo), saltcedar (Tamarix sp.), Russian olive (Elaeagnus angustifolia), and live oak (Quercus arifolia) for nesting. Four basic vegetation communities provide flycatcher habitat: monotypic willow, monotypic exotic, native broadleaf dominated, and mixed native and exotic (Sogge et al. 1997).

Southwestern willow flycatchers typically reach their breeding grounds between early May and early June with males arriving first to establish territories (Service 2002). Flycatchers demonstrate strong fidelity to breeding areas although movement among sites within and between years has been documented (Service 2002).

Historical distribution and status of the flycatcher in Nevada is not well known. Although accounts of breeding flycatcher locations date back to 1987, when Unitt reported flycatcher breeding at Indian Springs, Corn Creek, and the Colorado River, many areas with suitable breeding habitat for flycatchers were not surveyed until the early 2000s. Subsequent surveys have confirmed breeding at Ash Meadows NWR, the Lake Mead Delta, Meadow Valley Wash, the Muddy River, Pahranagat Valley, and the Virgin River. Many of these areas do not support breeding flycatchers on an annual basis, but sites in the Pahranagat Valley and at the Muddy River and Virgin River have remained relatively stable.

Declines in southwestern willow flycatcher populations have been attributed to loss, modification, and fragmentation of habitat, and brood parasitism by brown-headed cowbirds (Finch et al. 2000 as cited in Service 2002, Whitfield 1990). Habitat loss has occurred through water management, land use practices, fire, and introduction of exotic species. Water management activities that have reduced suitable riparian habitat include dams or reservoirs, diversions, and groundwater pumping. Riparian habitat is reduced or modified by these management practices by alterations in flood frequency and duration, sediment and nutrition deposition, floodplain hydration, inundation period, and seed dispersal of riparian species. Land use practices have also reduced southwestern willow flycatcher habitat.

Recovery objectives include but are not limited to: (1) increasing and improving occupied, suitable, and potential breeding habitat; (2) improving demographic parameters; (3) minimizing threats to wintering and migration habitat; (4) surveying and monitoring populations; (5) conducting research; and (6) providing public education and outreach (Service 2002).

Within the analysis area, the main conservation needs for the flycatcher are to maintain, improve, and increase the quantity of nesting habitat. In addition, monitoring of breeding flycatchers should continue in breeding sites within the Pahranagat Valley, Muddy River, and Meadow Valley Wash to estimate abundance and determine nest success and location of territories.

Designated Critical Habitat

On July 22, 1997, the Service published a final critical habitat designation for the flycatcher along 964 river kilometers (km) (599 river miles) in Arizona, California, and New Mexico (62 FR 39129). On January 3, 2013, the Service published a revised designation of critical habitat that included 3,364 km (2,090 mi) of stream in Arizona, California, New Mexico, Nevada, and Utah (78 FR 343-534). This revised designation identified 180.9 km (112.3 mi) of stream in Nevada for revised critical habitat designation.

Primary Biological Features of Critical Habitat

For inclusion in the designation of critical habitat for the southwestern willow flycatcher, the Service included those areas that contain the physical or biological features essential to the conservation of the species. These areas contribute to the conservation of the flycatcher by supporting metapopulation stability, population connectivity, and gene flow and protecting against catastrophic loss of populations. Using our current knowledge of the life history, biology, and ecology of the subspecies and the requirements of the habitat to sustain the essential life history functions, we determined the following to be the primary biological features (PBFs) of southwestern willow flycatcher habitat:

Primary Biological Feature (PBF) 1— Riparian vegetation.

Riparian habitat in a dynamic river or lakeside, natural or manmade successional environment (for nesting, foraging, migration, dispersal, and shelter) that is comprised of trees and shrubs (that can include Goodding's willow, coyote willow, Geyers willow, arroyo willow, red willow, yewleaf willow, pacific willow, boxelder, saltcedar, Russian olive, buttonbush, cottonwood, stinging nettle, alder, velvet ash (Fraxinus velutina), poison hemlock, blackberry, seep willow, oak (Quercus spp.), rose, sycamore, false indigo, Pacific poison ivy, grape, Virginia creeper, Siberian elm, and walnut) and some combination of:

Dense riparian vegetation with thickets of trees and shrubs that can range in height from 2 to 30 m (about 6–98 ft). Lower-stature thickets (2–4 m or 6–13 ft tall) are found at higher-elevation riparian forests and tall-stature thickets are found at middle- and lower-elevation riparian forests; or

- Areas of dense riparian foliage at least from the ground level up to approximately 4m (13 ft) above ground or dense foliage only at the shrub level, or as a low, dense tree canopy; or
- Sites for nesting that contain a dense (about 50 to 100 percent) tree or shrub (or both) canopy (the amount of cover provided by tree and shrub branches measured from the ground); or
- Dense patches of riparian forests that are interspersed with small opening of open water or marsh or areas with shorter and sparser vegetation that creates a variety of habitat that is not uniformly dense. Patch size may be as small as 0.25 ac or as large as 175 ac.

Primary Biological Feature (PBF) 2 — Insect prey populations.

A variety of insect prey populations found within or adjacent to riparian floodplains or moist environments, including: flying ants, wasps, and bees (Hymenoptera); dragonflies (Odonata); flies (Diptera); true bugs (Hemiptera); beetles (Coleoptera); butterflies and moths and caterpillars (Lepidoptera); and spittlebugs (Homoptera).

WS-Nevada's risk of adverse effects from using 4-wheel drive vehicles, ATVs, motorcycles, snow machines, aircraft or horses in occupied Southwest willow flycatcher habitat are insignificant to discountable. While conducting PDM activities WS-Nevada may inadvertently disturb a Southwest willow flycatcher. While it is highly unlikely, if a flycatcher were at an airfield, the effects of hazing coyotes or common ravens away from aircraft operations would likely be similar for a flycatcher resulting in the flycatcher not being struck or ingested by an aircraft. Any activity in the habitat would be very limited, as the habitat is not generally suitable for species targeted by PDM, with the exception of mountain lions. Gunshot noise may also disturb yellow-billed cuckoo, but the effects are likely to be insignificant and discountable as activity will not occur in suitable habitat during the Southwest willow flycatcher nesting season, June 1 – August 31.

- Given the isolated locations of flycatcher breeding, foraging habitat, and designated critical habitat, PDM conducted by WS-Nevada will have little if any affect in these areas as WS-Nevada typically does not work in these areas.

Additionally, APHIS-WS employs the minimization measures found in Section 2.4.2.1 a-p, t.

Based on the reasons describe above and in the consultation with USFWS, including the implementation of the minimization measures (Section 2.4.2.1 a-p, t), the USFWS concurred with WS-Nevada's determination that such activities are not likely to adversely affect the Southwestern willow flycatcher in Nevada.

3.6.4.4 *Yellow-billed Cuckoo*

In arid regions, the yellow-billed cuckoo establishes nesting sites in river bottoms, swampy areas, and damp thickets with relatively high humidity. Depending on the location, vegetation in the cuckoo's preferred nesting habitat can include cottonwoods, mesquite (Prosopis spp.), and willows (Hughes 2015). Sites with less than 40% canopy cover are unsuitable, those with 40% to 65% are marginal to suitable, and those with greater than 65% canopy cover are optimal (Halterman 1991).

Yellow-billed cuckoos have a varying patch size from upwards of 50 acres to sometimes approaching 100 acres (Laymon and Halterman 1989). The western population breeds June through August, with peak occurring mid-July to early-August. The yellow-billed cuckoo forages mainly in open areas, woodland, orchards, and adjacent streams. During breeding season, foraging areas of nesting pairs my overlap (Laymon 1980). Cuckoos primarily glean large insects, such as caterpillars, grasshoppers, and crickets (Laymon 1980).

The available data suggest that the yellow-billed cuckoo's range and population numbers have declined substantially across much of the western United States over the past 50 years. Based on historic accounts, the species was widespread and locally common in California and Arizona, locally common in a few river reaches in New Mexico, common very locally in Oregon and Washington, generally local and uncommon in scattered drainages of the arid and semiarid portions of western Colorado, western Wyoming, Idaho, Nevada, and Utah, and probably uncommon and very local in British Columbia (Federal Register 2001). Arizona probably contains the largest remaining yellow-billed cuckoo population among States west of the Rocky Mountains. The species was historically widespread and locally common. In Nevada, the yellow-billed cuckoo (western DPS) inhabits scattered riparian areas in west central (Carson river-Lyon County) and southeastern (Virgin, Upper and Lower Muddy Rivers-Clark County) Nevada.

The decline of the western yellow-billed cuckoo is primarily the result of riparian habitat loss and degradation. Within the three States with the highest historical number of western yellow-billed cuckoo pairs, past riparian habitat losses are estimated to be about 90 to 95 percent in Arizona, 90 percent in New Mexico, and 90 to 99 percent in California. Many of these habitat losses occurred historically, and although habitat destruction continues, many past impacts have subsequent ramifications that are ongoing and are affecting the size, extent, and quality of riparian vegetation within the range of the western yellow-billed cuckoo. These adverse impacts to the western yellow-billed cuckoo's habitat including habitat loss and degradation are occurring now and are anticipated to continue for decades.

Principal causes of riparian habitat destruction, modification, and degradation in the range of the western yellow-billed cuckoo have occurred from alteration of hydrology due to dams, water diversions, management of riverflow that differs from natural hydrological patterns, channelization, and levees and other forms of bank stabilization that encroach into the floodplain. These losses are further exacerbated by conversion of floodplains for agricultural uses, such as crops and livestock grazing. In combination with altered hydrology, these threats promote the conversion of existing primarily native habitats to monotypic stands of non-native vegetation, which reduce the suitability of riparian habitat for the western yellow-billed cuckoo. Other threats to riparian habitat include wildfire, pesticide effects on prey species, long-term drought, climate change, and small and widely separated habitat patches.

Given the isolated locations of cuckoo breeding and foraging habitat, PDM conducted by WS-Nevada will have little if any affect in these areas as WS-Nevada typically does not work in these areas.

Ground shooting is used in conjunction with calling, stalking, and thermal imaging and is used for the removal of mountain lions, coyotes, and badgers in areas that may be occupied by yellow-billed cuckoo. Shooting would have no direct lethal effect on yellow-billed cuckoo because positive target species identification is made before an animal is removed. Thus, WS-Nevada use of ground shooting has been and is expected to be virtually 100% selective for target species, and would not pose a significant lethal risk to yellow-billed cuckoo. Any activity in the habitat would be very limited, as the habitat is not generally suitable for species targeted by PDM, with the exception of cougars. Gunshot noise may disturb yellow-billed cuckoo, but the effects are likely to be insignificant and discountable as activity will not occur in suitable habitat during the cuckoo nesting season, June 1 – August 31.

WS-Nevada common raven removal for the protection of livestock and greater sage-grouse with the use of ground shooting and use of DRC-1339 would provide some benefit to yellow-billed cuckoo as common ravens are known nest and egg raiders that likely would prey upon cuckoo nests.

- WS-Nevada may use 4-wheel drive vehicles, ATVs, motorcycles, snow machines, aircraft or horses in occupied yellow-billed cuckoo habitat. While conducting PDM activities WS-Nevada may inadvertently disturb a yellow-billed cuckoo. Activities would not be directed at yellow-billed cuckoos, would be of temporary nature, and yellow-billed cuckoos would most likely not abandon an established territory. All WS-Nevada site access activities would be in compliance with all federal, state and local laws, as well as in compliance with the terms and conditions set forth in WS-Nevada MOUs with land management agencies.

Additionally, APHIS-WS employs the minimization measures found in Section 2.4.2.1 a-p, t.

Based on the reasons describe above and in the consultation with USFWS, including the implementation of the minimization measures (Section 2.4.2.1 a-p, t), the USFWS concurred with WS-Nevada's determination that such activities are not likely to adversely affect the Yellow-billed cuckoo in Nevada.

3.6.4.5 *Yuma Clapper Rail*

The present range of the Yuma clapper rail in the U.S. includes portions of Arizona, California, and Nevada. Occupied habitats exist in the lower Colorado River (LCR) from the Southerly International Boundary with Mexico to the upper end of Lake Mead at the Grand Canyon, the Virgin River (a tributary to Lake Mead) in Nevada, the lower Gila River from its confluence with the LCR to the vicinity of the Phoenix metropolitan area in Arizona, and the Imperial Valley and Salton Sea area in California.

The Yuma clapper rail has two major population centers in the United States; the Salton Sea and surrounding wetlands in California, and the LCR marshes from the border with Mexico to Havasu NWR. Smaller numbers of rails are found along the lower Gila River in Yuma County, the Phoenix metropolitan area (including portions of the Gila, Salt, and Verde rivers) in Maricopa County, Roosevelt Lake in Gila County, Picacho Reservoir in Pinal County, and the Bill Williams River in La Paz County, Arizona (Service annual survey data). Yuma clapper rails have also been documented in southern Nevada in Ash Meadows NWR, Pahranagat NWR, Overton WMA, the Las Vegas Wash, and Key Pittman WMA; and in the Virgin River in Clark County.

Yuma clapper rails feed upon crayfish, clams, isopods, freshwater shrimp, fish and insects. Habitat for the Yuma clapper rail is freshwater marshes with dense vegetation, dominated by cattails (Typha spp.) and bulrushes that include both mats of old material and more open stands. Yuma clapper rails occur most often in large, extensive patches of emergent marsh vegetation (hundreds of acres in size).

Yuma clapper rails begin breeding in March and April after breeding territories have been established. Nests are constructed in dense marsh vegetation, among low growing riparian plants at the edge of the water, or on the top of dead cattails remaining from the previous year's growth. Mature cattail/bulrush stands provide materials for nest building and cover for their nests.

Threats to the Yuma clapper rail and its habitat are interrelated and are primarily a result of the alteration of rivers in the southwest. Water management projects within the lower Colorado River basin have both destroyed and created Yuma clapper rail habitat. Dams constructed in the Colorado River altered natural flows regimes, inundated habitats, and created backwaters that developed extensive marshlands. Specific threats include development for industrial, agricultural, and urban uses; construction of dams and reservoirs; diversions and groundwater pumping; channelization and bank stabilization; and environmental contaminants. The ultimate effect of these threats is increased loss, modification, and degradation of marsh habitat due to the direct removal of marsh vegetation and the alteration of river and stream hydrology, water availability, and water table levels. Predation from coyotes (*Canis latrans*), great horned owls (*Bubo virginianus*), northern harriers (*Circus cyanus*), and Harris hawks (*Parabuteo unicinctu*s) is another threat to Yuma clapper rails (Eddleman 1989).

- Given the very low abundance and isolated locations of Yuma clapper rail or its habitat it is likely that PDM conducted by WS-Nevada will have little, if any effect in these areas as WS-Nevada typically doesn't conduct PDM in waterways/marshes where Yuma clapper rail could be found. However, should WS-Nevada conduct PDM in these drainages/waterways, it remains unlikely that any of WS-Nevada methods would adversely affect the Yuma clapper rail, or its habitat as PDM would be related to protection of: public safety (e.g. coyote, mountain lion) which has not happened in at least the last 10 years, but would likely involve the use of land set snares (with stops preventing closing on wildlife as small as a Yuma clapper rail) or foothold traps with underpan tension devices precluding capture of wildlife exerting under a three pound force, or use of mules with trained dogs that have no interest in birds and would typically go around cattails, mudflats or other areas that lions would typically avoid, and use of ground shooting which requires positive identification; and natural resources, which would be similar to public safety protection, but would typically stay outside of the periphery of core YCR habitat or would involve use of dog-bird proof traps to protect wild turkeys from egg raiding raccoons, likely increasing any existing YCR recruitment by reducing egg and juvenile YCR predation.

Additionally, APHIS-WS employs the minimization measures found in Section 2.4.2.1 a-p, u.

Based on the reasons describe above and in the consultation with USFWS, including the implementation of the minimization measures (Section 2.4.2.1 a-p, u), the USFWS concurred with WS-Nevada's determination that such activities are not likely to adversely affect the Yuma clapper rail in Nevada.

3.6.4.6 *Desert Tortoise*

This herbivorous tortoise occurs in the creosote bush (*Larrea tridentata*), shadscale (*Atriplex* spp.), blackbush (*Colegyne ramossisma*), and Joshua tree (*Yucca brevifolia*) areas of Mojave Desert. It typically occupies basins and bajadas, and occurs on rocky slopes below 4,000 feet in elevation. It is most active in the spring and early summer when annual plants are most available for forage. This species is threatened by habitat loss, collection, disease, and predation. Tortoises in this area are typically found at densities of 10 to 20 adults/mi^2. They range in size from 10 to 14 inches and can reach weights of 25 to 50 pounds; males tend to be slightly larger than females.

Desert tortoises are most active during the spring and early summer when annual plants are most common. Additional activity occurs during warmer fall months and occasionally after summer rain storms. Desert tortoises spend the remainder of the year in burrows, escaping the extreme conditions of the desert. The size of desert tortoise home ranges vary with respect to location and year. Females have long-term home ranges that are approximately half that of the average male, which range from 25 to 200 acres (Berry 1986). Over its lifetime, each desert tortoise may require more than 1.5 square miles of habitat and make forays of more than 7 miles at a time (Berry 1986). In drought years, the ability of tortoises to drink while surface water is available following rains may be crucial for tortoise survival. During droughts, tortoises forage over larger areas, increasing the likelihood of encounters with sources of injury or mortality including humans and other predators. Desert tortoises possess a combination of life history and reproductive characteristics which affect the ability of populations to survive external threats. Tortoises may require 20 years to reach sexual maturity (Turner, *et al.* 1987). Further information on the range, biology, and ecology of the desert tortoise can be found in Berry and Burge (1984); Burge (1978); Burge and Bradley (1976); Bury, *et al.* (1994); USFWS (1994); and Weinstein, *et al.* (1987).

Effects of the Proposed Action and Individual Methods

A variety of PDM methods may be used to reduce predator damage in desert tortoise habitat. The following management activities have potential to result in incidental take of the desert tortoise when they are used by WS-Nevada in areas where desert tortoise are present: chemical toxicants, foothold traps/snares, cage traps, firearms, treated egg bait, and vehicles/equipment used in conducting PDM. However, a majority of WS-Nevada PDM activities in desert habitats occur outside the range of the desert tortoise.

Chemical Compounds

The use of the chemical burrow fumigants consisting of gas cartridges (carbon monoxide) to manage coyote damage may occur in the range of desert tortoise. Using gas cartridges for PDM is unlikely to adversely affect desert tortoises as they are only used in active coyote dens and desert tortoises do not den with coyotes. Use of gas cartridges for coyote removal would likely be beneficial to desert tortoise as coyotes are known to prey upon all life stages of desert tortoise. Further, all fumigants used by WS-Nevada are done so in accordance with EPA label use restrictions.

Since 2003, use of burrow fumigants have not resulted in any incidental take of desert tortoise. Based on the level of impact and adherence to WS-Nevada's program policy and EPA label use restrictions it is unlikely that the use of burrow fumigants will result to jeopardy of this species. Critical habitat has been designated for the desert tortoise; however, WS-Nevada does not anticipate the destruction or modification of critical habitats due the use of burrow fumigants.

Foothold Traps and Foot/Neck Snares

Foothold traps are used to capture predators such as coyote. Foothold traps are placed in/near the travel lanes of target animals with baits that are expected to attract the target predator. Likewise snares (foot and neck) are also a valuable tool to target predators such as coyotes. The possibility exists that a wandering tortoise may be killed or injured by traps or snares if they are placed in paths traveled by the tortoise. However, tension settings/devices are set on foothold traps and foot snares to minimize the possibility of capture or injury to a tortoise. Neck snares are set at an above ground level that will exclude the possibility of tortoise capture. In accordance with WS policy, all traps and trap like devices used by WS-Nevada will be set in a manner which minimizes the chances of capturing non-target animals.

Since 2003, use of foothold traps and foot and neck snares have not resulted in any incidental take of desert tortoise. Based upon this level of impact and adherence to WS-Nevada's program policy it is unlikely that the use of footholds and foot and neck snares will result in jeopardy to this species. Critical habitat has been designated for the desert tortoise; however, WS-Nevada does not anticipate the destruction or adverse modification of critical habitats due to the use of foothold traps and foot and neck snares.

Cage Traps

Cage traps are used to capture predators such as raccoons and feral cats. The most commonly known cage traps used in the current program are box traps. Box traps are usually rectangular, made from plastic or heavy gauge wire mesh and baited with foods attractive to target species. These traps are used to capture animals alive and can often be used where many lethal or more dangerous tools would be too hazardous. Cage traps usually work best when baited with foods attractive to the target animal. In accordance with WS policy (WS Policy Directive 2.450 (attached)), all traps and trap like devices used by WS-Nevada will be set in a manner which minimizes the chances of capturing non-target animals. The possibility exists for a desert tortoise to wander into a trap for shade, then have a predator molest/drag the trap away in an attempt to eat the tortoise, causing injury or mortality.

Since 2003, use of cage traps has resulted in the incidental take of 1 desert tortoise on June 28, 2005, due to extenuating circumstances (Reported to the Service (Special Agent Ed Dominguez) June 28, 2005 via phone, with June 29, 2005 follow up with "Incidental Take Statement"). Based upon this level of impact and adherence to WS-Nevada's program policy, it is unlikely that the use of cage traps will result in jeopardy to the species. Critical habitat has been designated for the desert tortoise; however, WS-Nevada does not anticipate the destruction or adverse modification of critical habitats due to the use of cage traps.

Firearms

Firearms are used singularly or in concert with calling (call-shooting), for predators such as coyotes. Firearms could be used in tortoise habitat. Application of firearms is and would be in accordance with WS directive 2.615 (WS Firearms Use and Safety) and requires positive identification of target animal, minimizing the chance of killing non-target animals. Since 2003, WS-Nevada's use of firearms has not resulted in any incidental take of any desert tortoise. Therefore, WS-Nevada has determined that the use of firearms will have no effect on desert tortoise or its critical habitat

DRC-1339 (Treated Egg-baits)

DRC-1339 treated chicken eggs are used for raven removal in the desert tortoise range for PDM, particularly Nye and Lincoln Counties and possibly if requested in Clark County. Removal of ravens would likely have a beneficial effect on desert tortoise recruitment as ravens prey upon juvenile and hatchling desert tortoise. A search of the literature has produced no negative effects of DRC-1339 on desert tortoises. Use of DRC-1339 is and would continue to be in accordance with the EPA and Special local need (24c) labels and WS Directive, which precludes the take of desert tortoise.

Since 2003, WS-Nevada's use of DRC-1339 has not resulted in any incidental take of desert tortoise. WS-Nevada has not used DRC-1339 in Clark County since 2009 (primarily for juvenile desert tortoise protection from ravens). If predation becomes a serious limiting factor for tortoise, WS-Nevada would gladly discuss opportunities with USFWS and other tortoise conservation groups. Critical habitat has been designated for the desert tortoise; however, WS-Nevada does not anticipate the destruction or adverse modification of critical habitats due to the use of DRC-1339.

Vehicle/Equipment Use

Use of vehicles and all-terrain vehicles (ATVs) may crush tortoises above ground and in their burrows. To a lesser extent, additional harassment may also occur from the ground vibrations and noise produced by ATV vehicles utilized by WS-Nevada. However, when active in PDM activities in tortoise habitat, vehicle traffic is kept to roadways at reduced speed and WS-Nevada employees are trained to be alert to the presence of the species. Also when vehicles are parked in desert tortoise habitat during operation activities, they are checked (desert tortoise are attracted to the shade provided by a vehicle) prior to moving. When practical, activities are conducted on foot or mule, with ATV use kept at a minimum.

Since 2003, WS-Nevada's use of ATVs has not resulted in any incidental take of any desert tortoise. Based on this level of impact and actions taken by WS-Nevada, it is unlikely that the use of ATVs will result in jeopardy of this species. Critical habitat has been designated for this species; however, with the minimal use of ATVs in desert tortoise habitat areas by restricting use to existing roadways and trails, WS-Nevada does not anticipate the destruction or adverse modification of desert tortoise critical habitat.

In 2005, WS-Nevada incidentally killed one desert tortoise during the course of normal wildlife damage management activities when a juvenile desert tortoise was trapped in a cage trap. The take was reported to the USFWS and was covered under the 2003 incidental take statement, as all appropriate Terms and Conditions were followed. That is the only take of desert tortoise by WS-Nevada since the 2003 consultation. WS-Nevada expects that the proposed action is ***likely to adversely affect*** the desert tortoise in Nevada, but not likely to adversely affect its critical habitat. WS-Nevada therefore submitted a Biological Assessment to the Service with request for formal and informal consultation on August 7th, 2018. On August 27th, 2018, the Service responded with a biological opinion in which they determined that the implementation of WDM activities as proposed in the biological assessment is not likely to jeopardize the continued existence of the desert tortoise, based on APHIS-WS implementing actions identified in the BO to minimize or avoid adverse effects to Mojave desert tortoise (Section 2.4.2.2); No desert tortoise habitat is anticipated to be disturbed; and APHIS-WS personnel will be trained on the identification and sign of desert tortoise (USFWS 2018a).

3.6.5 *What are the Comparative Impacts of the Alternatives on Threatened and Endangered Species?*

3.6.5.1 *Alternative 1. Proposed Action/No Action Alternative: Continue WS-Nevada PDM assistance outside of WAs and WSAs*

Impacts on all state- and federally-listed T&E species from WS-Nevada IPDM activities are negligible. Since FY 2005, WS-Nevada has had no take of state- or federally-listed T&E individuals while conducting PDM activities. WS-Nevada follows all reasonable and prudent measures and terms and conditions required in its August 27, 2018 Biological Opinion from USFWS (Sections 2.4.1.18, 2.4.2.1, 2.4.2.2, WS Directive 2.310). In the Biological Opinion, USFWS determined that the actions as proposed by WS-Nevada are not likely to jeopardize desert tortoise populations. Additionally, USFWS has concurred with WS-Nevada's determination that all other animal species that may be affected by IPDM are not likely to be adversely affected based on the conservation measures documented in the formal and informal consultations and Sections 2.4.2.1 and 2.4.2.2, and WS Directive 2.310 (Section 2.4.1.18). WS-Nevada would continue to adhere to or update all Section 7 consultations as required by the ESA.

3.6.5.2 *Alternative 2. Proposed Action/Modified Current Program. A Continuance of the Current Program as modified to include PDM in WAs and WSAs*

Under this alternative, the potential impacts to T&E species are similar to Alternative 1 (No Action) even though WS-Nevada would extend IPDM to livestock producers with valid grazing permits in WAs and WSAs. PDM proposed in WAs and WSAs will be subjected to additional site-specific review by the land managing agency (as prescribed in Section 1.8.2.3), further safe-guarding any T&E species on those lands.

As with Alternative 1, impacts on all state- and federally-listed T&E species from WS-Nevada IPDM activities have been/would be negligible. Since FY 2005, during previous work in WAs and WSAs, WS-Nevada has had no take of state- or federally-listed T&E individuals while conducting PDM activities. WS-Nevada follows all reasonable and prudent measures and terms and conditions required in its August 27, 2018 Biological Opinion from USFWS (Sections 2.4.1.18, 2.4.2.1, 2.4.2.2, WS Directive 2.310). In the Biological Opinion, USFWS determined that the actions as proposed by WS-Nevada are not likely to jeopardize desert tortoise populations. Additionally, USFWS has concurred with WS-Nevada's determination that all other animal species that may be affected by IPDM are not likely to be adversely affected based on the conservation measures documented in the formal and informal consultations and Sections 2.4.2.1 and 2.4.2.2, and WS Directive 2.310 (Section 2.4.1.18). WS-Nevada would continue to adhere to or update all Section 7 consultations as required by the ESA.

3.6.5.3 *Alternative 3. Non-lethal PDM Required Before Applying Lethal Assistance (No Preventive Lethal PDM)*

Under Alternative 3, WS-Nevada would provide technical assistance for both lethal and non-lethal activities, but there would have to be extensive use of non-lethal methods by the cooperator and/or WS-Nevada before WS-Nevada could provide lethal assistance (Section 2.3.3). Lethal methods applied by WS-Nevada would have similar impacts on T&E species as those analyzed under Alternatives 1 and 2. Non-lethal methods implemented by WS-Nevada would not adversely affect T&E species (USFWS 2018a). The APHIS-WS Decision Model may not be fully effective because if they are deemed necessary, lethal actions could not be used by WS-Nevada during the time that non-lethal methods are attempted to address the immediate problems. WS-Nevada already encourages the use of non-lethal methods and recommends those that are deemed to be effective for the damage being caused (Alternatives 1 and 2). However, under Alternative 3, damage may continue while obligatory non-lethal methods are attempted, even in situations where there is immediate risk of more damage even with the application of non-lethal methods. Conversely, cooperators may hire other commercial, governmental, or private entities to conduct lethal PDM activities as described in Section 3.4.

During (or instead of) WS-Nevada's non-lethal assistance, landowners could still choose to address the problem themselves. If landowners determined that lethal PDM is immediately necessary, they may implement lethal methods before applying all reasonable non-lethal methods. Landowners could use trained and experienced WCOs or may implement lethal methods themselves. However, entities requesting lethal assistance would have to determine if a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Non-federal entities do not complete ESA Section 7 consultations, and it would be difficult to determine what, if any, conservation measures were in place by individual landowners to reduce the take of T&E species. Other entities may not be trained to identify T&E species and their habitats or be able to conduct lethal IPDM activities to protect T&E species from predation, unless authorized by USFWS.

Since WS-Nevada has not taken any T&E species since FY 2005, any increase in take of a T&E species by other entities would have greater adverse effects on T&E species populations compared to the potential adverse effects under Alternatives 1 and 2.

3.6.5.4 *Alternative 4. WS-Nevada Provides IPDM Lethal Assistance Only for Cases of Human/Pet Health or Safety*

Under Alternative 4, WS-Nevada would provide full PDM technical and operational assistance (Appendix A), but lethal control could only be included as an option when responding to requests to protect human/pet health or safety. WS-Nevada could not use lethal methods as part of IPDM to respond to other types of requests (e.g., agriculture, property, and game species). For threats to human and pet health or safety, the primary predator species of concern would be black bears, mountain lions, or coyotes in residential areas, or disease vector species. When WS-Nevada responds with lethal control of predator species under the limited circumstances allowable under this alternative, the impacts on T&E species from WS-Nevada would be less than those described for Alternatives 1, 2 and 3, since fewer predators are removed under this alternative. Other commercial, governmental, and private entities and landowners would continue to conduct IPDM activities as described in Section 3.4.

WS-Nevada would not be able to respond with lethal methods to damage or threats to any other resources or situations. Entities requesting lethal assistance would have to determine if a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Non-federal entities do not complete ESA Section 7 consultations, and it would be difficult to determine what, if any, conservation measures were in place by individual landowners to reduce the take of T&E species. Other entities may not be trained to identify T&E species and their habitats or be able to conduct lethal PDM activities to protect T&E species from predation, unless authorized by USFWS.

Since WS-Nevada has not taken any T&E species since FY 2005, any increase in take of a T&E species by other entities would have greater adverse effects on T&E species populations compared to the potential adverse effects under Alternatives 1 and 2.

3.6.5.5 *Alternative 5. No WS-Nevada IPDM Activities*

WS-Nevada would have no effect on T&E species under this alternative. T&E species would not benefit from PDM conducted by WS-Nevada for T&E species protection. Landowners experiencing damage or threats could only depend on advice and responses from NDA Wildlife Services, commercial WCOs, NDOW, or other entities. Entities requesting lethal assistance would have to determine if NDA Wildlife Services, NDOW, a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Non-federal entities do not complete ESA Section 7 consultations, and it would be difficult to determine what, if any, conservation measures were in place by individual landowners to reduce the take of T&E species. Additionally, T&E species would not benefit from the IPDM conducted by WS-Nevada for T&E species protection. Other entities may not be trained to identify T&E species and their habitats or be able to conduct lethal PDM activities to protect T&E species from predation, unless authorized by USFWS.

Since WS-Nevada has not taken any T&E species since FY 2005, any increase in take of a T&E species by other entities would have greater adverse effects on T&E species populations compared to the potential adverse effects under Alternatives 1-4.

Furthermore, other entities may not be able to conduct lethal PDM activities to protect T&E species from predation, unless authorized by USFWS.

3.7 What are the Effects on Species that WS-Nevada May Take Unintentionally During IPDM?

Between FY 2012 and 2016, WS-Nevada unintentionally killed an average of 7.8 animals per year while conducting PDM. An additional 10.8 animals were captured and freed per year, on average. The majority of the animals that were killed were bobcats, kit fox, mule deer and mountain lions, captured mostly in foothold traps and neck snares (most kit fox were taken by M-44 devices). WS-Nevada's unintentional lethal take of animals was 0.1% of the total intentional lethal take in the 5 year period. This indicates that the methods and procedures used are highly selective for target species.

Following is an account of the average number of animals of each species that WS-Nevada unintentionally took during PDM activities each year during the reporting period from FY 2012 through 2016. The capture methods and the percentage of take compared to intentional take is summarized.

Coyote. On average, 0.2 coyotes per year were captured unintentionally and euthanized by a neck snare (take analyzed in Section 3.5). This amounted to less than 0.00% of animals taken intentionally during IPDM.

Black Bear. On average, 0.4 black bears each year were taken unintentionally. All were taken with a neck snare (take analyzed in Section 3.5). None were released alive. Unintentional take of bears is less than 0.00% of animals taken intentionally by WS-Nevada during IPDM.

Raccoon. WS-Nevada unintentionally lethally removed an average of 0.4 raccoons per year. These animals were captured and euthanized in a neck snare (take analyzed in Section 3.5). Unintentional lethal take of raccoons was less than 0.00% of animals taken intentionally by WS-Nevada during IPDM.

Mountain Lion. WS-Nevada unintentionally lethal lethally removed 0.8 mountain lions per year, 2 were taken by neck snare, 2 by foothold trap (take analyzed in Section 3.5). No mountain lions were unintentionally captured and freed. Unintentional lethal take was less than 0.01% of animals taken intentionally by WS-Nevada during IPDM.

Red Fox. WS-Nevada unintentionally lethally removed 0.2 red fox per year with a foothold trap (take analyzed in Section 3.5). 0.6 red fox were captured and freed from foothold traps. Unintentional lethal take was less than 0.00% of the WS-Nevada's intentional lethal take during IPDM

Badger. WS-Nevada unintentionally lethally removed 0.6 badgers per year with foothold traps (take analyzed in Section 3.5). 0.6 badgers per year were captured in foothold traps and released. Unintentional lethal take of badgers was less than 0.01% of WS-Nevada's intentional lethal take during IPDM.

Bobcat. WS-Nevada unintentionally lethally removed 1.8 badgers per year. 5 bobcats were taken with neck snares while the remaining 4 were taken with foothold traps (take analyzed in Section 3.5). 3.8 bobcats were captured in foothold traps per year and released. Unintentional lethal take off bobcats was 0.2% of WS-Nevada's intentional lethal take during IPDM.

Kit Fox. WS-Nevada unintentionally lethally removed 1.4 kit fox per year. 6 kit fox were taken with M-44 devices while the remaining 1 was taken with a foothold traps (take analyzed in Section 3.5). 0.8 kit fox were captured in foothold traps per year and released and 0.2 kit fox were captured in neck snares and released. Unintentional lethal take off kit fox was less than 0.02% of WS-Nevada's intentional lethal take during IPDM.

Gray Fox. WS-Nevada unintentionally lethally removed 0.2 gray fox per year with a foothold trap (take analyzed in Section 3.5). 0.2 gray fox per year were captured in a foothold trap and released. Unintentional lethal take off gray fox was less than 0.00% of WS-Nevada's intentional lethal take during IPDM.

Feral/Free-ranging Dog. WS-Nevada unintentionally lethally removed 0.2 feral/free-ranging dogs per year with a neck snare (take analyzed in Section 3.5). 4 feral/free-ranging dogs were unintentionally captured in foothold traps: 1 was transferred to the Sheriff's department and the remaining 3 were released. Unintentional lethal take of feral/free ranging dogs was less than 0.00% of WS-Nevada's intentional lethal take during IPDM.

Domestic Animal (Pet or Livestock (undifferentiated in MIS)). WS-Nevada did not unintentionally lethally take any domestic animals. 4 were captured in foothold traps and released; 1 was caught in a cage trap and released and 1 was caught in a neck snare and released.

Mule Deer. WS-Nevada unintentionally lethally removed 1.2 mule deer per year. Of the 6 taken, 3 mule deer were taken with neck snares while the remaining 3 were taken with foothold traps. 2 mule deer were unintentionally captured in foothold traps per year and released and 2 mule deer were unintentionally captured in neck snares and released. Unintentional lethal take off mule deer was 0.01% of WS-Nevada's intentional lethal take during IPDM.

Antelope. WS-Nevada unintentionally lethally removed 0.4 antelope per year with foothold traps. 0.6 antelope were unintentionally captured in foothold traps per year and released. Unintentional lethal take of antelope was less than 0.00% of WS-Nevada's intentional lethal take during IPDM.

Porcupine. WS-Nevada did not unintentionally lethally any porcupines. 0.8 porcupines were captured in neck snares per year and released.

Turkey Vulture. WS-Nevada unintentionally lethally removed 0.2 turkey vultures per year with a foothold trap. Unintentional lethal take of turkey vultures was less than 0.00% of WS-Nevada's intentional lethal take during IPDM.

3.7.1 *What are the Comparative Impacts of the Alternatives on Populations of Animals Taken Unintentionally?*

3.7.1.1 *Alternative 1. No Action Alternative: Continue WS-Nevada PDM Assistance Outside of WAs and WSAs*

WS-Nevada lethally takes a small number of animals unintentionally each year, an average of 7.8 animals, with an additional 10.8 animals captured and freed or transferred custody. Under Alternative 1, WS-Nevada would expect to continue to have a similar minimal level of unintentional take each year. WS-Nevada would continue to use the same protective measures outlined in this EA (Section 2.4).

Unintentional predator take was evaluated in Section 3.5 as part of the cumulative effects analysis. Non-predator unintentional take is so low as to be negligible, especially because those species unintentionally taken are abundant in Nevada.

WS-Nevada's PDM activities are highly selective for predatory animals, and as shown in Sections 3.5 and 3.7, unintentional take is expected to remain negligible.

3.7.1.2 *Alternative 2. Proposed Action/Modified Current Program. A Continuance of the Current Program as modified to include PDM in WAs and WSAs*

Under this alternative, similar to Alternative 1 (No Action) except that WS-Nevada would extend IPDM to livestock with valid grazing permits, and natural resources, at the request of NDOW, in WAs and WSAs.

WS-Nevada lethally takes a small number of animals unintentionally each year, an average of 7.8 animals, with an additional 10.8 animals captured and freed or transferred custody. Under Alternative 2, WS-Nevada would be expected to continue to have a similar minimal level of unintentional take each year because work in WAs has historically been minimal and brings additional protective measures and oversight as part of the Wilderness act and FS/BLM management policies. Of importance, the data analyzed for this EA isn't just the "current" program, but includes data from when WS-Nevada was working in WAs and WSAs. As such, with such low non-target take, the effects of Alternatives 1 and 2 are similar. WS-Nevada would continue to use the same protective measures outlined in this EA (Section 2.4). Unintentional predator take was evaluated in Section 3.5 as part of the cumulative effects analysis. Non-predator unintentional take is so low as to be negligible, especially because those species unintentionally taken are abundant in Nevada.

WS-Nevada's PDM activities are highly selective for the target species, and as shown in Sections 3.5 to 3.7, and unintentional take is expected to remain negligible.

3.7.1.3 *Alternative 3. Non-lethal PDM Required Before Applying Lethal Assistance (No Preventive Lethal PDM)*

Under Alternative 3, WS-Nevada would provide technical assistance for both lethal and non-lethal activities, but the cooperator would need to apply reasonable non-lethal methods before WS-Nevada would provide lethal assistance. WS-Nevada would likely take slightly fewer individuals compared to Alternatives 1 and 2. Non-lethal methods would not likely contribute to an unintentional lethal effect on animals. The APHIS-WS Decision Model may not be fully effective because if they are deemed necessary, lethal actions could not be used by WS-Nevada during the time that non-lethal methods are attempted to address the immediate problems. Other commercial, governmental, and private entities and landowners would continue to conduct PDM activities as described in Section 3.4.

During (or instead of) WS-Nevada's non-lethal assistance, landowners could still choose to address the problem themselves. If landowners determined that lethal

PDM is immediately necessary, they may implement lethal methods before applying all reasonable non-lethal methods. Landowners could use trained and experienced WCOs or may implement lethal methods themselves. Other entities would likely increase lethal PDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada.

However, entities requesting lethal assistance would have to determine if a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Take of unprotected mammals by private individuals or their agent is not required to be reported to NDOW, potentially resulting in underreporting, compared to WS-Nevada's reporting under Alternatives 1 and 2. Additionally, private individuals are not likely to have the consistent training with lethal methods, the experience to confirm the cause of damage, or the level of selectivity possessed by WS-Nevada employees, increasing the risk of unintentionally taking animals.

Therefore, there is a potential for higher levels of unintentional take by other entities, compared to Alternatives 1 and 2. However, because the predator and non-predator species are generally resilient and below the current annual maximum sustainable harvest level (Section 3.5), the populations of unintentionally taken animals are expected to remain stable.

3.7.1.4 *Alternative 4. WS-Nevada Provides PDM Lethal Assistance Only for Cases of Human/Pet Health or Safety*

Under Alternative 4, WS-Nevada would provide full IPDM technical and operational assistance (Appendix A), but lethal control could only be included as an option when responding to requests to protect human/pet health or safety, or federally-listed T&E species. WS-Nevada could not use lethal methods as part of IPDM to respond to other types of requests (e.g., agriculture, property, and game species). For threats to human and pet health or safety, the primary predator species of concern would be black bears, mountain lions, or coyotes in residential areas, or disease vector species. All predator species have the potential to be threats to T&E species. Because operational lethal actions would be limited and not available to manage damage to other resources, WS-Nevada would likely take fewer predators than under Alternatives 1 and 2, and thus there would be less potential for unintentional take. Other commercial, governmental, and private entities and landowners would continue to conduct IPDM activities as described in Section 3.4.

However, WS-Nevada would not be able to respond with lethal methods to damage or threats to any other resources or situations. Entities requesting lethal assistance would have to determine if a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Other entities would likely increase lethal IPDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada. Take of unprotected mammals by private individuals or their agent is not required to be reported to NDOW, potentially resulting in underreporting, compared to WS-Nevada's reporting under Alternatives 1 and 2. Additionally, private individuals are not likely to have the consistent training with lethal methods, the experience to confirm the cause of damage, or the level of selectivity possessed by WS-Nevada employees, increasing the risk of unintentionally taking animals.

Therefore, there is a potential for higher levels of unintentional take by other entities, compared to Alternatives 1, 2 and 3. However, because the predator and non-predator species are generally resilient and below the current annual maximum sustainable harvest level (Section 3.5), the populations of unintentionally taken animals are expected to remain stable.

3.7.1.5 *Alternative 5. No WS-Nevada IPDM Activities*

WS-Nevada would have no unintentional take of individual animals under this alternative. Landowners experiencing damage or threats could only depend on advice and responses from NDA-WS, commercial WCOs, NDOW, or other entities. Entities requesting lethal assistance would have to determine if a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Other entities would likely increase lethal IPDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada. Take of unprotected mammals by private individuals or their agent is not required to be reported to NDOW, potentially resulting in underreporting, compared to WS-Nevada's reporting under Alternatives 1 and 2. Additionally, private individuals are not likely to have the consistent training with lethal methods, the experience to confirm the cause of damage, or the level of selectivity possessed by WS-Nevada employees, increasing the risk of unintentionally taking animals.

Therefore, there is a potential for higher levels of unintentional take by other entities, compared to Alternatives 1-4. However, because the predator and non-predator species are generally resilient and below the current annual maximum sustainable harvest level (Section 3.5), the populations of unintentionally taken animals are expected to remain stable.

3.8 What is the Potential for WS-Nevada IPDM Activities to Result in Ecological Trophic Cascades in Nevada?

3.8.1 *Introduction*

Trophic cascades are indirect species interactions that originate with predators and spread downward through food webs (Ripple et al. 2016). In a simple example, predators, their herbivore prey, and plants that provide food for herbivores are three trophic levels that interact in a food web. Some members of the public are concerned that APHIS-WS' activities which remove top (or apex) predators will create the conditions for trophic cascade by reducing the predation pressure on lower tropic levels, including plant communities. Apex predators can be defined as species that feed at or near the top of the food web of their supporting ecosystem and that are relatively free from predation themselves once they reach their adult size (Sergio et al. 2014), such as black bears, coyotes, and mountain lions in Nevada. The concern is that species in lower trophic levels could then take on new ecosystem roles, possibly having negative effects on other species and habitats (Appendix F). Concerns have been focused primarily on the potential for trophic cascades to occur due to predator removals to protect livestock. For example, decreasing apex predators could reduce pressure on herbivore populations, which in turn overexploit vegetation and effect water quality.

WS-Nevada does not dispute the significance of the ecological role played by predators. APHIS-WS shares concerns with the public and scientific community for the integrity of ecological systems in which we live, work, and recreate. APHIS-WS uses measures to protect ecosystem integrity and reduce adverse effects of IPDM by focusing IPDM on specific individuals or localized groups (Sections 1.12.3 & 2.4).

Our analysis, however, indicates that the IPDM activities evaluated in this EA are not expected to cause trophic cascades. This section will discuss why WS-Nevada IPDM activities do not affect predator populations in Nevada and therefore are unlikely to create trophic cascades.

APHIS-WS has reviewed concerns that have been commonly raised by the public during similar APHIS-WS NEPA processes (USDA-APHIS-WS 2011; 2014; 2016) and by some authors (Bergstrom et al. 2014) that its' activities might disrupt ecosystems and cause trophic cascades by eliminating or substantially reducing top predators. Consequently, we reviewed pertinent scientific literature on the subject to consider as part of the analysis of this issue (e.g., , Stenseth et al. 1997, Halaj and Wise 2001, Terborgh et al. 2001, Wilmers et al. 2003, Schmitz et al. 2004, Hebblewhite et al. 2005, Ripple and Beschta 2006, 2007, 2011, Berger et al. 2008, Kauffman et al. 2010, Brown and Conover 2011, Estes et al. 2011, Ripple et al. 2011, Beschta and Ripple 2012, Levi and Wilmers 2012, Squires et al. 2012, Callan et al. 2013, Marshall et al. 2013, Sergio et al. 2014, Painter et al. 2015, Ripple et al. 2015, 2016, Benson et al. 2017, Engeman et al. 2017, Allen et al. 2017).

A summary of relevant scientific publications on trophic cascade research and related topics is in Appendix F. The results of the literature review, combined with the analyses of potential direct and cumulative impacts to populations of predator species (Section 3.5), provides the basis for WS-Nevada's conclusion that IPDM activities are highly unlikely to cause trophic cascades in Nevada.

3.8.2 *What are the Relevant Scientific Concepts and Studies for Understanding Trophic Cascades?*

The science associated with the study of trophic cascades is relatively new, and is based primarily on freshwater aquatic, marine intertidal, and terrestrial grassland and crop-dominated ecosystems. Only recently has trophic cascade research been focused on understanding coyote and wolf responses to predator control (e.g., Berger and Gese 2007, Ripple et al. 2013). Studies suggest that different ecosystems respond dissimilarly to changes in apex predator populations for many reasons, including the inherent variability in and different levels of productivity of terrestrial, aquatic, and marine ecosystems; the number of ecological interactions and interrelationships among predators and prey within a food web; the ability of animals to move into and out of a particular area (an open system), which affects to the food web are being studied; whether a predator may also eat plants; and whether a predator may eat individuals of another predator species, such as coyotes eating foxes within a trophic food web (e.g., Pace et al. 1999, Borer et al. 2005, Vance-Chalcraft et al. 2007, Ripple et al. 2016).

Recently, Winnie and Creel (2016) reviewed literature related to trophic cascades, concluding that predators exert significant pressure on prey species both killing prey and altering their behaviors. This pressure is exerted through 2 mechanisms – behavior mediated trophic cascades and density mediated trophic cascades. Behavior mediated trophic cascade are the result of a predator altering prey behavior. However, the study (Winnie and Creel 2016) indicates that behaviorally mediated trophic cascades are not likely to occur in systems with coyotes or wolves because those predators are highly mobile and only cause temporary changes in prey behavior, not chronic ones. Because the effects of the proposed PDM are likely to result in temporally short, localized reductions in predators (EA Section 3.5), prey populations are unlikely to experience significant changes in stressors that would result in a behavior mediated trophic cascades.

Winnie and Creel (2016) also expressed concern that cases where there were no behavior mediated trophic cascades (BMTC) occurring were underrepresented in the literature. The authors stated:

> *"Thus data from places were a BMTC is not occurring, but the hypothesis predicts one should be occurring, are considered uninformative and excluded from consideration. This approach is not in keeping with the scientific method, nor with accepted practices in hypothesis testing, and illustrates the necessity of revisiting fundamental principles of logic during the design phase of studies."*

Conversely, Winnie and Creel (2016) stated that density mediated trophic cascades are well supported by studies. Density mediated trophic cascades occur where predators affect prey populations through consumption. Density mediated trophic cascades have been documented in areas where the prey base is naïve to new predators, such as the elk in Yellowstone when wolves were reintroduced to the ecosystem. When a predator is introduced, the predator-naïve population is more likely to be depleted because they do not know how to avoid predation until they adapt. This can result in a density mediated trophic cascade if the predators are able to take advantage of the prey's naivety (Wood et al. 2020). Where the prey-base is predator savvy, prey will modify their behavior, preventing significant population shifts. The complete removal of a predator species is not the goal of PDM, and will not occur under any of the alternatives analyzed in Section 3.5, 3.6, and 3.7. Therefore, unlike the Yellowstone examples, Nevada lacks a truly predator naïve prey population that would be susceptible to density mediated trophic cascades.

The study of trophic cascades is complex, and includes the following concepts:

- **Intraguild predation** (IGP), which broadened the trophic relationships from vertical chains sometimes involving shared prey, to include horizontal relationships where predators kill and sometimes eat other predators in what became known as a food web rather than a food chain (e.g., Polis et al. 1989, Palomares 1995, Livaitis and Villafuerte 1996, Palomares et al. 1996, Arim and Marquet 2004, Finke and Denno 2005, Berger and Gese 2007, Daugherty et al. 2007; Appendix F.8.1);

- **Mesopredator release** (MPR), a concept in which the suppression or removal of historical top predators may release populations of smaller predators, such as foxes, raccoons, or often coyotes, which may have different impacts on the ecosystem (e.g., Crooks and Soulé 1999, Prugh et al. 2009, Ritchie and Johnson 2009, Roemer et al. 2009, Brashares et al. 2010, Ripple et al. 2013, Allen et al. 2014, Allen et al. 2018; Appendix F);
- **Adaptive behavior** of individuals or groups of prey species to reduce the risk of predation, such as changing habitat use, social structure, and time of certain activities (e.g., Gese 1996, Gese et al. 1996b, Gese 1998, Gese 1999, Kitchen et al. 2000, Schmitz et al. 2004, Peckarsky et al. 2008, Berger-Tal et al. 2011, Wallach et al. 2009b, Wilson et al. 2010; Appendix F);
- **Resource partitioning**, wherein predators and prey avoid each other by using different portions of the same habitat, often due to **competitive exclusion** when two species have similar diets or habitats, causing one species to interfere with the ability of the other to use those resources (e.g., Polis et al. 1989, Arjo et al. 2002, Wilmers et al. 2003, Finke and Denno 2005, Atwood et al. 2007, Gehrt and Prange 2006, Brook et al. 2012, Lendrum et al. 2014; Appendix F);
- **Ecosystem resilience**, the ability of ecosystems to rebound to previous conditions after a major impact or disruption, such as from a wildfire, major weather even, removal of a species, or introduction of an invasive species (Hooper et al. 2005, Srivasta and Vellend 2005, Balvanera et al. 2006, Casula et al. 2006, Duffy et al. 2007, Cleland 2011, Ritchie et al. 2012; Appendix F);
- **Ecosystem services**, wherein ecosystems provide sustainable ecological services to humans, such as food, crop pollination, clean water, and clean air (e.g., Duffy 2003, Hooper et al. 2005, Srivasta and Vellend 2005, Balvanera et al. 2006, Dobson et al. 2006, Duffy et al. 2007, Cleland 2011; Appendix F).

Most of the literature is not highly applicable to understanding trophic cascades and contributing processes as they relate to large terrestrial predators because of differences in ecosystems (Appendix F), challenges to conducting and interpreting research of complex and dynamic ecological systems (Appendix F), or serious discrepancies in the study design or conclusions (Appendix F). Researchers have questioned the capability of these studies to be scaled up to larger-scale ecosystems and more complex ecological trophic structures (Borer et al. 2005, Ray et al. 2005, Ripple and Beschta 2006, Vance-Chalcraft et al. 2007, Engeman et al. 2017). Additionally, what we understand in about these complex systems is changing and improving. Mech (2012) stated, “science is self-correcting” remarking that researchers review or build upon others research has the advantage of scrutinizing and improve upon their predecessors work.

With large free-ranging carnivores, intended removal of predators as part of a study is typically socially, ethically, and politically challenging or impossible (Ray et al. 2005, Estes et al. 2011, Engeman et al. 2017). Therefore, many studies rely on areas in which large apex predators were extirpated and either were reintroduced or rapidly recolonized the area, while the original conditions remain substantially the same, such as in older national parks, including Yellowstone National Park, Zion NP, and Banff NP (e.g., Heeblewhite et al. 2005, Ripple and Beschta 2006, Berger et al. 2008, Estes et al. 2011, Beschta and Ripple 2012, Ripple et al 2015). However, to the extent that these areas can be used to research these complex systems, national parks comprise a small portion of the ecosystem, and that if those ecological effects are found, they don't necessarily apply everywhere else (Muhly 2010, Mech 2012).

Many apex predator species have experienced dramatic range contractions. Their eradication is believed to have trophic impacts on the ecosystems in which they occur, especially through the phenomenon of mesopredator release (Crooks and Soulé 1999, Prugh et al. 2009, Roemer 2009, Brashares et al. 2010, Miller et al. 2012). The presence of predators causes reductions in the prey population or cause the prey population to alter its habitat use. In turn, changes in prey behaviors impact plant community composition and health (Terborgh et al. 2001, Ripple and Beschta 2011, Beschta and Ripple 2012). 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 (Naiman and Rogers 1997, Beschta and Ripple 2006). In the Midwest, changes in coyote activity impacted white-tailed deer activity, with associated impacts to plant communities (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) did not detect evidence that the presence of vertebrate predators fundamentally affected primary production or seed survival in a grassland ecosystem. Similarly, Kauffman et al. (2010) found that predation risk on herbivores alone is unlikely to alter the survivorship of plant communities, but predation in combination with site productivity and abiotic factors, such as soil moisture, mineral content, or snow accumulation, may allow for landscape-level recovery of vegetation.

3.8.3 *What is the Risk that WS-Nevada IPDM Activities May Result in Trophic Cascades?*

Most evaluations of the impacts of predator removal or loss on biodiversity involve complete removal over the course of years (e.g., Ripple and Beschta 2006, Berger et al. 2008, Ripple et al. 2016). APHIS-WS does not strive to eliminate or remove native predators from any area on a long term basis. When direct management of depredating animals is deemed legal, necessary, and desirable, efforts focus on management of the specific depredating animal or local group of animals. Consequently, no predators or prey would be extirpated and none would be introduced into an ecosystem.

APHIS-WS operates on relatively small portions of properties, over relatively short periods, and in accordance with federal and state laws and regulations. APHIS-WS impacts are generally temporary due to natural immigration and reproduction of predators. Additionally, take of predator species are in relatively small or isolated geographic areas in comparison with the overall population. APHIS-WS only conducts activities when and where it is permitted, needed, and requested by cooperators or the public. Since APHIS-WS' actions do not result in long-term extirpation or eradication of any native wildlife species, the findings of most of these studies are not relevant.

Some studies indicate that the conditions necessary for a trophic cascade may require the drastic reduction or complete collapse of apex predator populations (e.g., Brashares et al. 2010, Ripple et al. 2011, Beschta and Ripple 2012). WS-Nevada works closely with state and federal wildlife managers and land owners to assure that cumulative take of native target and non-target species is managed at levels that would not have significant impacts on wildlife populations, including those of apex predators. Current APHIS-WS activities do not result in the direct or indirect loss of any wildlife species population or sustained reduction in predator population densities.

WS-Nevada's take of potential apex predator species (i.e., black bears, coyotes and mountain lions) is small compared with broader populations of those species. The cumulative take of black bears, coyotes and mountain lions in Nevada, respectively, (Sections 3.5 to 3.7) is substantially below that of the annual maximum sustainable harvest level for each species. WS-Nevada's take for black bears and mountain lions is a lower proportion of the cumulative take than all non-WS take sources reported to NDOW. WS-Nevada's take of coyotes is within 0.3% of non-WS sources take reported to NDOW.

Since WS-Nevada does not have significant effects on target and non-target species populations (Sections 3.5 to 3.7), there is no potential for the elimination of apex predators or other native species, and the conditions to precipitate a trophic cascade are not produced. The limited nature of WS take of predator species is so low that substantive long-term shifts in population age structure do not generally occur (Section 3.5). NDOW has reported that black bear, coyote, and mountain lion populations (as well as other native predators) are stable in NDOW (NDOW 2018a, 2018b, and Russel Woolstenhulme, NDOW, pers. comm. 06/13/2018).

3.8.4 *What are the Comparative Impacts of the Alternatives on Ecological Trophic Cascades?*

3.8.4.1 *Alternative 1. Alternative 1. No Action Alternative: Continue WS-Nevada PDM Assistance Outside of WAs and WSAs*

APHIS-WS continues to acknowledge the important ecological role played by predators. However, due to the targeted nature of predator removals (Sections 2.3.1.7, 2.3.1.8, 3.5.1), including short duration, small geographic scope, and low proportion of take compared with the populations, the localized IWDM activities explored in this EA are not expected to change this balance. The effects of WS-

Nevada activities are therefore temporary, localized, and of low magnitude (Section 3.5). Negative population-level effects on apex predators from APHIS-WS are very unlikely because predator populations are stable under the current and projected levels of cumulative take (Section 3.5.18).

Therefore, under Alternative 1, it is highly unlikely that WS-Nevada's current and projected direct and cumulative take (Section 3.5.18.1) is contributing to any ecologically-forced trophic cascades, mesopredator releases, and any resulting adverse ecological effects on biodiversity, ecosystem resilience, or ecosystem services.

3.8.4.2 *Alternative 2. Proposed Action/Modified Current Program. A Continuance of the Current Program as modified to include IPDM in WAs and WSAs*

Under this alternative, similar to Alternative 1 (No Action) except that, WS-Nevada would also conduct IPDM in WAs and WSAs.

APHIS-WS continues to acknowledge the important ecological role played by predators. However, due to the targeted nature of predator removals (Sections 2.3.1.7, 2.3.1.8, 3.5.1), including short duration, small geographic scope, and low proportion of take compared with the populations, the localized IWDM activities explored in this EA are not expected to change this balance. The effects of WS-Nevada activities are therefore temporary, localized, and of low magnitude (Section 3.5). Negative population-level effects on apex predators from APHIS-WS are very unlikely because predator populations are stable under the current and projected levels of cumulative take (Section 3.5.18) and any additional IPDM that would be conducted in WAs and WSAs would be minimal as has been the case historically. IPDM work in WAs and WSAs also bring additional protective measures and oversight as part of the Wilderness Act and FS/BLM management policies, further reducing the chance of ecological trophic cascades.

Therefore, under Alternative 2, it is highly unlikely that WS-Nevada's current and projected direct and cumulative take (Sections 3.5.18.1, 3.5.18.2) is or would be contributing to any ecologically-forced trophic cascades, mesopredator releases, and any resulting adverse ecological effects on biodiversity, ecosystem resilience, or ecosystem services.

3.8.4.3 *Alternative 3. Non-lethal PDM Required Before Applying Lethal Assistance (No Preventive Lethal PDM)*

Under Alternative 3, WS-Nevada would provide technical assistance for both lethal and non-lethal activities, but the cooperator would need to apply reasonable non-lethal methods before WS-Nevada would provide lethal assistance. Lethal methods applied by WS-Nevada would have slightly less take of predator populations as compared to Alternatives 1 and 2. Non-lethal methods would have negligible impacts on predators. The APHIS-WS Decision Model may not be fully effective because if they are deemed necessary, lethal actions could not be used by WS-Nevada during the time that non-lethal methods are attempted to address the immediate problems. Other commercial, governmental, and private entities and landowners would be likely to continue to conduct IPDM activities as described in Section 3.4.

Other entities would likely increase lethal PDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada. During (or instead of) WS-Nevada's non-lethal assistance, landowners could still choose to address the problem themselves. If landowners determined that lethal PDM is immediately necessary, they may implement lethal methods before applying all reasonable non-lethal methods. Landowners could use trained and experienced WCOs or may implement lethal methods themselves. However, entities requesting lethal assistance would have to determine if a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Additionally, private individuals are not likely to have the consistent training with lethal methods, the experience to confirm the cause of damage, or the level of selectivity possessed by WS-Nevada employees.

Under Alternative 3, predator populations are expected to remain stable with similar levels of take by other entities as under Alternatives 1 and 2. Take of unprotected mammals by private individuals or their agent is not required to be reported to NDOW, potentially resulting in underreporting, compared to WS-Nevada's reporting under Alternatives 1 and 2. However, cumulative take would not be expected to near annual maximum sustainable harvest levels established for the predator species, despite any reasonably foreseeable levels of increased take by other entities.

Therefore, under Alternative 3, there is no potential for WS-Nevada to initiate a trophic cascade. Additionally, it is highly unlikely that cumulative take will contribute to any ecologically-forced trophic cascades, mesopredator releases, and any resulting adverse ecological effects on biodiversity, ecosystem resilience, or ecosystem services.

3.8.4.4 *Alternative 4. WS-Nevada Provides PDM Lethal Assistance Only for Cases of Human/Pet Health or Safety*

Under Alternative 4, WS-Nevada would provide full IPDM technical and operational assistance (Appendix A), but lethal control could only be included as an option when responding to requests to protect human/pet health or safety, or federally-listed T&E species. WS-Nevada could not use lethal methods as part of IPDM to respond to other types of requests (e.g., agriculture, property, and game species). For threats to human and pet health or safety, the primary predator species of concern would be black bears, mountain lions, or coyotes in residential areas, or disease vector species. All predator species have the potential to be threats to T&E species. When WS-Nevada responds with lethal control under the limited circumstances allowable under this alternative, the impacts on predator populations from WS-Nevada would be less than those described for Alternatives 1, 2 and 3, since fewer predators are removed under this alternative. Other commercial, governmental, and private entities and landowners would continue to conduct IPDM activities as described in

Section 3.4. Other entities would likely increase PDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada.

However, WS-Nevada would not be able to respond with lethal methods to damage or threats to any other resources or situations. Entities requesting lethal assistance would have to determine if a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Additionally, private individuals are not likely to have the consistent training with lethal methods, the experience to confirm the cause of damage, or the level of selectivity possessed by WS-Nevada employees. Take of unprotected mammals by private individuals or their agent is not required to be reported to NDOW, potentially resulting in underreporting, compared to WS-Nevada's reporting under Alternatives 1 and 2.

Under Alternative 4, predator populations are expected to remain stable, but experience higher levels of take by Non-WS entities compared to Alternatives 1 and 2. Take of unprotected mammals by private individuals or their agent is not required to be reported to NDOW, potentially resulting in underreporting, compared to WS-Nevada's reporting under Alternatives 1 and 2. However, cumulative take would not be expected to near annual maximum sustainable harvest levels established for the predator species, despite any reasonably foreseeable levels of increased take by other entities.

Therefore, under Alternative 4, there is no potential for WS-Nevada to initiate a trophic cascade. Additionally, it is highly unlikely that cumulative take will contribute to any ecologically-forced trophic cascades, mesopredator releases, and any resulting adverse ecological effects on biodiversity, ecosystem resilience, or ecosystem services.

3.8.4.5 *Alternative 5. No WS-Nevada IPDM Activities*

Under this alternative, WS-Nevada would have no effect on predator populations or the potential to initiate a trophic cascade. Landowners experiencing damage or threats could only depend on advice and responses from NDA-WS, commercial WCOs, NDOW, or other entities. Entities requesting lethal assistance would have to determine if NDA-WS, a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Other entities would likely increase PDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada.

Additionally, private individuals are not likely to have the consistent training with lethal methods, the experience to confirm the cause of damage, or the level of selectivity possessed by WS-Nevada employees or NDA-WS employees. Take of unprotected mammals by private individuals or their agent is not required to be reported to NDOW, potentially resulting in underreporting, compared to WS-Nevada's reporting under Alternatives 1 and 2. However, while take by other entities would be higher than under Alternatives 1-4, cumulative take would not be expected to near annual maximum sustainable harvest levels established for the predator species, despite any reasonably foreseeable levels of increased take by other entities.

Therefore, under Alternative 5, there is no potential for WS-Nevada to initiate a trophic cascade. Additionally, it is highly unlikely that cumulative take will contribute to any ecologically-forced trophic cascades, mesopredator releases, and any resulting adverse ecological effects on biodiversity, ecosystem resilience, or ecosystem services.

3.9 How Do Wildlife Professionals and Others Consider Ethics and Humaneness in Predator Damage Management?

WS-Nevada takes ethics and humaneness seriously. The science of wildlife biology and management, including IWDM and wildlife research, often involves directly capturing, handling, physically marking, taking samples from, and, at times, lethally removing free-ranging animals. These actions can cause stress, pain, and sometimes-inadvertent injury to the individual animals (e.g., Kreeger et al. 1990, Proulx and Barrett 1989, Vucetich and Nelson 2007, Sneddon et al. 2014). WS-Nevada field personnel strive to undertake these activities as ethically and humanely as possible under field conditions.

3.9.1 *What are the Ethics and Attitudes about Wildlife Damage Management?*

Ethics are standards of human conduct. The management of wildlife, especially if it involves lethal actions, can elicit varied emotional reactions, depending somewhat on geographic location and species, and these reactions can change over time (Littin et al. 2004, Haider and Jax 2007). The degree of interaction with natural resources appears to be a factor influencing value systems regarding wildlife (Section 1.4.2).

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. The impacts are analyzed in this EA in a general sense; specifics effects of individual actions are considered by WS-Nevada employees through the use of the WS Decision model to select methods that are effective and appropriate for the given location. WS-Nevada personnel are trained in the safe and effective use of PDM methods and the integrated PDM strategy. The 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-Nevada 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.

Based on this information, the WS-Nevada PDM program meets the six "Gold Standard" criteria of Littin et al. (2004), and is considered ethically sound.

The issue of ethics is evolving over time (Perry and Perry 2008). WS has numerous policies, directives, and protective measures that provide direction to staff reinforcing the achievement of the most appropriate and effective PDM program possible. Many of these guidance documents incorporate aspects of the ethical considerations discussed above. Directives pertaining to APHIS-WS activities are located on the APHIS-WS home page at http://www.aphis.usda.gov/wildlifedamage.

Humaneness is most often related to human interactions with wildlife, especially when humans kill, capture, or otherwise directly interact with animals. However, humaneness also pertains to human suffering caused by wildlife directly hurting or impacting them. In addition, some people are highly concerned with suffering caused by predation on wildlife and domestic animals, including horses, livestock guard animals, and pets. People have bred many of the defensive capabilities out of domestic animals and may feel it is unethical and inhumane not to effectively protect them from predation, as predators can have very inhumane killing techniques where animals are injured or ate on prior to or without being killed. Additionally, humaneness is not always present in nature. Even if uninfluenced by human actions, animal populations and individual animals experience natural mortality factors from predation, accidents, weather, disease, mortality of young, habitat degradation from overuse, and malnutrition. Wildlife populations reproduce at greater rates than necessary to replace deaths if all individuals died from old age. Most populations fluctuate around a habitat-driven density, called the carrying capacity. Populations that approach or overshoot this density become more sensitive to many sources of mortality (Section 3.8).

People's concern with humaneness falls on a spectrum. Schmidt (1989) and Bekoff (2002) define advocates of "animal rights" as those who often place priority on individual animals, ranking animal rights as morally equal to human rights. These advocates believe that animals should not be used for human benefits (such as research, food, recreational use such as hunting and trapping, being displayed in zoos, protecting livestock or even being livestock, being used for laboratory research, or protecting natural resources from wildlife damage), unless that same action is morally acceptable when applied to humans. Advocates of "animal welfare" are those who are concerned with the welfare of animals in relation to human actions involving those animals, such as the level of suffering of individual animals, while recognizing that human benefits may sometimes justify costs to animals, such as the use of animals for research or food. Advocates for animal welfare believe that humans are obligated to manage animal populations to reduce animal suffering, especially when ecological imbalances are caused by human actions (Varner 2011). As with most things, people have a range of attitudes and beliefs from one end of the spectrum to the other (Section 1.4.2).

3.9.2 *How are Euthanasia and Humane Killing Defined?*

APHIS-WS policy and operations (and NDA-WS as supervised by WS-Nevada) comply with the guidelines of the American Veterinary Medical Association (AVMA 2020) whenever practicable. 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 2020). This typically involves unconsciousness followed by cardiac or respiratory arrest, leading to loss of brain function, with reduced stress and discomfort prior to the animal losing consciousness.

The AVMA distinguishes between euthanasia, typically conducted on a restrained animal, and methods that are more accurately characterized as humane killing of unrestrained animals under field conditions. AVMA (2020) 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."

Classification of a given method as a means of euthanasia or humane killing varies by circumstances and species. Methods that do not meet the AVMA criteria for euthanasia may still be characterized as "humane" under some circumstances (AVMA 2020), such as those encountered during PDM activities. 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. AVMA (2020) states that in field cases where sophisticated equipment is not available, the only practical means of killing an animal may be using a lethal method of trapping or, if the animal is captured, still alive, and cannot or should not be released, or is unrestrained in the wild, a killing gunshot. The AVMA (2020) states that personnel should be proficient and should use the proper firearm, ammunition, and trap for the species.

AVMA (2020) notes, "…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. 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."

As described by the AVMA, there may be a distinction between clinical euthanasia and field practices for humane killing, but field practices are still considered an acceptable form of euthanasia. APHIS-WS policy and operating procedures fully comply with these guidelines, and APHIS-WS recognizes the importance of careful decision making in the field regarding all use of lethal methods.

In 2019, AVMA published a report titled *AVMA Guidelines for the Depopulation of Animals: 2019 Edition*. Depopulation of wildlife is defined in AVMA (2019) as the "rapid destruction of a population of animals in response to the urgent circumstances with as much consideration given to the welfare of the animals as practicable". Depopulation of wildlife is substantially different from the selective removal of damage-causing individuals, and is not proposed in this EA. WS-Nevada has reviewed the publication, however, they do not apply to activities proposed in this EA. AVMA (2019) refers the reader to the AVMA Guidelines for the Euthanasia of Animals (AVMA 2020) for guidance on the types of actions WS-Nevada is proposing.

3.9.3 *How are Pain and Suffering Evaluated?*

Animal suffering is often considered in terms of physical pain, physiological and emotional stress, and tissue, bone, and tooth damage that can reduce future survivability and health (Sneddon et al. 2014). Injury to an animal caused by trapping can range from losing a claw, breaking a tooth, tissue damage, and wounds, to bone fractures and death (Olsen et al. 1986, Onderka et al. 1990, Phillips et al. 1996, Engeman et al. 1997, International Organization for Standardizations (ISO) 10990-5 Annex C 1999). However, the conditions of physical trauma, such as the location of the wound, whether the animal is young, old, with young, female or male, can affect the long-term fecundity and survival when released (Iossa et al. 2007).

Assessing pain experienced by animals can be challenging (AVMA 2013, CDFG 1991). The International Association for the Study of Pain, as cited by AVMA (2013), describes pain as "An unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage." Because we cannot directly ask an animal about its pain, and even humans have different pain thresholds and have difficulty communicating a particular level of pain, it is difficult to quantify the nebulous concept of pain and suffering (Putman 1995).

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 (AVMA 2013). It is the goal of professional IPDM programs to reduce distress in animals to the maximum extent practicable.

Pain, anxiety, and stress caused by restraint and physical exertion due to struggling to escape can manifest physiologically through the sympathetic nervous system and interplay among hormones produced by the hypothalamus, pituitary and adrenal glands. Pain and stress can be measured through short-term increases in cortisol from the adrenal glands, heart rate, blood pressure, body temperature, and breathing rate, and a long-term loss of body weight. Kreeger et al. (1990) found that the physiological and hormonal stress indicators in trapped red fox occurred during the first two hours of capture. The authors assumed that these indicators were caused by anxiety, pain, fear, physical exertion, either individually or in combination. After two hours of capture, in which the animal was in "fight or flight" stress reaction, bouts of struggle became intermittent, resulting in a "conservation/withdrawal" reaction in which the animal was in a calmer state. The authors also found that padded traps caused less physical and physiological trauma than unpadded traps when traps were checked between 4 and 8 hours after setting.

Although humans cannot be fully certain that animals can experience pain-like states, assuming that animals can suffer pain ensures that we take appropriate steps to reduce that risk and treat the animal with respect (Kreeger et al. 1990, Iossa et al. 2007, Sneddon et al. 2014).

3.9.4 *What Factors Influence Selectivity and Humaneness of Trapping?*

Several researchers and organizations have attempted to develop objective, comparable, and statistically relevant methods for evaluating selectivity and humaneness in captured animals (Olsen et al. 1986, Onderka et al. 1990, Phillips et al. 1996, Engeman et al. 1997, International Organization for Standardizations (ISO) 10990-5 Annex C 1999). The AFWA, as the representative for state wildlife agencies, has a test program for evaluating trap humaneness and effectiveness using five performance criteria: animal welfare, efficiency, selectivity, practicality, and safety to the user. AFWA's overarching goal regarding recreational trapping is to maintain the regulated use of trapping as a safe, efficient, and acceptable means of managing and harvesting wildlife for the benefits it provides to the public, while improving the welfare of trapped animals (AFWA 2006a).

This effort has resulted in species-specific best management practices (BMPs) for use by recreational trappers for selecting traps and trapping practices considered to be effective and humane (http://jjcdev.com/~fishwild/?section=best_management_practices). These BMPs are updated as new information, traps, and practices are developed, with the most recent BMPs updated in 2016. The resulting information is provided to state and federal wildlife agencies, trapper associations, and state agency trapper education programs through workshops, internet, and interactive CDs. These testing and outreach programs have included funding from the USDA, the International Fur Trade Federation, and state wildlife management agencies. AFWA has tested and approved a variety of commercially-available trap types and trapping practices that meet or exceed BMP standards and guidelines, and the AFWA recognizes that it is likely that additional traps may exist that have not yet been tested (AFWA 2006a).

AFWA's Furbearer Conservation Technical Working Group has developed BMPs for each species (http://fishwildlife.org/?section=best_management_practices). The BMPs are based on the most extensive study of animal traps ever conducted in the US, and scientific research and professional experience regarding currently available traps and trapping technologies. Trapping BMPs identify both techniques and trap types that address the welfare of trapped animals and allow for the efficient, selective, safe, and practical capture of furbearers. Trapping BMPs are intended to be a practical tool for recreational trappers, wildlife biologists, and wildlife agencies interested in improved traps and trapping practices. BMPs include technical recommendations from expert trappers and biologists, as well as a list of specifications of traps and/or trap types that meet or exceed BMP criteria. BMPs provide options, allowing for discretion and decision making in the field when trapping furbearers in various regions of the United States. They do not present a single choice that can or must be applied in all cases.

The following BMPs are available for use in Nevada for predators (as updated):

- Badger BMPs (2014): http://www.fishwildlife.org/files/8915/2105/0193/Badger_BMP_2014_F.pdf
- Bobcat BMPs (2014):

http://www.fishwildlife.org/files/3115/2105/0700/Bobcat_BMP_2014_F.pdf

- Coyote in western US (2016): http://www.fishwildlife.org/files/2015/1975/8962/Western_Coyotes_BMP_2016.pdf
- Gray fox (2014) http://www.fishwildlife.org/files/6415/2105/2319/GrayFox_BMP_2014_F.pdf
- Red fox (2016) http://www.fishwildlife.org/files/5615/2105/2398/Red_Fox_BMP_2016.pdf
- Kit fox (not updated): http://www.fishwildlife.org/files/3015/2105/2508/Swift_KitFoxes_final.pdf
- Raccoon (2014) http://www.fishwildlife.org/files/1615/2105/2995/Raccoon_BMP_2014_F.pdf
- Mink: https://www.fishwildlife.org/application/files/2015/2105/2663/MinkRV3.pdf
- Ringtail (not updated): https://www.fishwildlife.org/application/files/5815/2105/3155/Ringtail_BMP_Final.pdf
- Striped skunk (not updated) http://www.fishwildlife.org/files/9915/2105/3256/Skunk_BMP.pdf
- Weasel (not updated) http://www.fishwildlife.org/files/4415/2105/3337/Weasel_BMP.pdf

Humaneness of trapped animals is improved by using traps types and design, and trapping practices that reduce animal injury and suffering, and increasing trap selectivity. The use of BMPs incorporates practices that include equipment specifications, the knowledge of the person using the equipment, and how the equipment is set up (with accessories) and used. Although specific traps are tested, the characteristics of the traps are identified and described as features that, either by themselves or when incorporated with other practices and the experience of the applicator, improve animal welfare and increase trappers' efficiency and selectivity.

3.9.5 *What is APHIS-WS Approach to Humaneness, Ethics, and Animal Welfare?*

The APHIS-WS Code of Ethics (WS Directive 1.301) states that all employees, volunteers, interns, and personnel conducting official APHIS-WS duties shall adhere to the Code of Ethics, including:

- Promoting competence in the field of wildlife damage management through continual learning and professional development;
- Showing exceptionally high levels of respect for people, property, and wildlife;
- Respecting varying viewpoints regarding wildlife and wildlife damage management;

- Using the APHIS-WS Decision Model to resolve wildlife damage problems and strive to use the most selective and humane methods available, with preference given to non-lethal methods when practical and effective.

APHIS-WS believes that all professional personnel must have the skills, experience, and expertise to select the most effective, humane, and practical strategies suitable to the needs and circumstances. Continual learning and training are critical for ensuring that the most effective tools are used, and research and testing must be implemented continuously to improve the tools available and develop new tools. APHIS-WS also considers a tool's effectiveness in meeting the need as well as the effectiveness of an employee's time and cost in implementing those tools. Factors such as weather, device selectivity and effectiveness, personnel considerations, public safety, and other factors must be considered. Selecting effective tools and methods while considering the potential to reduce the risk of suffering helps to increase the overall effectiveness and ethical approach of IPDM.

Wildlife Services employees are concerned about animal welfare. APHIS-WS is aware that some members of the public believe that some IPDM techniques are controversial. Wildlife professional organizations (e.g., The Association of Fish and Wildlife Agencies and The Wildlife Society) recognize that traps and snares are effective and humane for recreational and management use (AFWA 2006, The Wildlife Society, no date) Training, proper equipment, policy directives, and the use of best practices in the field help ensure that these activities are conducted humanely and responsibly.

In addition, APHIS-WS and the National Wildlife Research Center (NWRC) strive to bring additional non-lethal damage management alternatives into practical use and to improve the selectivity and humaneness of management and capture devices. APHIS-WS has improved the selectivity of management devices through research and development of pan-tension devices, break-away snares, and chemical immobilization/euthanasia procedures that reduce pain.

When implementing IPDM management activities, APHIS-WS evaluates all potential tools for their humaneness, effectiveness, and ability to target specific individuals as well as species, and potential impacts on human safety. APHIS-WS supports using humane, selective, and effective damage management techniques, and continues to incorporate advances into wildlife control program activities. APHIS-WS field specialists conducting wildlife damage management are highly experienced professionals, skilled in the use of management methods and committed to minimizing pain and suffering. APHIS-WS has numerous policies and directives that provide direction to staff involved in wildlife control, reinforcing safety, effectiveness, and humaneness (Section 2.4).

WS Directive 2.450 (Section 2.4.1.2) establishes guidelines for APHIS-WS personnel using certain types of capture devices and promotes training of its employees to improve efficiency, effectiveness, and humaneness. Additionally, all use by APHIS-WS complies with applicable federal, state, and local laws and regulations. Nevada state laws also regulate the use of traps, snares, and capture devices (Section

2.4.4.3). Testing of traps and trapping systems by AFWA has continued to provide valuable information on the humaneness of traps and practices. As the information comes available, it is reviewed by APHIS-WS for its use and application in the field. Recent updates to the BMPs and forthcoming research publications indicate that there will be an increasing number of commercially available traps that meet and or exceed BMP guidelines. WS-Nevada continues to use and implement BMP tools and practices as they become available and when appropriate for IPDM. Recognizing the goals of the AFWA, APHIS-WS has voluntarily agreed to assist in the development of BMPs and to abide by the BMPs developed by this program, as applicable, using the APHIS-WS Decision Model in the field.

3.9.5.1 *What are the Considerations for Humaneness for Different Physical Capture Methods?*

Different capture methods are discussed below. Impacts to human and pet health and safety and the environment are evaluated in Section 3.10. Traps are designed either to restrain an animal or to kill it upon capture. A humane live-capture (restraint) trap is one that holds an animal with minimal distress or trauma. A humane killing trap is one that renders an animal irreversibly unconscious as quickly as possible. Proper training in the use of traps makes it unlikely that pain or distress would result from the use of traps (Sikes 2016). WS-Nevada personnel receive the necessary training on trap use, safety, and selectivity to ensure humane outcomes in PDM activities.

Seasonality and timing of the use of physical capture devices is an important consideration for humaneness. The removal of predators during the spring months has the potential to result in litters of coyotes or other predators becoming orphaned. When WS-Nevada conducts lethal PDM activities during the April-June period, sometimes one or both adults of a coyote pair are killed and may have a den of pups in the vicinity. WS-Nevada field personnel make a concerted effort to locate the den 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 1980). 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).

3.9.5.1.1 Foothold Traps

Traps used in the United States and elsewhere have undergone extensive standards testing and selection as part of an international effort to optimize trap humaneness, selectivity, and effectiveness (Batcheller et al. 2000, AFWA 2006, White et al. 2015), and was partially funded by APHIS-WS (Association of Fish and Wildlife Agencies 2006a). Humane traps should be practical and equally effective at capturing target animals and avoiding capturing non-target animals (Andelt et al. 1999). BMPs for the predator species in this EA identify key designs or modifications to foothold traps to reduce injury. Approved BMP-compliant foothold trap designs include regular jaw, padded jaw, offset jaw, double jaw, laminated jaw, double-laminated jaw, wide jaw, and some variations combining those features. The "jaw" part of a trap is the portion that makes contact with the foot of the animal being restrained. The various jaw types are designed to reduce injury by increasing surface area, reducing sharp edges, providing gaps to allow more circulation and decreased compression, or padding. They are also designed to reduce the movement of the foot, which allows for secure foot retention while decreasing the risk of injury.

Other features of traps to improve humaneness include anchors attached to the center point of the trap with swivels. Additionally, the use of shorter chain lengths with multiple swivels, and shock springs, help to reduce the impact to the animal when they attempt to pull free, while allowing 360 degree movement to reduce the risk of injury.

The skill-set and experience of the individual deploying the traps, combined with these trap modifications and features, complement the BMP guidelines by integrating the trap design, trap accessories, and trapper knowledge to improve humaneness.

Published data from the more recent BMP testing is not currently available and awaiting for publication. However, BMP's for available species can be found at: http://fishwildlife.org/?section=best_management_practices, and are referenced above in section 3.9.5.

3.9.5.1.2 Box and Cage Traps

Animals captured in box and cage traps for smaller predators and mountain lions, and culvert-type traps for bears may have fewer physical and behavioral traumas than those captured in snares and foothold traps. Although injury rates in cage traps are lower than cables and snares, use of cage traps is a not without risk of injury to the captured animal because animals can injure themselves attempting to escape the trap (e.g., swelling, damage to teeth and muscles) (Shivik et al. 2005, Muñoz-Igualada et al. 2008). Generally, these traps are used if the animal is intended to be released, which is uncommon with IPDM actions except in some circumstances for black bears captured for and transferred custody to NDOW, and mountain lions typically near houses, or if the animal is relatively small, such as bobcats, opossums and raccoons, and the animal will be euthanized on-site. Canids or other trap wise animals appear to be truly reluctant to enter cage traps (Way et al. 2002, Shivik et al. 2005).

3.9.5.1.3 Foothold and Neck Snares

WS-Nevada uses foothold snares most often for black bears, but rarely for mountain lions or smaller predators. Neck snares are used routinely for coyotes and mountain lions and often for most or all of the other predator species (Table 2.1, Table E.1). Snares are highly portable and can be readily adapted by the field biologist for use in the field for many situations.

Effectiveness of snares depend greatly on the skill and expertise of the trapper, often causing them to be less effective than foothold traps when used by less experienced trappers (Skinner and Todd 1990, Onderka et al 1990). WS-Nevada's use of snares is highly selective to reduce unintentional captures (Section 3.7). Turnbull et al. (2011) found recent models of traps and snares to be about equally effective with low levels of apparent injury and trauma. Foothold snares with stops set at the appropriate size for the target species (and to avoid non-target species capture) appear to have an acceptable effect on animal welfare, with little mortality of target species. However, animals typically have swelling of the foot, with possible long-term limping (Onderka et al. 1990). Darrow et al. (2009) cited Reiter et al. (1999) that public acceptance of the use of cable foot-restraints is slightly higher than for jawed foothold traps. The AFWA Western Coyote BMP identifies specifications for foot snare devices, using 1/8 inch cable meet BMP compliance (Onderka et al. 1990, BMP 2016a).

Black bears can be effectively captured using modified foot snares. These snares can be readily transported into and set up in the backcountry, which is difficult with large culvert raps pulled behind vehicles. Under normal conditions, injuries may include swelling and abrasions. However, if the snare becomes entangled or the black bear struggles energetically, severe injuries can result. Small black bears held in traps are vulnerable to predation by larger black bears. Mountain lions may also be effectively and humanely captured using foot snares (Powell and Proulx 2003).

When neck snares are set correctly as a restraint (not as a kill trap), using a stop on the cable, serious injuries are relatively uncommon, although the risk of mortality may be higher than with foothold snares. However, long-term survival is difficult to determine (Iossa et al. 2007). Increased size of the cable for both neck-hold and foothold snares can reduce lacerations but may also decrease effectiveness. Swivels give a struggling animal more flexibility and make it more difficult to entangle or twist the snare. Fall (2002) and Garvey and Patterson (2014) also found neck snares with a positive lock, such as Collarum™, to be humane, resulting in fewer injuries to target animals, when set by experienced trappers (APHIS-WS does not endorse any brands). This is a newer model, dependent on a cable loop triggered by pulling on a baited bit piece, and is selective especially for coyotes and dogs (Huot and Bergman 2007). Snares are also effective in a variety of weather, but use in cold weather should be avoided to reduce risk of limb freezing.

Frey et al. (2007) used snares to live-capture red fox for fitting with radio collars and found the foxes were active the evening following capture and that all females captured reared young the following spring. Over the 3 year study period, the authors caught 21 foxes with neck snares, with only 2 fatal injuries.

Both foot and neck restraint snares can capture non-target species, with risk of mortality. Adding a breakaway snare lock, snare stops, and appropriate pan tension can reduce capture of non-target species and reduce the risk of holding a non-target animal (Iossa et al 2007).

3.9.5.1.4 Shooting and Pursuit with Dogs

WS-Nevada uses shooting and pursuit dogs on a routine basis. Firearms are used for all species once the animal is controlled. Shooting, when applied by a skilled and experienced shooter, is highly selective and humane, causing immediate death when aimed to kill (Huot and Bergman 2007, Julien et al. 2010, AVMA 2013).

Pursuit of mountain lions and black bears with trained dogs can be very effective. Once the animal is either treed or cornered, the animal is typically shot but can be tranquilized when requested by NDOW prior to WS-Nevada personnel taking action. A possible concern using pursuit dogs is causing the animal to be physically exhausted, as well as possibly being injured before or during handling (Powell and Proulx 2003). WS-Nevada is concerned for the well-being of pursuit dogs used for IPDM and wants to avoid injury or exhaustion from a pursuit. WS-Nevada reduces these risks by considering the terrain, time of day, and duration of pursuit dog use to reduce the risk to both the pursuit dogs and the animal being pursued.

Elbroch et al. (2013) found that the number of hounds used in a mountain lion capture attempt did not necessarily predict the likelihood of capturing a mountain lion, although that is dependent on the skills and experience of both the dogs and the handler. Injuries to dogs and mountain lions may also depend on the skills and experience of the dogs and handler. The authors suggest that foot snares are a potentially safer and more humane capture method for mountain lions than pursuit with dogs when mountain lions are targeted in grassy or open areas with limited opportunities to tree or escape, but hounds may be more effective in habitats with refugia (places to tree or escape) in habitats. Dogs work best when a target mountain lion is actively working the site, as they may not return to the depredation or threat site, or may not return for several nights. The authors did not provide details on the breed and training of the pursuit dogs used, nor the level of experience of the dogs, which can differ substantially among pursuit dog handlers. Dogs bred and carefully trained for pursuit of large predators, such as those used by WS-Nevada personnel, are important for consistent safety and effectiveness.

Nevada state law and regulations allow the use of pursuit dogs on mountain lion, black bear, bobcat, raccoon, fox, and unprotected animals.

3.9.5.2 *What are the Considerations for Humaneness for Different Chemical Methods?*

Chemical methods may be used for lethal take, such as gas cartridges, M-44s, DRC-1339, and euthanasia, or for non-lethal take, such as immobilization. Impacts on human health and safety and the environment for chemical methods are evaluated in Section 3.10.3.

3.9.5.2.1 M-44 Sodium Cyanide

WS-Nevada uses sodium cyanide (NaCN) capsules are used to remove individual coyote, red fox, gray fox, and feral dogs that prey upon livestock, poultry, and federally designated threatened or endangered species. The M-44 spring ejector device delivers a single dose sodium cyanide capsule directly into the mouth or face when the animal bites and pulls up on the spring-activated bait device, pushing the dry sodium cyanide powder into the mouth. Sodium cyanide reacts rapidly with moisture in the mouth or mucus membranes of the nose and eyes to form hydrogen cyanide (HCN), a poisonous toxicant. One sodium cyanide capsule contains enough cyanide to be lethal to animals that come in direct contact through the mouth, the skin, or through inhalation. Cyanide is a rapid-acting asphyxiator, causing death within minutes by depressing the central nervous system, resulting in respiratory arrest. Inhalation toxicity quickly causes disabling muscle weakness, vomiting, convulsions, bloody saliva, and loss of consciousness.

M-44s are highly selective for canids (Section 3.10.3.1) and have many restrictions in their use per the label (Section 2.4.1.6), including in areas away from human activities in public areas, with warning signs in the area. The animal normally dies quickly in the field, within 1 to 5 minutes due to major depression of the central nervous system, cardiac arrest, and respiratory failure (Section 3.10.3.1). The risk of the animal being observed by a person before death is very low because of the restrictions on using this method in locations where public exposure is probable (Section 2.4).

3.9.5.2.2 Gas Cartridge for Denning

WS-Nevada uses the Large Gas Cartridge (EPA Reg. No. 56228-21) in rangelands, crop, and non-crop areas to remove coyotes, red foxes, and skunks in dens and burrows. The registered gas cartridge product contains the active ingredients sodium nitrate and charcoal, and 2 inert ingredients (Fuller's earth and/or borax, which control the rate of burn in the burrow; Johnston et al. 2001). The sodium nitrate supports the combustion of the charcoal, which emits carbon monoxide inside the enclosed burrow while burning. Like oxygen, the primary route of entry for carbon monoxide into an animal is through breathing. Carbon monoxide is poisonous to all animals, like mammals, that use hemoglobin to transport oxygen from the lungs to the cells of the body. Carbon monoxide attaches to hemoglobin to form carboxyhemoglobin, which causes a decrease in oxygen to cells throughout the body resulting in asphyxiation. During the combustion/burning process, oxygen in the burrow is depleted through the combustion of the charcoal.

AVMA (2013) documents that the use of 6% CO on dogs for euthanasia resulted in 20 to 25 seconds of abnormal cortical function, during which the dogs became agitated, although it is not clear if this is a sign of distress. CO induces the loss of consciousness without pain and with minimal discernible discomfort. Death occurs rapidly at low concentrations. Personnel using CO must be highly trained and educated. With use by trained and experienced personnel, AVMA (2013) and APHIS-WS consider CO a humane euthanasia method.

3.9.5.2.3 DRC-1339

WS-Nevada may use hard boiled chicken eggs treated with Compound DRC-1339 Concentrate (3-Chloro-p-Toluidine Hydrochloride (CPTH)-Livestock, Nest & Fodder

Depredations-Nevada EPA SLN No. NV-150001; EPA Registration No. 56228-29 to control common ravens that a) prey upon newborn livestock in rangeland or pasturelands, prey on or are suspected of preying on the eggs or the young of Federally-designated threatened or endangered species, or on other species designated to be in need of special protection by Federal or State wildlife agencies; b) nest, roost, or loaf at landfills, deadpits, dump site locations or on utility poles, electrical line towers, communication towers, or other man-made structures and cause fire threat, or that feed on the contents of silage/fodder bags or c) that pose a threat to human health and safety, threat to sensitive wildlife species or damage to structures or a threat to human health and safety. Hard boiled chicken eggs are injected with 0.02 grams of DRC-1339 in a 1 ml solution. Treated eggs are placed strategically throughout the project area. The treated eggs are eaten, which leads to renal failure in the common ravens typically within 12 hours or less.

The chemical is metabolized and rapidly excreted outside of the body, greatly reducing the chance of secondary poisoning. There are no reports available on the pain experienced by birds treated with DRC-1339, but information on acute kidney failure in people indicates that it may be erroneous to assume that birds treated with DRC-1339 experience a very painful death. Symptoms of renal failure vary among individuals, with some individuals experiencing no symptoms while others may experience symptoms such as fluid retention, headache, nausea, fatigue and/or chest pain or pressure, and/or seizures (Mayo Clinic 2011, American Urological Association 2011). Common field observations of common raven response to DRC-1339 treatment are: increase in water consumption followed by standing/perching without interest; feathers become ruffled as if cold; and behavior is listless. Nelson (1994) also pointed out that affected birds ruffle their feathers before becoming comatose but show no apparent signs of distress, leading to what is presumed to be a humane death.

Some people have stated that DRC-1339 is an inhumane toxicant and should not be used. WS recognizes that any use of lethal methods, toxicants in particular, is considered by many individuals to be inhumane even if time until death and symptoms exhibited appear to be minimal. DRC-1339 causes renal failure in treated birds (Timm 1994). Renal failure in birds causes weight loss, depression, lethargy, increased thirst (polydipsia) and urination (polyuria), dehydration, articular gout, and eventually death. Death in birds occurs typically within a few days following ingestion of a lethal dose (Timm 1994). Mammals can succumb rather quickly with those ingesting a lethal dose dying in 3 to 12 hours (Timm 1994). Higher doses do not increase the speed of mortality (Timm 1994). Research is not available on pain experienced by birds treated with DRC-1339, just observational reports (DeCino et al. 1966, Timm 1994, Dawes 2006); convulsions, spasms or distress calls have not been observed in birds receiving a lethal dose, rather the birds die a seemingly quiet death. Birds that get a lethal dose may show no outward clinical signs for many hours and go about normal activities. About four hours before death, the birds cease to eat or drink and become listless and inactive, and possibly comatose (Timm 1994, Dawes 2006). They perch with their feathers puffed up (piloerection) and appear to doze. The product has been assessed as relatively humane and suitable for further investigation into potential use in Australia (Dawes 2006, Bentz et al. 2007) and is registered in New Zealand.

Placing hard boiled chicken eggs treated with DRC-1339 to target common ravens where they are less likely to be eaten by non-target species reduces the chance of non-target consumption of eggs (Coates et al. 2007 and Spencer 2002). Further, both Special Local Need Label (24c) and EPA restricted use pesticide label have many restriction on application and use. Species other than common ravens, noted by Coates et al. (2007) that were observed by hidden trail camera/videography consuming untreated and treated eggs were ground squirrels, primarily Wyoming and Piute ground squirrels neither of which is known to succumb to effects of DRC-1339. Although LD_{50} values have not been described for ground squirrels, they have been for similar species, such as white rats (1,170 mg/kg) (Clark 1986). Averaging 10 grams/Piute ground squirrel, ground squirrels would have to consume over 4 grams of DRC-1339 for half of the ground squirrels to die. Putting this in perspective, at .02 grams of DRC-1339/treated egg, a ground squirrel would have to consume the egg yolks and portions of the treated egg whites of over 200 eggs to have a 50% chance of dying from DRC-1339. That is simply not possible, additionally, a Piute ground squirrel's home range is estimated to be 1,357 m^2 (Yensen, 2019), slightly more than 1/3 acre and 200 treated eggs would never be placed in such a high concentration.

DRC-1339 appears to pose little risk of secondary poisoning to non-target animals, including avian scavengers (Cunningham et al. 1979, Schafer 1984, Knittle et al. 1990). The technical grade of the active ingredient is very highly acutely toxic to many pest birds, but generally less acutely toxic to raptors, waterfowl, finches, and other birds, and most mammals (DeCino et al. 1966, Palmore 1978, Schafer 1981). For example, an 89 g starling, a highly sensitive species, requires a dose of only 0.3 mg/bird to cause death (Royall et al. 1967) while many other bird species such as raptors, house sparrows, and finches are classified as non-sensitive, requiring a much higher dose (Eisemann et al. 2003). A 29 g house sparrow would require a dose of 9 mg, while a 22 g house finch and a 118 g American kestrel would require more than 5 mg and 38 mg (DeCino et al. 1966, Schafer et al. 1983). It should be noted that larger birds and pigeons require more product (more toxicant) to be taken lethally. Secondary hazards of DRC-1339 are likely very low unless toxic bait is still largely intact in the carcass. DRC-1339 acts in a relatively humane manner producing a quiet death (Timm 1994, Dawes 2006). Prior to the application of DRC-1339, prebaiting is often required to monitor for non-target species that may consume the bait. If non-target species are observed, then the use of DRC-1339 would be postponed or not applied at that particular location. The application method such as the use of prebaiting to assess palatability of the bait and prevent overbaiting, and the low risk of secondary hazards reduce the potential exposure to sensitive threatened and endangered species as well as preclude hazards to most other non-target species.

3.9.5.2.4 What Field Immobilizations Methods are Humane?

Immobilization drugs are used primarily to release an unintentionally captured animal that can't be safely restrained or to safely transport animals that can't be euthanized on site. Immobilization drugs can be administered with a hand syringe of a safely restrained animal, jab stick, or dart gun. WS-Nevada would rarely and infrequently use immobilization drugs. Indeed, WS-Nevada has not used immobilization drugs for over 5 years.

Ketamine (Ketamine HCl; Ketaset™) is a rapid acting, non-narcotic, non-barbiturate injectable anesthetic agent that immobilizes the animal and prevents the ability to feel pain (analgesia). The drug produces a state of dissociative unconsciousness, which does not affect the reflexes needed to sustain life, such as breathing, coughing, and swallowing. Ketamine is possibly the most versatile drug for chemical capture and has a wide safety margin (Fowler and Miller 1999). When used alone, this drug may produce muscle tension, resulting in shaking, staring, increased body heat, and, on occasion, seizures. Ketamine is often combined with other drugs, such as Xylazine, maximizing the reduction of stress and pain and increasing human and animal safety during handling. Following administration of recommended doses, animals become immobilized in about 5 minutes, with anesthesia lasting from 30 to 45 minutes. Depending on dosage, recovery may be as quick as four to five hours or may take as long as 24 hours. Recovery is generally smooth and uneventful.

Xylazine is a sedative (analgesic) that calms nervousness, irritability, and excitement, usually by depressing the central nervous system. Xylazine is commonly used with Ketamine HCl to produce a relaxed anesthesia. This combination can reduce heat production from muscle tension, but can lead to lower body temperatures when working in cold conditions. Xylazine can also be used alone to facilitate physical restraint. Because Xylazine is not an anesthetic, sedated animals are usually responsive to stimuli. Therefore, personnel must reduce sight, sound, and touch to reduce the animal stress. Recommended dosages are administered through intramuscular injection, allowing the animal to become immobilized in about 5 minutes and lasting from 30 to 45 minutes. Yohimbine is a useful drug for reversing the effects of Xylazine.

Capture-All 5™ is a combination of Ketaset™ and Xylazine, and is regulated by the FDA as an investigational new animal drug. The drug is available through licensed veterinarians to individuals sufficiently trained in the use of immobilization agents. Capture-All 5™ is administered by intramuscular injection; it requires no mixing, and has a relatively long shelf life without refrigeration, all of which make it ideal for the sedation of various species.

Telazol™ is a combination of equal parts of tiletamine hydrochloride and zolazepam hydrochloride, and is a powerful anesthetic for larger animals, such as bears, coyotes, and mountain lions (Fowler and Miller 1999). Telazol™ produces dissociative unconsciousness, which does not affect the reflexes needed to sustain life, such as breathing, coughing, and swallowing. Following a deep intramuscular injection of Telazol™, onset of anesthetic effect usually occurs within 5 to 12 minutes. Muscle relaxation is optimum for about the first 20 to 25 minutes after administration, and then diminishes. Recovery varies with the age and physical condition of the animal and the dose of Telazol™ administered, but usually requires several hours. Although the combination of Ketamine HCl and Xylazine are effective, WS-Nevada would prefer to use Telazol™ for most of the species that would be immobilized.

3.9.5.2.5 What Field Methods are Used for Humane Killing (Euthanasia)?

During PDM activities, most captured animals are humanely killed in place, rather than immobilized and relocated.

AVMA (2013 Appendix 2) supports the use of barbiturates (such as sodium pentathol and phenobarbitol), carbon dioxide, carbon monoxide, and gunshot directly to the head for humane euthanasia. Potassium chloride and other chemical drugs are used only when the animal is already immobilized.

Using the following unweighted criteria, a panel of fifteen experienced wildlife professionals evaluated eight methods of field euthanasia (Julien et al. 2010):

- Ability to induce loss of consciousness and death without causing pain
- Time required to induce loss of consciousness
- Reliability
- Safety of personnel
- Irreversibility
- Compatibility with requirement and purpose
- Emotional effect on observers or operators
- Compatibility with subsequent examination or use of tissue
- Drug availability
- Human abuse potential
- Compatibility with species, age, sex, and health status of animal
- Ability for equipment to be maintained in proper working order in the field
- Safety for predators or scavengers, should the carcass be consumed

The panel found that carbon dioxide used with the proper equipment is highly humane and effective, especially for use on raccoons, skunks, and birds. Anesthesia is induced within one to two minutes without undue stress on the animal at CO_2 concentrations of 30% to 40%. However, this needs well-maintained equipment that may not be practical to carry in the field. Gunshot to the brain by an experienced field biologist is humane, instantaneous, and may be the quickest and only method available under most field conditions. All methods of euthanasia should be performed discretely and only by properly trained personnel. Barbiturates such as sodium pentathol and phenobarbitol depress the central nervous system and cause rapid death with minimal discomfort through respiratory and cardiac arrest. With intravenous injection, death typically occurs within 25 to 300 seconds, meeting the standard for humaneness.

The American Society of Mammalogists (1998) concurs that shooting is the most effective and humane method of euthanasia in the field if conducted by experienced personnel. Carbon dioxide is also effective and humane, but more difficult to perform in the field without specialized, well-maintained equipment. The Society also recommends discretion when performing any kind of euthanasia when members of the public may be present.

3.9.5.3 *Conclusion*

From FY 2012 through 2016, the foothold trap, neck snare, firearms and DRC-1339 were the most consistently used tools for lethal take of many target predator species. Foothold traps, aerial shooting, neck snares, firearms, and, to a lesser degree, M-44s with sodium cyanide were used for lethal take of coyote, which was the species with the highest lethal take, followed closely by common ravens which were primarily taken by DRC-1339. Cage traps are also commonly used for smaller predators. Black bears are mostly caught with foot snares and shot with firearms, neck snares or pursued by trailing dogs and euthanized with a firearm. Mountain lions are mostly pursued with trailing dogs and humanely shot with firearms, followed by neck snares foothold traps and box traps. Other than DRC-1339 for lethal take of common ravens and M-44s for lethal take of coyotes, chemical methods such as sodium nitrate, chemical euthanasia, and immobilizing drugs are rarely used in the field by WS-Nevada (Table 2.1, 2.2 and Table E.1).

These methods are highly selective for target animals, with low unintentional take of predator and non-predator species during WS-Nevada PDM activities (Section 3.7). WS-Nevada personnel are highly trained in the proper use of these methods, follow applicable policies, and use best practices to undertake these activities as ethically and humanely as possible under field conditions.

3.9.6 *What are the Comparative Impacts of the Alternatives on Humaneness?*

3.9.6.1 *Alternative 1. No Action Alternative*

All WS-Nevada field personnel are highly trained in the use of lethal and non-lethal take methods, must follow APHIS-WS training, Directives, and ethics policies (Section 2.4), and have extensive field experience in their use and best practices. WS-Nevada uses the species-specific BMPs for trapping documented by AFWA as applicable and effective based on specific conditions and availability of and funding for new traps. Field personnel are sometimes requested to provide training in the effective and humane use of capture methods by cooperators who wish to do their own work, when compliant with state law. Traps and snares used by WS-Nevada are updated as often as funding allows, and field personnel trained in their use. APHIS-WS NWRC actively works to develop new methods and trap modifications to improve effectiveness, selectivity, and humaneness.

WS-Nevada follows applicable state laws and regulations regarding the frequency of trap checks (Section 2.4.4.3). When warranted, WS-Nevada employees may check traps more often than required, but no less often than agreed upon in APHIS-WS/NDOW MOU (12-73-32-6500-MU) signed 06/03/2015.

APHIS-WS recognizes that not all devices recommended in the BMP guidelines for general public use meet the stringent performance requirements for use in APHIS-WS activities (or other professional wildlife management agencies), particularly for efficiency and durability. WS Directive 2.450 establishes guidelines for APHIS-WS personnel using certain types of capture devices, and promotes training of its employees to improve efficiency, effectiveness and humaneness. Additionally, all use by WS-Nevada complies with applicable federal, state, and local laws and regulations. WS-Nevada continues to use and implement BMP tools and practices as they become available and when appropriate for managing wildlife damage. Therefore, WS-Nevada professional practices, experience, selectivity, and effectiveness in the use of capture and kill methods reduce the risk of suffering to the extent possible under field conditions, weather, APHIS-WS policy, and state laws and regulations. Landowners are notified of their responsibility for the safety of their pets and livestock on private land.

From FY 2012 through 2016, the foothold trap, neck snare, and firearms were the most consistently used tools for lethal take of many target predator species. Foothold traps, aerial shooting, neck snares, firearms, and, to a lesser degree, M-44s with sodium cyanide were used for lethal take of coyote, which was the species with the highest lethal take, followed by DRC-1339 for lethal take of common raven. Cage traps are also commonly used for smaller predators, sometimes in conjunction with chemical euthanasia (sodium pentobarbital). Black bears are mostly caught with foot snares and shot with firearms, neck snares or pursued by trailing dogs and euthanized with a firearm. Mountain lions are mostly pursued with trailing dogs and humanely shot with firearms, followed by neck snares, foothold traps and box traps. Other than M-44s for lethal take of coyotes, and DRC-1339 for common ravens, chemical methods such as sodium nitrate, chemical euthanasia, and immobilizing drugs are rarely used in the field by WS-Nevada (Table 2.1 and Table E.1). These methods are highly selective for target animals, with low unintentional takes of predator and non-predator species during WS-Nevada PDM activities (Section 3.7). Therefore, WS-Nevada would continue to practice and uphold high standards of humaneness and ethics under Alternative 1.

3.9.6.2 *Alternative 2. Proposed Action/Modified Current Program*

Under this alternative, WS-Nevada would continue the current program (Alternative 1) as modified to include IPDM in WAs and WSAs.

As such, this Alternatives' impact on humanness would be essentially the same as Alternative 1 (Section 3.9.6.1). Although M-44 devices would not be used in WAs, they may be used in WSAs as per annual work plans (Sections 2.4.3.2 and 3.11, Appendix H).

3.9.6.3 *Alternative 3. Non-lethal PDM Required Before Applying Lethal Assistance (No Preventive Lethal PDM)*

Under Alternative 3, WS-Nevada would provide technical assistance for both lethal and non-lethal activities, but the cooperator would need to apply reasonable non-lethal methods before WS-Nevada would provide lethal assistance. WS-Nevada would continue to practice and uphold high standards of humaneness and ethics, as described under Alternatives 1 and 2. The APHIS-WS Decision Model may not be fully effective because even if they are deemed necessary, lethal actions could not be used by WS-Nevada during the time that non-lethal methods are attempted to address the immediate problems. Other commercial, governmental, and private entities and landowners would be likely to continue to conduct IPDM activities as described in Section 3.4.

Other entities would likely increase lethal IPDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada. During (or instead of) WS-Nevada's non-lethal assistance, landowners could still choose to address the problem themselves. If landowners determined that lethal PDM is immediately necessary, they may implement lethal methods before applying all reasonable non-lethal methods. Landowners could use trained and experienced WCOs or may implement lethal methods themselves. Entities requesting lethal assistance would have to determine if a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Relatively few WCOs are available for large predator damage management, but landowners can request someone to work as their agent. Private individuals are not likely to have the consistent training with lethal methods, the experience to confirm the cause of damage, or the level of selectivity possessed by WS-Nevada employees. WCOs may not have the experience or response capability with some of the species and methods if they are not already conducting IPDM activities for those particular species (Section 3.4.2).

Other entities would likely increase lethal IPDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada. Depending on the skillset of others, it is possible that more animals could be taken unintentionally or less humanely by other entities, as a result of less selective and less proficient removal efforts. Additionally, WCOs and other private entities are not required to follow BMP guidelines. Therefore, other private entities may have less ethical or less humane lethal PDM actions. While WS-Nevada would still be available for lethal technical assistance and could advise private entities on applicable BMPs, these efforts would not compensate an individual's lack of experience and proficiency.

Therefore, under Alternative 3, there are likely to be less humane and ethical practices by other entities compared to Alternatives 1 and 2.

3.9.6.4 *Alternative 4. WS-Nevada Provides PDM Lethal Assistance Only for Cases of Human/Pet Health or Safety*

Under Alternative 4, WS-Nevada would provide full IPDM technical and operational assistance (Appendix A), but lethal control could only be included as an option when responding to requests to protect human/pet health or safety, or federally-listed T&E species. WS-Nevada could not use lethal methods as part of IPDM to respond to other types of requests (e.g., agriculture, property, and game species). For threats to human and pet health or safety, the primary predator species of concern would be black bears, mountain lions, or coyotes in residential areas, or disease vector species. All predator species have the potential to be threats to T&E species. WS-Nevada would continue to practice and uphold high standards of humaneness and ethics, as described under Alternatives 1 and 2. Other commercial, governmental, and private entities and landowners would continue to conduct IPDM activities as described in Section 3.4. Other entities would likely increase IPDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada.

However, in the absence of lethal assistance from WS-Nevada for non-T&E species protection requests, some people may feel that it is unethical and inhumane not to take lethal measures to protect domestic animals from predation, if necessary. Entities requesting lethal assistance would have to determine if a commercial WCO or other private individual with the capabilities, approvals, and interest is available, or attempt to address their IPDM needs themselves (as discussed in Section 3.4). Relatively few WCOs are available for large predator damage management, but landowners can request someone to work as their agent. Private individuals are not likely to have the consistent training with lethal methods, the experience to confirm the cause of damage, or the level of selectivity possessed by WS-Nevada employees. WCOs may not have the experience or response capability with some of the species and methods if they are not already conducting PDM activities for those particular species (Section 3.4.2).

There is a potential for other entities (as discussed in Section 3.4) to attempt to fill the need for lethal IPDM activities in the absence of lethal operational assistance from WS-Nevada. Other entities would likely increase lethal PDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada. Depending on the skillset of others, it is possible that more animals could be taken unintentionally or less humanely by other entities, as a result of less selective and less proficient removal efforts. Additionally, WCOs and other private entities are not required to follow BMP guidelines. Therefore, other private entities may have less ethical or less humane lethal IPDM actions. While WS-Nevada would still be available for lethal technical assistance and could advise private entities on applicable BMPs, these efforts would not compensate an individual’s lack of experience and proficiency.

Therefore, under Alternative 4, there are likely to be less humane and ethical practices by other entities compared to Alternatives 1 and 2.

3.9.6.5 *Alternative 5. No WS-Nevada PDM Activities*

WS-Nevada would continue to practice and uphold high standards of humaneness and ethics, as described under Alternative 1. Landowners experiencing damage or threats could only depend on advice and responses from NDA-WS, commercial WCOs, NDOW, or other entities. Entities requesting lethal assistance would have to determine if NDA-WS, NDOW or a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Other entities would likely increase PDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada.

Depending on the skillset of others, it is possible that more animals could be taken unintentionally or less humanely by other entities, as a result of less selective and less proficient removal efforts. Additionally, while NDA-WS is trained in BMPs, WCOs and other private entities are not required to follow BMP guidelines. Therefore, other private entities may have less ethical or less humane lethal PDM actions.

Therefore, under Alternative 5, there are likely to be less humane and ethical practices by other entities compared to Alternatives 1-4.

3.10 What are the Potential Impacts on the Environment and Risks to Human and Domestic Animal Health and Safety of WS-Nevada IPDM Methods?

This section evaluates the potential impacts and risks associated with mechanical and chemical IPDM methods used by WS-Nevada on environmental resources and human and domestic animal (including pets and livestock) health and safety. This includes effects on the environment as applicable for each method (water, soil, aquatic and terrestrial vertebrates and invertebrates, including wildlife) and members of the public, recreationists, sportsmen, and WS-Nevada employees.

The analysis of each mechanical and chemical method is based on a thorough national risk assessment of each APHIS-WS method (USDA 2019), with additional information included from WS-Nevada activities and the literature where available.

All of the methods evaluated in this section are described in detail in Appendix A and summarized in Section 2.3.1.

Other issues related to the use of these methods and chemicals are evaluated in the following sections:

- Efficacy of IPDM (Section 1.12)
- Impacts on predator populations (Sections 3.5 to 3.7)
- Impacts on predator and non-predator populations, including federally-listed threatened and endangered species from unintentional take (Sections 3.6 and 3.7)
- Humaneness of methods (Section 3.9)

APHIS-WS Directives and policies for the use of IPDM methods are described in Section 2.4.1 through 2.4.3 and the associated state of Nevada laws and regulations are included in Section 2.4.4.

In December 2019, APHIS-WS published "Human Health and Ecological Risk Assessment for the use of Wildlife Damage Methods by USDA-APHIS-Wildlife Services" online (https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/programs/nepa/ct-ws-risk_assessments). This publication is a collection of formal risk assessments prepared by USDA-APHIS-WS and peer reviewed by non-federal professionals, with knowledge of the methods and risks associated with their use, have conducted, or will be conducting, peer reviews of the assessments. The peer reviewers were selected by the Association of Fish and Wildlife Agencies, the organization of state, provincial and territorial fish and wildlife agencies in North America, entrusted with primary stewardship over vital wildlife resources. The publication evaluates 17 wildlife damage management methods in Chapters. The analysis in this Section will reference these Risk Assessments. While the analysis provided in them is extremely detailed, the entirety of those documents will not be included in this EA.

3.10.1 *What are the Potential Impacts and Risks Associated with Mechanical/Physical Methods?*

Mechanical/physical methods include physical capture devices, such as cage traps, cable restraints, foothold traps, and quick-kill/body grip traps. Additionally, the use of firearms, aerial shooting, and trained animals are distinct methods, but also are often used in conjunction with physical capture devices. The impacts and risks associated with lead ammunition associated with these mechanical/physical methods will be discussed in Section 3.10.2.

3.10.1.1 *What are the Potential Impacts and Risks Associated with Physical Capture Devices?*

WS-Nevada uses 4 primary types of physical capture devices during IPDM activities – cage traps, cable restraints (both foothold and neck snares), foothold traps, and quick-kill/body grip traps. Descriptions of these methods are found in Appendix A. The impacts and risks related to the use of mechanical/physical capture devices by APHIS-WS are examined in detail in various chapters of *USDA, APHIS, WS Risk Assessment* (USDA 2019), and will be discussed in Section 3.10.1.

3.10.1.1.1 What are the Potential Impacts of Physical Capture Devices on Soil, Water, and Terrestrial and Aquatic Species?

Cage traps, metal foothold traps, quick-kill traps, and snares are physical devices that have little to no potential to affect soil, water, terrestrial plants, freshwater and terrestrial invertebrates, amphibians, reptiles, and fish. Food baits, such as tuna fish, eggs, meat, or peanut butter, are sometimes used to encourage target animals to investigate and enter or activate traps; however, the amount of natural bait is small, and quickly decomposes or is eaten by small animals or insects. When the trap is pulled, the WS-Nevada employee removes and discards any remaining bait. Although plant matter may be used to hide or camouflage the trap, this is usually dead material already existing in the trap area, such as sticks or plant debris.

Therefore, there is little to no potential effect on soil, water, or terrestrial plants by the use of physical capture devices when used either by WS-Nevada employees and/or any other person.

3.10.1.1.2 What are the Potential Risks from Physical Capture Devices on Public Health and Safety, Including Recreationalists and Sportsmen, and Domestic Animals?

Per WS Directive 2.450, capture devices should be set to reduce the visibility of captured animals to the public (Section 2.4.1.2). 56.4% of total WS-Nevada predator take occurs on BLM land, 39.5% on private land (Table 2.2) and WS Directive 2.450 requires APHIS-WS employees to make reasonable efforts to obtain approval from adjacent landowners when setting traps or snares under fence lines to avoid capture of domestic animals (Section 2.4.1.2). Most PDM activities are conducted away from areas of high human activity except when directly applied on private landowner property to address a specific damage problem. If there is a risk of people being present, then, whenever possible, activities are conducted during periods when human activity is low, such as at night or early morning (Section 2.4.3.1).

Bilingual warning signs are used near trap sets placed on public lands to alert the public about hazards to people and domestic animals from traps or captured animals. Cage traps set for mountain lions and black bears, and foot snares set for black bears are typically used on private lands to protect livestock, when placed on public land, they are placed so that captured animals are not readily visible from any designated recreation road or trail or from federal, state, or county roads, signs are placed at access points to communicate the potential hazard (Section 2.4.3.1).

Use of traps and snares is restricted in public safety zones designated in USFS or BLM Annual Work Plans for IPDM on federally managed lands. A 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. IPDM conducted on federally managed lands within identified public safety zones are generally limited to activity conducted for the protection of human health and safety. However, a land management agency or cooperator could request IPDM activities in the public safety zone for another type of identified need, as approved by/coordinated with the managing agency (as appropriate). Depending on the situation and applicable laws and regulations, federal grazing permittees could request either WS-Nevada or others to conduct IPDM activities. However, when WS-Nevada conducts the activities, it notifies the land management agencies of IPDM activities that involve methods of possible concern, such as firearms, M-44 devices, dogs, and traps, before these methods are used in a public safety zone, unless specified otherwise in the Annual Work Plan and as appropriate (Section 2.4.3.1). This is not necessarily the case for IPDM work conducted by other entities or individuals.

No pet/livestock animals have been unintentionally killed in FY 2012 through FY 2016 by WS-Nevada. In the same 5 year period, 5 pets/livestock animals were captured and freed unharmed, 2 each in a foothold trap and 1 in a cage trap. During that same period, 4 free-ranging/feral dogs were unintentionally captured in foothold traps and released unharmed (with 1 transferred to the Sheriff's department). In 5 years, only 1 feral/free-ranging dog was unintentionally killed; it was caught in a neck snare (Section 3.7).

Therefore, the potential for the public, recreationists, sportsmen, landowners, and domestic animals to encounter and be captured or killed by a trap or snare set by WS-Nevada and/or any other person/entity is very low on private lands and public lands.

3.10.1.1.3 What are the Potential Risks of Using Physical Capture Devices to WS-Nevada Employees?

WS-Nevada employees operating in the field work with physical capture devices routinely, and also have a high potential to encounter and handle wildlife, both live and dead, as part of their daily work. The health and safety hazards associated with the use of physical capture devices potentially include cuts, abrasions, bruises, or bone fractures for the hands or fingers from the accidental discharge of a trap or the trigger of some snares. Most injuries occur while setting or placing metal foothold traps. Setting traps also involves bending, kneeling, and pounding and pulling stakes, which could potentially lead to back strains. When using snares, an employee may be cut on broken strands of cable.

APHIS-WS field employees are experienced and knowledgeable in the use of traps and snares, and handling of animals under stress. APHIS-WS field employees whose duties involve animal capture are required to take intensive courses (WS Directive 2.450, Section 2.4.1.2). They must also participate in recurrent firearms training (WS Directive 2.615, Section 2.4.1.3), which is important when firearms are used to euthanize captured animals.

WS has taken specific precautions to reduce the risk of employees being bitten by a diseased animal. The bite from a wild predator has the potential to carry disease, which can infect the employee. The risk of being bitten is primarily from live-traps such as foothold traps and snares. Quick-kill body-grip traps are intended to immediately kill the animal when the trap is triggered, so the risk of an employee being bitten is extremely low. Employees may also get bitten or scratched while setting an animal free or attempting to euthanize a captured animal.

WS Directives 2.601 and 2.635 (Section 2.4.1.12) address this hazard. Supervisors of field employees are responsible for identifying possible hazards, including wildlife-borne diseases, and ensuring that employees are provided information, training, and personnel protective equipment (PPE), especially safety glasses and heavy gloves, to optimize employee safety. Employees are empowered to immediately report unsafe working conditions to their supervisor. Because of the potential for doctors to misdiagnose wildlife-borne diseases because of their rarity in the general population, employees are advised to alert their doctors of the potential for exposure, and all field employees are provided with a Physician's Alert Card with pertinent information about the more relevant diseases. The APHIS-WS Biological Risk Management Training Manual provides information about disease safety, biosecurity, and PPE use.

When using cage traps, the risk to employees from captured animals is minimal. The animal is entirely enclosed in the trap and the trap can be readily moved (if captured in a public area) to release the animal with little risk to the employee, as the door can be opened while the employee is safely behind the door. Animals can also be immobilized and/or euthanized while still inside the trap. When necessary, mountain lions and other species are euthanized directly in the trap, usually using a firearm. Most reported bites have occurred from handling live animals at the APHIS-WS NWRC laboratory, not in field conditions.

If the animal is to be transported for release or euthanasia away from a public place, the animal is usually immobilized for safe handling (Appendix A and Section 3.9). Smaller animals can be handled with a catchpole to control the animal and prevent or reduce risk to the employee or animal. Securely staking the trap rather than using a drag holds the animal in place, avoiding the surprise of finding an animal that has moved from the original trapping location and minimizing the risk of attacks and bites.

There are no records of employees receiving broken fingers from handling foot-hold traps and activating snares during the 2012-2016 time frame.

Nationwide, from FY 2008 through FY 2012, APHIS-WS field personnel were bitten 14 times (1 black bear, 1 coyote, 2 feral cats, 3 feral dogs, 2 bats, 1 pelican, and 4 unknowns). Since 2013, an average of only 2.3 animal bites were recorded nationwide, with 2 of those bites from cats and dogs. Wild animals under stress from handling can behave unpredictably. However, since most animals are safely euthanized while still captured, the potential for bites is low.

Between FY 2012 and FY 2016, there were 3 field-related injuries reported by WS-Nevada field employees through workman's compensation processes, none of which were related to physical capture equipment.

Skilled WS-Nevada professionals routinely follow WS Directives and standard safety practices, especially the use of PPE and safety requirements, which substantially reduces the risk of major or even minor injury during trapping and snaring activities, based on historical records. Therefore, the risk to WS-Nevada field employees is considered very low. The risk to non-WS-Nevada entities depends on their proficiency and experience with the equipment and its placement.

3.10.1.2 *What are the Potential Impacts and Risks from the Use of Firearms and Firearm-like Devices?*

Firearms, including rifles, pistols, air rifles, and shotguns, are used on a frequent or even daily basis by APHIS-WS and WS-Nevada field employees to lethally take or euthanize wildlife during IWDM activities.[9] Firearm application is one of the most frequently used methods by APHIS-WS field employees, and are used in all types of settings, including urban and rural areas, if they can be used safely. Because firearms are inherently dangerous and use may occur under difficult conditions or high-profile public circumstances, all use must be safe, accurate, and with high competency. Therefore, APHIS-WS requires extensive training and certification for employees to use firearms (WS Directive 2.615, Section 2.4.1.3).

APHIS-WS field employees are required to take extensive and repeated training and receive certification for use and proper storage of firearms and firearm-like devices (WS Directive 2.615, Sections 2.4.1.3 and 2.4.1.4), including the proper use of personal protection equipment (PPE) such as ear protectors and glasses. Training in the proper and safe use of firearms consists of an initial training course, followed by a requirement for continuing education on an annual basis. To ensure APHIS-WS employees receive uniform firearms safety training, National Rifle Association (NRA) certified instructors and the NRA's curriculum for the basic pistol, rifle, and shotgun certification is the only officially recognized program of initial firearms safety training for new APHIS-WS employees. The training requirement for firearm-like devices, at a minimum, includes the NRA's curriculum for the basic pistol, rifle, or shotgun certification that best fits the device's profile. New WS-Nevada employees cannot use firearms in an official capacity until they have completed the NRA Basic Firearm Course pursuant to the firearms the employee will use on the job. Once that training is completed, annual firearms safety continuing education is required. A component of the training is learning to estimate the distances that a projectile of a certain type will travel (maximum projective range), in order to avoid unintended damage or injury in the case of a missed target.

APHIS-WS and WS-Nevada personnel who use firearms are subject to new applicant drug testing, random drug testing, reasonable suspicion testing, and post-accident testing. As a condition of employment, APHIS-WS employees who carry and use firearms are subject to the Lautenberg Domestic Confiscation Law, which prohibits firearm possession by anyone who has been convicted of a misdemeanor crime of domestic violence (18 USC §922(g)(9)).

APHIS-WS employees adhere to 3 basic safety rules, including always pointing the firearm in a safe direction, always keeping fingers off the trigger until ready to shoot, and always keeping the gun unloaded until ready to use.[10]

APHIS-WS field personnel select firearms appropriate to an intended use, and which include rifles, shotguns, air rifles, or pistols. For example, WS-Nevada personnel may use a larger caliber rifle to take mountain lions or a smaller caliber rifle for

[9] The humaneness of using firearms for removing or euthanizing animals is discussed in Section 3.9.6. The use of firearms during aerial activities is discussed in Section 3.10.1.3. APHIS-WS policy for use of firearms is found in WS Directive 2.615 (Section 2.4.1.3).

[10] The risks to human health and safety and the environmental impacts and fate for lead used in ammunition are found in Section 3.10.2.

raccoons. Field employees base the selection of firearm type and size on several factors, including the target animal, likely distance to target, humaneness, accuracy, safety, and noise in sensitive areas. Direction of ricochet/pass-through is difficult to predict and is a safety concern, especially at airports, in areas near residences, areas with rocky substrate, and for APHIS-WS personnel shooting from aircraft.

Field employees generally use rifles, rather than shotguns or handguns, to target animals accurately at greater distances or that are not restrained. Shotguns are generally used to target animals at distances less than 100 yards, and in most cases, less than 50 yards. Modified shotguns can also be used for non-lethal purposes, such as to fire pyrotechnics such as shell crackers to disperse target animals and to discharge rubber projectiles to physically hit and frighten animals. Shotguns are also used during aerial shooting to limit the risk of ricochet and increase effectiveness and efficiency of humanely killing the target predator (Section 3.9). When shooting animals from aircraft, shooters target the space directly behind the animal's ear, and the ammunition must be able to penetrate the thick skin located in this region. Handguns such as pistols are used for close-range euthanasia of a captured animal or for protection from attack by wild animals such as mountain lions or feral dogs.

Firearm-like devices are firearms that have been modified to fire 12-gauge cracker shells and non-lethal rubber bullets or beanbags for harassment. Immobilizing dart-firing guns are firearms modified to fire immobilizing agents in darts from a safe distance. They are used when immobilizing or for moving animals to reduce stress and increase handler safety. Firearms that have been modified to fire non-lethal rubber bullets or beanbags are used to harass and disperse target animals. Paintball guns and rubber bullets may be used for harassing predators.

In addition to euthanasia, WS-Nevada uses firearms to intentionally lethally remove 36.68% of predators, with 98.91% of the take with firearms being coyotes (including aerial shooting take). Firearms are also used to intentionally take common ravens, badgers, mountain lions, striped skunks, raccoons, red fox, bobcats and black bears (Table 2.1, Appendix E Table E. 1). Firearms are highly selective; WS-Nevada employee did not take predators or non-predator animals unintentionally with this method (Section 3.7).

3.10.1.2.1 What are the Potential Impacts from to the Environment from the Use of Firearms?

Firearms are highly selective when used by experienced and trained personnel. APHIS-WS personnel are highly trained in safety, target selection, and humaneness training and experience. There is no impact on the environment when a firearm is used as a euthanizing agent at very close range, and an impact on the environment is highly improbable when a firearm is used at the appropriate distance from the ground or from an aircraft.

Night shooting may be conducted in sensitive areas that have high public use or other activity during the day or to detect and shoot target animals that are active at night, such as coyotes. Specialized equipment, such as lights, night vision, and thermal imagery, increases the selectivity and accuracy of firearm use at night.

Most shotgun shell casings (hulls) are plastic with a brass end (a mixture of mostly copper with some zinc alloys); bullet casings are composed primarily of brass. Bullet casings from centerfires and shotgun hulls may be left on the ground, but are typically retrieved by field personnel, with the exception of shotgun hulls from aerial shooting. Brass is generally resistant to environmental corrosion, and oxidizes over a very long period of time. The primers are also generally made up of brass. Materials making up the explosives in the primer are burned upon contact. Plastic shell hulls are mostly made of high-density polyethylene plastic and, sometimes, a low-density polyethylene plastic. If not retrieved, the plastic will degrade into small pieces in sunlight over a long period of time. Paper wads in the projectile follows the shot for a distance, then fall to the ground to degrade quickly.

Firing at target animals with harassment projectiles is always conducted at a sufficient distance to cause the animals to flee and is not intended to harm the target animal. Paintballs used in hazing are non-toxic to the environment, biodegradable and soluble in water. Most of the ingredients are food grade.

With the high level of proficiency and safety training provided to APHIS-WS and WS-Nevada field employees and when firearms are used according to WS Directives and training, the use of firearms and firearm-like devices is highly selective and have a negligible impact on the environment.

3.10.1.2.2 What is the Accident Risk of WS-Nevada's Use of Firearms to the Public, Including Recreationists, Sportsmen, and Domestic Animals?

APHIS-WS and WS-Nevada employees are highly trained and proficient in the use of firearms. They are trained to know the distance that different ammunition types fired from various firearms may travel before losing energy and are cognizant of the potential for recreationists and hunters to be in the area. APHIS-WS has never had an accidental shooting of any member of the public.[11]

Dogs have been known to eat paintballs, which may cause toxicosis. However, with veterinary treatment, they typically recover within 24 hours (Donaldson 2003). WS-Nevada is not aware of any dog having eaten a paintball it has used in IPDM. WS-Nevada anticipates rarely using paintball guns for hazing predators.

Based on the level of training and proficiency in the use of firearms under a variety of circumstances and conditions, and the lack of past accidents, the likelihood for an incident involving any member of the public or domestic animals is negligible.

[11] The risks to human health and safety and the environmental impacts and fate for lead used in ammunition are found in Section 3.10.2.

3.10.1.2.3 What are the Potential Risks to WS-Nevada Field Employees from Using Firearms?

The risk to WS-Nevada field employee's health with the use of firearms and firearm-like devices ranges from minor incidents to potentially significant accidents that may result in injury or property damage. The most common potential risks involve bruises to the shoulder and face from firearm recoil, damage to hearing from sustained use without proper hearing protection, eye damage from ammunition debris upon firing, and accidental gunshot wound from improper handling. Mechanical function of the firearm or defective ammunition could result in shrapnel, lacerations, punctures, or damage to eyes or limbs.

To protect hearing, in addition to using PPE when appropriate, APHIS-WS initiated a Hearing Conservation Program to reduce hearing loss and monitor employees subjected to frequent noise based on the applicable Occupational Safety and Health Administration Hearing Conservation guidelines (https://www.osha.gov/Publications/osha3074.pdf). This program provides hearing tests for employees exposed to eight hours of 85 dB or higher noise. Employees are required to wear adequate hearing protectors and be trained how to use them before working at harmful noise exposure thresholds. Periodic hearing tests for such employees are required to determine if hearing is being impaired.

Additionally, precautions taken by APHIS-WS employees include knowing what is beyond targets, wearing eye protection, and storing firearms and ammunition so they are not accessible to unauthorized persons.

WS-Nevada employees are highly familiar with the firearms they use, which ensures accuracy and safety. Nationwide, APHIS-WS employees have had 8 accidents with uses of all firearms between 2012 and 2016, average of 1.6 per year, typically by operator error, firearm and ammunition malfunctions (Table 3.19).

No accidents or incidents were recorded by WS-Nevada involving firearms between FY 2012 and 2016.

Lastly, since WS-Nevada field personnel operate firearms outdoors, they are not directly exposed to the low volume of particulates created by firing a firearm.

With proper and repeated training per WS Directives 2.615 and 2.625 (Section 2.4.1.3), constant awareness, and proper use of PPE, accidents other than those caused by firearm and/or ammunition malfunctions can be and are mostly avoided, as indicated by data in Table 3.19.

Table 3-19. APHIS-WS Nationwide Total and Average Record of Accidents and Incidents with Firearms and Firearm-like Devices during all IWDM Activities, FY 2012-2016.

Firearm[1]	Operator Error (avg./yr)	Mechanical Failure (avg./yr)	Ammunition Failure (avg./yr)	Mishap (avg./yr)	Injury (avg./yr)
Shotgun (ground)	0.4	--	--	--	--
Shotgun (aerial)	--	--	--	--	--
Rifle	0.2	--	--	--	--
Pistol	0.2	--	--	--	--
Air rifle	0.4	--	--	0.2	0.2
Cracker shell pyrotechnic	--	0.2	0.2	--	0.2
Paint balls, rubber bullets	--	--	-	--	--
Average Total	1.2	0.2	0.2	0.2	0.4

[1]No accidents were recorded due to use of dart guns or other non-lethal projectiles

Risks associated with the use of firearms is detailed in Chapter 6 of the Risk Assessments (USDA 2019) and was finalized after peer review in 2019. The Risk Assessment concluded:

> *Firearms and firearm-like devices are very selective for target animals and used frequently in WDM for many different species. WS personnel receive training in the proper use of firearms and firearm-like devices pursuant to WS directives. With proper training, WS employees are effective and efficient at using these to focus their efforts to specific target animals and can use those methods with very low risks to human safety and to the environment. WS personnel have been very effective in using firearms and relatively few personnel have been injured and few accidents and incidents have occurred as a result of the use of firearms. Few nontarget species, mistaken identity for the most part, have been taken. Thus, it is concluded that the use of firearms is of low risk to WS personnel, the public, nontarget species, and environment.*

3.10.1.3 *What are the Potential Impacts and Risks from the Use of Aircraft and Aerial Shooting?*

WS-Nevada uses or contracts for fixed-wing aircraft and helicopters for intentional aerial shooting of coyotes (an average of 31.89% of total IPDM lethal take (Appendix E, Table E.1) on areas under agreement. In Nevada, these activities occur primarily in late fall and early spring, during lambing and calving seasons, and the most commonly used aircraft are fixed-wing Piper PA-18 Super Cubs, CubCrafters CC-18 Top Cubs; and rotary-wing Hughes MD500. WS-Nevada currently uses shotguns for aerial shooting, but some rifles may be used selectively in the future if approved by APHIS-WS.

APHIS-WS has used aerial shooting for over 60 years, with no known adverse impacts on any native wildlife populations, and adverse impacts are not anticipated in the future. APHIS-WS avoids other wildlife when observed during flying time. It is expected that WS-Nevada aerial shooting and flights will not cause any long-term adverse impacts to non-target species, including those that are listed as threatened and endangered (USFWS 2018a). In addition, no unintentional take by WS-Nevada has occurred between 2012 and 2016 during aerial shooting activities, and no humans on the ground have been injured as a result of a crash or during aerial shooting.

Chapter 5 of the Risk Assessment (USDA 2019) is the peer-reviewed chapter on risks from "The Use of Aircraft in Wildlife Damage Management". Detailed analysis on the following topics can be found in that publication, online, at https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/programs/nepa/ct-ws-risk_assessments.

3.10.1.3.1 What are the Potential Impacts on Wildlife from Low-level Overflights?

Low-level flight impacts to wildlife have been studied extensively, and this research has informed the APHIS-WS position on the potential effects of our aerial operations. Studies evaluated as part of this analysis included:

- **Kushlan (1979)**: low-level overflights of 2-3 minutes by a fixed-wing airplane and a helicopter produced no drastic disturbance of tree-nesting colonial waterbirds
- **Conomy et al. (1998)**: only 2% of wintering American black ducks, American wigeon, gadwall, and American green-winged teal (*Anas crecca carolinensis*) exposed to low-flying military aircraft reacted
- **Delaney et al. (1999)**: 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 but were more prone to flush from chain saws.
- **Johnson and Reynolds (2002)**: Mexican spotted owls showed minor behavioral changes to F-16 training runs, but less than to natural and other man-made occurrences
- **Andersen et al. (1989)**: red-tailed hawks habituate to low-level helicopter flights during the nesting period
- **White and Thurow (1985)**: ferruginous hawks are sensitive to certain types of ground-based human disturbance. However, neither low-flying military jets nor fixed-wing aircraft within 100 feet impacted them
- **Ellis (1981)**: 5 species of hawks, 2 falcons, and golden eagles were tolerant of overflights by military fighter jets; negative responses were brief and never limited productivity

- **Grubb et al. (2010)**: golden eagles were not adversely affected by civilian and military helicopter flights in northern Utah
- **Krausman et al. (1986)**: 3 of 70 observed mule deer responses to fixed-wing aircraft overflights at 150 to 500 feet above ground resulted in changing habitats, but they may have become accustomed to frequent aircraft activity in the area
- **VerCauteren and Hygnstrom (2002)**: overflown deer typically stood up from beds, but did not flush
- **Krausman and Hervert (1983)**: in 32 observations of responses 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
- **Krausman et al. (1998)**: 14% of bighorn sheep had elevated heart rates that lasted up to 2 minutes after an F-16 overflight at 400 feet, but it did alter the behavior of penned bighorns.
- **Weisenberger et al. (1996)**: desert bighorn sheep (*Ovis canadensis nelsoni*) and mule deer had elevated heart rates for 1 to 3 minutes and became alert for up to 6 minutes following exposure to jet aircraft.
- **Fancy (1982)**: 2 of 59 bison groups reacted to fixed-wing aircraft flying at 200-500 feet above ground

APHIS-WS uses fixed- and rotary-wing aircraft for aerial WDM activities only in areas under agreement and primarily conducts efforts during certain times of the year such as during lambing. APHIS-WS annually flies less than 20 min/mi^2 (this is equivalent to under 2 seconds per acre), on properties under agreement. APHIS-WS avoids non-target wildlife such as wild horses and grizzly bears. APHIS-WS has concluded that disturbance effects on raptors, ungulates, and other species are short-lived and negligible and will not cause adverse impacts to non-target species including those that are threatened or endangered.

3.10.1.3.2 What Are the Potential Impacts of Aircraft Sound on the Public, Including Recreationists and Sportsmen?

The response of humans to noise depends on the frequency, intensity, duration, and fluctuations in sound pressure, personal perception, and atmospheric conditions (cold dense air transmits sound more readily than warm breezy air). The distance from the source of the noise and attenuation of the sound from buildings, vegetation, wind, humidity, and temperature also affects the level of perceived noise.

WS-Nevada limits or avoids aerial shooting during hunting seasons, and it conducts most aerial shooting on or adjacent to livestock on private lands and less in remote areas. These measures prevent or limit overlap between aerial shooting and recreational uses. Furthermore, if WS-Nevada aerial shooting occurs over private land, landowners would notify WS-Nevada of ongoing recreational uses. When on public lands, WS-Nevada is notified by public land managers, during Annual Planning meetings and at other times, of areas with high potential for recreational use.

Federal Aviation Administration rules require pilots to stay at least 500 feet from people or human structures. It is feasible that a person may not be seen, but air and ground crews watch for people to avoid them. Most areas where WS-Nevada conducts aerial shooting are sparsely vegetated and people are likely to be seen. In rare instances, people in the vicinity of aerial PDM activities are startled, but have not been within minimum safe distances. Additionally, both fixed wing and rotary aircraft would be expected to be heard coming in from a distance, reducing the chance of being startled.

3.10.1.3.3 What are the Potential Risks to the Health and Safety of WS-Nevada Employees during Aerial Activities?

Between 2000 and 2016, APHIS-WS recorded 7 incidents nationwide involving firearms causing damage to the aircraft during aerial shooting (both directly shooting parts of the aircraft and shot ricochet from rocks on the ground), with the last incident occurring in Nevada in 2010. WS-Nevada has not recorded any accidents or incidents related directly to aerial shooting since 2010 (Scott Jensen, ATOC Flight Instructor, Pers. Comm. 6/29/18)).

WS-Nevada has determined that the risk of accidents related to aerial shooting is minimal and less than that for general aviation. WS-Nevada has not experienced any accidents or mishaps since 2003.

3.10.1.3.4 What is the Potential for Hazardous Spills from an APHIS-WS Aircraft Crash?

The risk of fire or hazardous spills related to WS-Nevada's aerial shooting program are considered negligible. In addition, the National Transportation Safety Board considers risks of fire and from hazardous spills related to government aircraft operations and accidents to be negligible nationwide, and no such incidents have been attributed to WS-Nevada aerial operations.

3.10.1.3.5 What is the Potential for Compromised Physical Security of APHIS-WS Aircraft and Related Facilities?

WS-Nevada personnel are trained to reduce the threat of theft or illicit activities associated with APHIS-WS or contracted aircraft. No aircraft either owned or contracted by APHIS-WS or WS-Nevada has ever been stolen and the potential for such occurrences is considered negligible under all alternatives considered here.

3.10.1.3.6 Conclusion

APHIS-WS works cooperatively with other natural resource agencies at the state and national level to implement the use of aircraft. Implementation of program-specific measures designed to reduce accidents with aircraft has reduced the risk to the public and workers. WS will continue to evaluate and implement, where appropriate, new protection measures. APHIS-WS believes that the risks to people from crashes and theft of an airplane, to non-target wildlife from misidentification and aerial overflights, and to the environment from fires and spills as a result of an accident are minimal. In addition, the use of firearms in aircraft has resulted in very few problems. WS will continue to support and conduct extensive training for pilots and crewmembers to make them more effective and reduce these risk (USDA 2019).

3.10.1.4 *What are the Potential Impacts and Risks from the Use of Trained Animals?*

A trained dog, as defined by WS Directive 2.445 (Section 2.4.1.14) is a dog that is proficient in the skills necessary to perform specific functions in a manner responsive to its handler's commands by exhibiting the desired or intended behavior. Such dogs shall not pose a threat to humans or domestic animals or cause damage to property.

Trained dogs are used to track or trail animals, detect particular species or their sign, retrieve animals taken with another method such as firearms, haze animals from an area where they are not wanted such as birds in an air operating area, and decoy or attract coyotes which respond to canid invasions of their territories. Additionally, dogs, along with other animals, are sometimes used to guard and protect livestock from other predators.

Dogs may be owned by APHIS-WS personnel or by contractors hired by the agency for use. The tracked or decoyed animal may be either euthanized or immobilized, depending on state law and management objectives. WS Directive 2.445 requires personnel to ensure that trained dogs have all the necessary care, including appropriate housing, food, and all required licenses and vaccinations per applicable state and local laws.

3.10.1.4.1 What are the Potential Impacts of the Use of Trained Animals to the Environment?

Dogs in training or improperly trained dogs could pursue and harass non-target wildlife from the area.

Pursuant to the Migratory Bird Treaty Act, a dog handler cannot allow their dog to catch or harm protected migratory birds unless they are targeted and being harassed or retrieved by working dogs under the appropriate permit. In some cases, a state permit may also be required to harass wildlife using dogs. Handlers must especially consider the flightless period for birds or birds commonly on the ground feeding, nesting, or molting to ensure that dogs do not harass or kill them as easy targets.

To avoid stress and injury of the target animals from the resultant struggle to avoid a dog when restrained, the handler must exhibit a high level of respect and professionalism and control the dog from harassing or attacking the animal.

Complying with the requirements of WS Directive 2.445 (Section 2.4.1.13) results in a negligible risk of injury to non-target animals or to restrained animals.

3.10.1.4.2 What are the Potential Risks to the Health and Safety of WS-Nevada Employees and the Public from the Use of Trained Animals?

To ensure proper control of the dogs, APHIS-WS personnel use various methods and equipment, such as muzzles, electronic training collars, harnesses, and leashes. In addition, APHIS-WS personnel are required to obtain appropriate licenses and vaccinations for their trained dogs in accordance with applicable state and local laws. When in appropriate settings such as an urban area, APHIS-WS dog handlers follow applicable leash laws when using trained dogs. These policies tend to reduce problems with dogs and potential to impact human health and safety.

No members of the public have been injured by trained dogs handled by APHIS-WS employees or by animals that were at bay or controlled by trained dogs for at least the last 10 years. All employee bites were from ranch or feral dogs, not trained dogs.

Highly trained livestock guarding animals, such as dogs or llamas, are under the ownership, care, and control of the livestock owner or their agent. Activities of WS-Nevada field personnel in investigating depredation events or conducting PDM activities may be in the vicinity of such animals and must take care not to distract or directly interact with them. They are trained to protect the livestock from all threats, including perceived threats from people, and are not socialized to human interactions.

The risk of injury to field employees or the public from trained dogs actively working in the field and under the control of handlers, as well as livestock guarding animals, is negligible.

3.10.1.4.3 What are the Overall Environmental Impacts and Health and Safety Risks Associated with the Use of Trained Animals?

The limited number of WS-Nevada field personnel experienced in the use of trained dogs, or currently using them, are required to protect both themselves and their dogs. WS-Nevada personnel are also experienced with the training and behavior of valuable livestock guarding animals, and they are careful to protect themselves and the animals. The impacts and risks are negligible for both employees and animals under all alternatives involving WS-Nevada field activities associated with livestock or the use of pursuit dogs for trailing or capturing predators.

For alternatives involving non-WS-Nevada field personnel, risks and impacts associated with the use of trained dogs would likely be similar, since owners of such trained and valuable dogs are presumably experienced. However, non-WS-Nevada entities hired by landowners may not be experienced with conducting activities near livestock guarding animals and may be injured or inadvertently injure the animal. This could occur for any alternative in which WS-Nevada activities are restricted.

3.10.1.5 *What are the Comparative Impacts of the Alternatives from the Use of Physical/Mechanical Methods?*

3.10.1.5.1 Alternative 1. No Action Alternative: Continue WS-Nevada IPDM Assistance outside of WAs and WSAs

The analysis for impacts on soil, water, and terrestrial and aquatic species indicates little to no effect on the environment from WS-Nevada's use of any physical capture devices, shooting, aerial shooting, or trained animals. The effects of lead ammunition will be discussed in Section 3.10.2.

Risks to human health and safety, including recreationists, sportsmen, and domestic animals from WS-Nevada's use of mechanical/physical methods is very low on private lands. Additionally, impacts or risks to humans and domestic animals are highly unlikely on public lands due to the very low potential to encounter equipment set, the relatively short duration of PDM activities occurring in a particular area and protective measures as described in Section 2.4. WS-Nevada employees have a high level of proficiency and are routinely trained in the use of mechanical/physical methods.

WS-Nevada employees always follow APHIS-WS Directives and other protective measures, including the use of PPE and safety requirements, which substantially reduces the risk of major or minor injuries during IPDM activities, based on historical records (Table 3.19). Reported injuries for WS-Nevada over the last 5 years average approximately 0.6 per year, all related to conducting operations in the outdoors, but not necessarily related to the use of the equipment. Therefore, the risk to humans and domestic animals from WS-Nevada's use of mechanical/physical methods is very low on private lands and highly unlikely on public lands.

3.10.1.5.2 Alternative 2. Proposed Action/Modified Current Program. A Continuance of the Current Program as modified to include IPDM in WAs and WSAs

Under this alternative, WS-Nevada would extend IPDM to livestock with valid grazing permits, and natural resources, at the request of NDOW, in WAs and WSAs. The analysis for impacts on soil, water, and terrestrial and aquatic species indicates little to no effect on the environment from WS-Nevada's use of any physical capture devices, shooting, aerial shooting, or trained animals. The effects of lead ammunition will be discussed in Section 3.10.2.

Risks to human health and safety, including recreationists, sportsmen, and domestic animals from WS-Nevada's use of mechanical/physical methods is very low on private lands. Additionally, impacts or risks to humans and domestic animals are highly unlikely on public lands due to the very low potential to encounter equipment set, the relatively short duration of PDM activities occurring in a particular area and protective measures as described in Section 2.4. WS-Nevada employees have a high level of proficiency and are routinely trained in the use of mechanical/physical methods.

WS-Nevada employees always follow APHIS-WS Directives and other protective measures, including the use of PPE and safety requirements, which substantially reduces the risk of major or minor injuries during IPDM activities, based on historical records (Table 3.19). Reported injuries for WS-Nevada over the last 5 years average approximately 0.6 per year, all related to conducting operations in the outdoors, but not necessarily related to the use of the equipment. Therefore, the risk to humans and domestic animals from WS-Nevada's use of mechanical/physical methods is very low on private lands and highly unlikely on public lands.

3.10.1.5.3 Alternative 3. *Non-lethal PDM Required Before Applying Lethal Assistance (No Preventive Lethal PDM)*

Under Alternative 3, WS-Nevada would provide technical assistance for both lethal and non-lethal activities, but the cooperator would need to apply reasonable non-lethal methods before WS-Nevada would provide lethal assistance. The APHIS-WS Decision Model may not be fully effective because lethal actions could not be used by WS-Nevada during the time that non-lethal methods are attempted to address damage or the threat of damage. Other commercial, governmental, and private entities and landowners would continue to conduct PDM activities as described in Section 3.4.

During (or instead of) WS-Nevada's non-lethal assistance, landowners could still choose to address the problem themselves. If landowners determined that lethal IPDM is immediately necessary, they may implement lethal methods before applying all reasonable non-lethal methods. Landowners could use trained and experienced WCOs or may implement lethal methods themselves. Other entities would likely increase lethal IPDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada.

Relatively few WCOs are available for large predator damage management, but landowners can request someone to work as their agent. Private individuals are not likely to have the consistent experience with lethal methods and/or the knowledge to confirm the cause of damage, or the level of selectivity possessed by WS-Nevada employees. WCOs may not have the experience or response capability with some of the species and methods if they are not already conducting IPDM for those particular species (Section 3.4.2). Both private individuals and WCOs may not have the specific initial and reoccurring training for firearm, aerial shooting, and other methods that WS-Nevada implements for its employees. The consistent use of PPE by private entities is likely to be lower than that used by WS-Nevada employees. The level of accidents and risk of injury may be higher for private individuals and landowners who are not proficient or experienced with the use of many of the physical/mechanical methods. When aerial shooting, private individuals may spend more time flying over an area or implementing IPDM as described in Section 3.4.

Since it is likely that most lethal methods used by private entities would be conducted mostly on private land, there is low likelihood that recreationists and hunters would encounter equipment placed by landowners or their agents. However, depending on the skillset of other entities in minimizing the risks to the environment, humans, and domestic animals, effects could be greater than, less than, or similar to those under Alternatives 1 and 2. It is possible that the environment, humans, and domestic animals may have fewer exposures to IPDM in the absence of lethal operational assistance from WS-Nevada because there may be fewer entities readily available to help address conflicts, and because individuals experiencing damage may not take action themselves. Conversely, people and domestic animals could be exposed to an increase in IPDM by other entities as a result of increased and less selective IPDM efforts. While WS-Nevada would still be available for lethal technical assistance and could advise private entities on applicable BMPs, these efforts would not compensate an individual's lack of experience and proficiency.

WS-Nevada's effects on the environment, humans, and domestic animals from the use of mechanical/physical methods would be similar to Alternatives 1 and 2. Other entities would be expected to have greater effects on the environment, humans, and domestic animals from the use of mechanical/physical methods compared to Alternatives 1 and 2.

3.10.1.5.4 Alternative 4. WS-Nevada Provides PDM Lethal Assistance Only for Cases of Human/Pet Health or Safety

Under Alternative 4, WS-Nevada would provide full IPDM technical and operational assistance (Appendix A), but lethal control could only be included as an option when responding to requests to protect human/pet health or safety, or federally-listed T&E species. WS-Nevada could not use lethal methods as part of PDM to respond to other types of requests (e.g., agriculture, property, and game species). For threats to human and pet health or safety, the primary predator species of concern would be black bears, mountain lions, or coyotes in residential areas, or disease vector species. Any predator species have the potential to be threats to T&E species. However, other commercial, governmental, and private entities and landowners would continue to conduct or increase their IPDM activities as described in Section 3.4.

Entities requesting lethal assistance would have to determine if a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Other entities would likely increase lethal PDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada. Additionally, private individuals are not likely to have the consistent training with lethal methods, the experience to confirm the cause of damage, or the level of selectivity possessed by WS-Nevada employees. This lack of training and experience will likely increase adverse effects on the environment, humans, and domestic animals.

Because operational lethal actions would be limited and not available to manage damage to other resources, WS-Nevada effects on the environment, humans, and domestic animals from the use of mechanical/physical methods would be less than Alternatives 1, 2 and 3. Other entities would be expected to have greater effects on the environment, humans, and domestic animals from the use of mechanical/physical methods compared to Alternatives 1 and 2.

3.10.1.5.5Alternative 5. No WS-Nevada IPDM Activities

WS-Nevada would have no effect on the environment, humans, and domestic animals from the use of mechanical/physical methods. Landowners experiencing damage or threats could only depend on advice and responses from commercial WCOs, NDA-WS, NDOW, or other entities.

Entities requesting lethal assistance would have to determine if NDA-WS, NDOW or commercial WCOs or other private individuals with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Other entities would likely increase lethal PDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada. Private individuals are not likely to have the consistent training with lethal methods, the experience to confirm the cause of damage, or the level of selectivity possessed by WS-Nevada employees, though any NDA-WS that could help would.

Therefore, effects on the environment, humans, and domestic animals by the use of mechanical/physical methods by other entities would be expected to be higher than under Alternatives 1-4.

3.10.2 *What are the Potential Impacts and Risks from the Use of Lead Ammunition?*

Agencies and members of the public have expressed concerns regarding the potential for adverse environmental impacts and risks to human and wildlife health and safety and environmental contamination from the use of lead ammunition by APHIS-WS. APHIS-WS prepared a risk assessment on the human health and ecological risks from lead use, in Chapter 12 of USDA (2019). "WS use of lead has declined as non-lead substitutes have become available, researched, and determined to be effective; however, the use of non-lead shot is dependent on availability and whether non-lead ammunition can be safely used to address the wildlife damage management situation" (USDA 2019).

Humans and the environment have been, and can be, exposed to lead from a variety of sources. The primary sources today are lead-acid batteries, lead-based chemicals, and to a lesser extent, construction materials. Lead poisoning has been documented in humans for at least 2,500 years, and in waterfowl from spent lead for over 100 years (Golden et al. 2016). Metallic lead released into the environment can be readily released for transport through the environment and bio-accumulated into living plants and beings when fragmented into small pieces or under strong acidic conditions in water, soils, or digestive systems (Golden et al. 2016, TWS 2017).

Efforts to reduce environmental concentrations of lead, predominantly through phasing out the use of leaded gasoline, have resulted in substantial decreases in the introduction of lead into the environment (IARC 2006). Lead, however, is retained in soils and sediments, where it can be stable and intact for long periods of time, resuspended and re-deposited multiple times before further transport becomes unlikely, and released for transport through environmental and biological systems under certain conditions (EPA 2013).

Additional, but substantially smaller and more localized sources of lead in the environment and human exposure involve the use of leaded ammunition and fishing sinkers. Lead ammunition from bullets and shot, and sinkers can be directly introduced into the terrestrial and freshwater environment, where it can potentially be transported, and to humans through ingestion of game meat shot with leaded ammunition (TWS 2017). Threats to scavenging wildlife persist in the form of lead fragments and shot from ammunition that remain within the animals. Of particular concern are avian scavengers that frequently consume the remains of animals shot with lead ammunition, which are discussed further below.

3.10.2.1 *Background*

An average lead shotgun shot or pellet contains 97% metallic lead and jacketed bullets contain up to 90% metallic lead (Tanskanen et al. 1991, Scheuhammer and Norris 1995, Scheetz and Rimstidt 2009). The amount of lead in ammunition varies based on the type of firearm; the size and weight (pellet grain) of the shell, shot, bullet, or pellet; the shotgun gauge or bullet caliber; and the physical length of the shell used (and therefore the number of pellets incorporated).

An important environmental concern for lead ammunition is its high frangibility (the tendency of a lead pellet or bullet to break up into small fragments once it strikes tissue or hard surfaces). When a lead bullet strikes tissue, it quickly begins to expand and break up into tiny pieces as it continues through the tissue. Gutpiles that are left behind in the field are typically contaminated with lead fragments, and lead has been recovered from game meat shot with lead ammunition (NPS 2017).

Effects of lead exposure can have rapid onset and be caused by just one exposure (acute, such as ingesting one or more pellets at one feeding to susceptible organisms) or can occur chronically (multiple exposures over time, such as ingesting multiple meals made up of meat or gutpiles with lead fragments). Lead can cause a variety of adverse health and physiological effects in people, terrestrial wildlife, aquatic organisms, and plants (IARC 2006, ATSDR 2016, EPA 2013, Golden et al. 2016). Lead can affect reproduction, the nervous system (including the brain), the heart, fetal and juvenile development, and behavior in humans and other vertebrates, with fetuses and small children especially susceptible (IARC 2006, EPA 2013, ATSDR 2016).

In the environment, waterfowl, raptors, and scavenging birds are especially subject to lead poisoning from leaded ammunition. Waterfowl may pick up shot pellets from feeding on the bottom of lakes and ponds; raptors and scavenging birds may ingest it from wounded and dead game animals and gut piles left in the field. If ingested, birds with gizzards grind the lead into very small fragments, making it more active. Carnivorous birds have highly acidic stomachs, which also make the lead more physiologically active (Golden et al. 2016). The US Fish and Wildlife Service has banned the use of lead shot in waterfowl hunting since 1991, phased in beginning in 1986 (Golden et al. 2016). NDOW requires non-leaded ammunition for all State wildlife management areas.

Ground and aerial shooting are critical components of APHIS-WS activities. The APHIS-WS program has specific ammunition and firearm requirements to maximize performance (accuracy and conveying its full energy to the target and resulting in low or no pass-through), safety, and humaneness (shot placement to result in rapid death) (Caudell et al. 2012). The objective of field personnel is to use the fewest number of shots on a particular targeted animal, with the intent of a clean kill with one shot.

The current use of non-leaded ammunition varies among states, but approximately 64% of the APHIS-WS programs nationally use less than 20% leaded ammunition. Use of leaded ammunition by APHIS-WS is expected to continue to decline as non-leaded ammunition continues to increases in availability and effectiveness, and decrease in cost. Cooperators may be unwilling to pay any additional costs associated with some non-leaded ammunition where it is otherwise legal to use leaded ammunition. Landowners, land managers, state wildlife management agencies, and federal/state land management agencies continue to have the option to limit the use of leaded ammunition on their property, and APHIS-WS works with those entities to determine an acceptable wildlife damage management plan to meet objectives while minimizing or avoiding the use of lead-based ammunition when practicable. Periodic proficiency training received by WS-Nevada's employees in firearm use and accuracy increases the likelihood that animals are harvested humanely with clean and humane kills and infrequent misses, using the minimum amount of ammunition (WS Directive 2.615, Section 2.4.1.3).

Average lead used by APHIS-WS programs nationally is approximately 11,080 pounds or approximately 5.6 tons per year (USDA 2019). Put into perspective, this is 67mg lead/acre for WDM activities annually. WS-Nevada anticipates using an average of 587.38 pounds of leaded ammunition (including copper-plated lead ammunition) per year. WS-Nevada used non-lead shot for aerial shooting from 1996-2017. However due to a change in policy because of ricochet/safety issues after the analysis period, WS-Nevada is required to use copper plated lead shot until such time as appropriations/funding allow for the increased cost associated with safe effective and humane non-steel and non-lead alternatives (such as Hevi-Shot®). The amount of lead released into the environment from APHIS-WS activities is less than 0.01% of the amount currently being released into the environment in the United States due to hunting, fishing and industrial activities.

For all activities throughout the country, APHIS-WS uses lead-free ammunition when practical, effective, and available to mitigate and/or reduce the effects of its use of lead ammunition on the environment, wildlife, and public health and in compliance with federal, state, territory or tribal regulations on the use of lead ammunition. APHIS-WS evaluates new lead-free ammunition options as they become available. As a federal agency, APHIS-WS takes a cautious approach to ensuring that adverse program effects are reduced by complying not only with applicable federal laws, but also with state and local laws and regulations for the protection of the environment. Further, WS-Nevada adheres to landowner and land manager agreements (Directive 2.210, Section 2.4), and therefore would not use lead ammunition in any location where it was so specified within the agreement.

The EPA has developed several scientific analyses regarding toxic chemicals and their effects on humans and the environment, including for lead, which were referenced in this analysis.

- **Ecological Soil Screening Levels for Lead (Eco-SSL), 2005 (Interim Final):** EPA (2005) established ecological soil screening levels (Eco-SSL) that can be used as an effect threshold based on the available toxicity data. The Eco-SSLs are concentrations of contaminants in soil that are protective of various ecological resources that commonly come into contact with and/or consume biota that live in or on soil.
- **Integrated Science Assessment (ISA) for Lead:** EPA (2013) conducted a very detailed assessment of the sources of lead and the relative potential for lead to have a causal relationship to effects on human health and the environment.
- **Integrated Risk Assessment System (IRAS) for Lead:** This EPA (2004) database system provides detailed human health assessment information, including carcinogenicity, for potentially toxic compounds, including inorganic lead, for chronic exposure, including recognition that humans are typically cumulatively exposed from multiple sources.

Additional pertinent analyses used in the analysis include:

- **International Agency for Research on Cancer (IARC):** IARC (2006) issued an analysis for cancer risk in humans potentially associated with lead. This monograph evaluates the sources of inorganic lead, methods of human exposure, and toxic effects, especially related to its carcinogenicity in humans.
- **Agency for Toxic Substances and Disease Registry (ATSDR) Lead Toxicity (last updated 2016):** This review states the US standards for lead levels.
- **Golden et al. (2016):** This publication is a detailed review and assessment of spent lead ammunition and its exposure and effects on scavenging birds in the United States. This comprehensive review of the literature regarding the potential effects of lead ammunition on birds, with a focus on scavenging birds provides the most current data and interpretations, including an analysis of alternative non-lead ammunition approved by the USFWS. Source documents not otherwise cited can be readily obtained from this publication.
- **National Park Service (2017):** This website summarizes recent findings and provides links to many original papers and conference proceedings related to the effects of lead on birds

(http://www.nps.gov/pinn/learn/nature/leadinfo.htm). Source documents not otherwise cited can be readily obtained from links on this website.

Environmental impacts and risk to human health and safety from the use of firearms are analyzed in Section 3.10.2.

Inorganic lead is not a natural component of any biological system, and can affect many different components of the environment, including people. Review of the documents above indicates that most of the human health and environmental impacts associated with lead are caused by sources of lead other than lead ammunition, including the comparatively small amount of lead ammunition used by APHIS-WS and WS-Nevada during wildlife and predator damage management activities. The primary safety and health concerns with lead is caused by lead ingested by individual scavenging birds that feed on a shot carcass, crippled animals, and/or gut piles left in the field (Section 3.10.2.5), and human ingestion of game meat shot with lead ammunition (Section 3.10.2.6), but the environmental impacts from those effects are low to negligible.

3.10.2.2 *What is the Environmental Fate of Lead and its Exposure through Soil and Water Media and Uptake by Terrestrial and Freshwater Plants?*

Lead may be introduced to soil and water through WS-Nevada PDM activities in several ways, including if an animal is fatally wounded in an aquatic environment and the body is not retrieved, if ammunition is discharged into aquatic areas, or if shooting predators on land, and either leaving the carcass in the field or the lead passing through the animal.

Lead fragments may move physically through water and soil based on the velocity/volume of water, the slope steepness, soil type, and vegetation obstacles. Chemically, lead oxidizes when exposed to air and dissolves when exposed to acidic water or soil, where it can then move through soil and into groundwater and surface water. Due to 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 6-8 inches (Cullen et al. 1996, Hui 2002, Laidlaw et al. 2005).

The average amount of lead used by APHIS-WS nationally is approximately 11,249 pounds or approximately 5 metric tons per year. WS-Nevada uses an average of 587.38 pounds of leaded ammunition per year. The amount of lead released into the environment from APHIS-WS activities is less than 0.01% of the amount currently being released into the environment in the United States due to hunting, fishing and industrial activities.

A representative average weight of soil is in the range of 110 pounds per cubic foot (Houlihan and Wiles 2001). The number of cubic feet of soil in the top 6 inches in 1 acre is about 21,780 cubic feet. Therefore, a reasonable estimate of the total weight of the top layer of soil per acre where spent lead shot should remain would be 2.4 million pounds (110 x 21,780). If considered over the amount of land area involved in WS-Nevada wildlife damage management during a typical year, the amount of lead distributed from such activities would constitute an average of about

0.000019299 ppm (mg/kg soil). Natural background levels of lead in soil range from 50-400 ppm (EPA 2016) and the threshold for residential soil in a child's play area is 400 ppm (40 CFR 745).

Impacts of lead to soils, water, and plants from WS-Nevada activities are expected to be negligible.

3.10.2.3 *What are the Impacts of Lead on Freshwater and Terrestrial Invertebrates, Amphibians, Reptiles, and Fish?*

Exposure to lead at sufficient levels can reduce reproduction and growth, especially in freshwater invertebrates. Lead exposure can also affect behavior in vertebrates, such as limiting the ability to avoid and escape predators, find and capture food, and behavioral regulation of body temperature. Physiological markers for stress have also been found in plants, invertebrates and vertebrates, potentially increasing susceptibility to other environmental stressors. Terrestrial and aquatic organisms respond according to the gradient of increasing concentrations of lead. Effects on the reproduction, growth, and survival in sensitive freshwater invertebrates are well characterized from controlled studies at concentrations at or near lead concentrations occasionally encountered in US fresh surface waters. However, in natural environments, factors such as pH and organic matter composition modify and reduce the bioavailability and toxicity of lead. Most studies of the effects of lead at the community and ecosystem levels are from highly contaminated areas where concentrations are substantially higher than typically encountered in the environment.

Although lead from spent ammunition and lost fishing tackle is not readily released into aquatic and terrestrial systems, under acidic environmental conditions it can slowly dissolve and enter groundwater. Risks of this type of impact are greatest near some shooting ranges and at heavily hunted sites, particularly those hunted year after year, and under acidic water and soil conditions with low levels of organic matter. Lead can especially concentrate in aquatic filter feeders and algae (Eisler 1988).

A majority of the published literature regarding the impacts of lead on terrestrial invertebrates focuses on the potential residues that could occur in these organisms in areas that are adjacent to industries related to lead use or production. EPA (1995) established ecological soil screening levels (Eco-SSL) that can be used as an effect threshold based on the available toxicity data. The Eco-SSL in this case was based on the geometric mean of the maximum allowable toxicant concentration (MATC) using the collembolan (*Folsomia candida;* a small insect-like organism that lives in soil) and reproduction as the endpoint. The value estimated from these studies was 1,700 ppm dry weight (dw). Soil pH ranged from 4.5 to 6.0 (relatively acidic) with an organic matter content of 10% in all studies. Other toxicity studies assessing lead effects on nematodes (small worm-like organisms that live in the soil) and earthworms did not meet the criteria for estimating the Eco-SSL but still provide information regarding lead sensitivity for other soil-borne terrestrial invertebrates. In these studies, median lethality values for the nematode

(*Caenorhabditis elegans*) ranged from 11.6 to 1,434 ppm dry weight (dw) with higher toxicity at lower pH (acidic) and organic matter values. Median lethality for the earthworm (*Eisenia fetida*) was reported at 3,716 ppm dw with reproductive effects noted between 1,629 and 1,940 ppm dw.

Effects from lead shot have been observed in reptiles, especially from chronic exposures. Lance et al. (2006) reported reproductive impacts on captive American alligators (*Alligator mississippiensis*) that were fed nutria containing lead shot. This supports previous work regarding the detection of lead in captive alligators that were related to ingestion of nutria containing lead shot (Camus 1998). Lead blood levels of 0.28 ppm with no apparent lead toxicosis suggest that reptiles may be less sensitive to the effects of lead. Hammerton et al. (2003) made similar observations with the estuarine crocodiles (*Crocodylus porosus*) that had high lead blood levels from consuming prey contaminated with lead ammunition.

Sub-lethal lead exposures can impact multiple physiological and biochemical functions in aquatic vertebrates that can lead to reduced reproduction and growth, and the inability to avoid predators and forage for prey items (Eisler 1988). Median lethality values for amphibians range in the low part per million to greater than 12.5 ppm in pore water, or water occupying the spaces between particles in sediment, for the northern leopard frog (*Lithobates pipiens*), while no observable effect concentrations were reported as low as 0.01 ppm (Eisler 1988, Chen et al. 2006). Adverse effects on fish occur at concentrations ranging from 0.0035 ppm to 29 ppm, with cold water species such as the rainbow trout (*Onchorhynchus mykiss*) being one of the more sensitive species to the effects of lead (Eisler 1988). Based on available data, it appears that the range of fish sensitivity appears similar to the range of sensitivities for amphibians (Eisler 1988).

Risk to aquatic ecosystems is expected to be minimal based on the available toxicity data for lead, the potential exposure pathways, and low environmental fate and transport for lead. Risk to aquatic ecosystems including fish, amphibians, invertebrates and plants will occur primarily as lead ammunition either degrades in soil and is transported via runoff, or is directly deposited.

Lead levels estimated from APHIS-WS activities based on conservative assumptions of exposure would not exceed toxicity levels for aquatic non-target organisms. In addition, risk to aquatic ecosystems is further reduced as APHIS-WS transitions to non-lead ammunition where it is feasible to do so. With approximately 64% of the state APHIS-WS programs using less than 20% lead ammunition, exposure and risk of lead to aquatic organisms such as fish and aquatic invertebrates is expected to be negligible. The long half-life of lead ammunition in water, soil, and sediment combined with the minor amounts of lead that would be used in the program reduce the potential for significant water exposure from lead discharged directly into aquatic systems or from runoff from soil where lead ammunition may be present (Jørgensen and Willems 1987, EPA 2005a).

Exposure by animals eating plants with lead would not be considered a potential exposure pathway, since the lead is sequestered in roots. Lead uptake in plants and various prey items have been shown to occur; however, the low amounts of lead ammunition that are being used by WS-Nevada in any one location and the lack of bioavailability to plants and other prey items suggest this exposure pathway to terrestrial vertebrates is negligible, with or without further transition to non-leaded ammunition.

Overall, the potential for lead from WS-Nevada wildlife damage management in general and predator damage management activities in particular to cause negative impacts to terrestrial and freshwater invertebrates, amphibians, and fish is negligible.

3.10.2.4 *What are the Impacts of Lead on Migratory, Carnivorous, and Scavenging Birds?*

APHIS-WS has a Memorandum of Understanding with the USFWS pursuant to EO 13186 in which APHIS commits to "evaluate a reasonable range of alternatives in environmental reviews to avoid and minimize adverse effects to migratory birds...". USFWS interprets this to mean that APHIS-WS has an obligation to analyze, through NEPA, the potential effects of its programs on migratory birds and implement reasonable measures to conserve avian species protected by MBTA.

Bird sensitivity from dietary exposure to leaded ammunition such as lead shot, bullets, or bullet fragments has been extensively studied and documented (see Golden et al. 2016 for a comprehensive analysis of the literature; Golden et al. 2016 is used extensively in this summary). Birds are especially sensitive to direct lead poisoning from ingestion because seed-eating birds that may pick up grains of ammunition-sourced lead from the ground have strong gizzards that grind the lead into small fragments, creating greater surface area. Meat-eating birds have strongly acidic stomach digestion conditions that cause the lead to be more bioavailable once it enters the bloodstream through the intestinal tract. Since lead can cause live prey to behave abnormally, contaminated prey may be more easily captured. Carcasses, gut piles, and crippled prey contaminated with lead are readily available sources of lead for scavenging birds in the field, of which many may feed on an individual carcass over time, getting a chronic and possibly lethal load of lead. Scavenging bird species include condors and vultures (exclusively scavengers), bald and golden eagles (both scavengers and meat eaters), and crows and common ravens (which both scavenge and eat other meat and non-meat foods); hawks may also scavenge as the opportunity arises (Golden et al. 2016).

Lead poisoning is typically a chronic condition resulting in anorexia, loss of fat reserves, muscle wasting, wing droop, green-stained feces and cloaca due to bile staining, reluctance to fly or inability to sustain flight (causing people to think they have been crippled during the hunting season), and overall debilitation and weakness. Severely affected birds often do not have an escape response but will usually seek isolation and cover, making them difficult to find (Golden et al. 2016, NPS 2017). Clinical signs of lead poisoning in birds are observed when blood lead concentrations reach 0.2 to 0.5 ppm, while severe clinical signs are observed at concentrations exceeding 1.0 ppm. (NPS 2017).

Pain et al. (2010), in a review regarding the impacts of lead shot and bullets on terrestrial birds, documented impacts on 33 raptor species and 30 other species including, but not limited to, raptors, ground nesting birds, cranes, and upland game birds. Lead impacts from spent ammunition have also been noted in numerous waterfowl species (Tranel and Kimmel 2009). An individual lead pellet has been shown to result in lead toxicosis in waterfowl and ground nesting birds, with as little as 10 pellets resulting in lethal and sub-lethal impacts on large raptor species such as the bald eagle, *Haliaeetus leucocephalus* (Eisler 1988). The baseline lead load would determine the degree to which lead consumed from the low level of lead ammunition used across the landscape would contribute to adverse health effects on bird populations.

Cruz-Martinez et al. (2012) evaluated data on 1,277 bald eagles admitted to the University of Minnesota Raptor Rehabilitation Center from January 1966 to December 2009. Of these, 334 were identified as elevated lead cases (322 live, 12 dead). The researchers detected significantly increased odds for elevated lead levels based on season (late fall and early winter), deer hunting rifle zone, and age of bird (adult birds), with higher levels of lead in hunting zones using rifles versus shotguns. The difference was attributed to the fact that rifle lead bullets are more likely to fragment into small pieces that would be more readily ingested by eagles. Similar seasonal patterns in lead exposure corresponding with hunting season have been reported for common ravens (Craighead and Bedrosian 2008).

Over the past 3 decades, California condor recovery efforts have clearly demonstrated how this lead pathway in the ecosystem can threaten the survival of a species. Semi-annual test results show that the majority of free-flying condors at Pinnacles National Park in Central California have blood lead levels that exceed 0.1 ppm, which is the same used by the Center for Disease Control as an initial warning sign that a human child is at risk (NPS 2017). Some condors have been measured with blood lead levels as high as 5.7 ppm, a value that would potentially kill a human. By the time condors at Pinnacles reach breeding age of 7 years old, almost all of them have received emergency, life-saving chelation treatment at least once. Numerous condors in the flock have now required multiple chelation cycles. Because condors only feed on dead animals and are group feeders, even small amounts of lead can sicken or kill many condors. Also, since all of their meals come from dead animals, condors are more frequently exposed to lead bullet hazards than most wildlife (NPS 2017). Despite apparent success from the ban on the use of lead shot for hunting waterfowl in North America in 1991, upland gamebirds (which pick up lead particles with gravel for their crop) and scavenging birds continue to be exposed to lead shot.

At least 2 studies have indicated that the ban on the use of lead shot for hunting waterfowl in North America in 1991 has been successful in reducing lead exposure in waterfowl. Other studies have found that upland game, like doves and quail, and scavenging birds, such as vultures and eagles, continue to be exposed to lead shot, putting some populations (California condors in particular) at risk of lead poisoning. From 1983 through 1985, the U.S. Fish and Wildlife Service conducted a nationwide monitoring program for lead exposure in waterfowl. Samples from more than 8,000 waterfowl were collected on National Wildlife Refuges and analyzed at the National Wildlife Health Center. During the first 2 years of monitoring, the prevalence of ingested lead shot was highest in diving ducks at nearly 10%, with lower frequencies in dabbling ducks, geese, and swans. The study provided data that addressed phase-in criteria for nontoxic shot zones, but the impetus for the implementation of the nationwide ban on lead shot for waterfowl hunting was lead poisoning of bald eagles (NPS 2017).

The Breeding Bird Surveys (BBS) provide trend information on raptors from 1966 to 2015 and 2005 to 2015. Of the raptors in the Western BBS area, only the American Kestrel and White-tailed Kite show a significant decrease in their population from 1966-2015 (Sauer et al. 2017). These are 2 species likely unaffected by lead in carcasses as they primarily prey on insects and small mammals; lack of nest sites and clean farming, and specifically for the kestrel, the loss of prey from the use of insecticides, are likely reasons for their decline (Dunk 1995, Smallwood and Bird 2002). Two species of raptors that primarily scavenge, the turkey vulture and bald eagle, and would be most susceptible to lead-based reductions in their populations, show significant increases in their populations from 1966-2015. Another species that will scavenge readily, the golden eagle, shows a non-significant decreasing trend of -0.19%/year (95% CI = (-1.25 to 0.48). However, collisions with stationary objects and electrocutions were the greatest sources of mortality; lead is a concern, though it mostly has been found at sub lethal levels, but likely could weaken their immune and other systems (Kochert et al. 2002). Other species with non-significant decreasing trends include the northern harrier, northern goshawk, barn owl, western screech-owl, burrowing owl, and short-eared owl. In addition to bald eagles and turkey vultures, 5 other species show significant increases and include the red-shouldered, red-tailed, and Swainson's hawks, osprey, and merlin. The BBS Nevada data shows similar positive trends except that great horned owl shows a non-significant declining trend, northern harriers show a significant increasing trend, burrowing owls and short eared owls show a non-significant increasing trend,. The overall BBS data basically shows that lead, especially for species that typically scavenge carcasses, is likely not impacting any population.

Exposure and risk to non-target birds will be greatest for those that consume animal carcasses containing lead ammunition from APHIS-WS activities. However, the potential for lead exposure and risk to these types of scavengers will be reduced in instances where carcasses are removed by APHIS-WS. There is also the potential for lead exposure and risk to non-target mammals and birds that may consume soil that could contain lead fragments or pellets. Risk would be greatest for birds that consume soil for grit to aid in digestion. APHIS-WS adheres to all applicable laws governing the use of lead ammunition in APHIS-WS activities and landowner/manager desires for lead-free ammunition in their projects.

Additionally, APHIS-WS is shifting to lead-free ammunition as new lead-free alternatives that meet APHIS-WS standards for safety, performance, and humaneness become reliably and cost-effectively available in adequate quantities for program use. Use of lead ammunition by APHIS-WS activities is decreasing over time. The use of non-lead ammunition and pellets by APHIS-WS removes the risk of lead exposure. The potential for lead exposure and risk to these types of scavengers is reduced in situations where carcasses are removed or otherwise rendered inaccessible to scavengers through burial or other approved carcass disposal practices. Consequently, cumulative impacts of APHIS-WS use of lead ammunition would be very low.

3.10.2.5 *What are the Impacts of Lead on Terrestrial Mammals and Domestic Animals?*

Lead has the potential for adverse effects on a variety of small and large mammal species (TWS 2009). The potential for effects on wild and domestic mammals from APHIS-WS activities would be the greatest for mammals that scavenge carcasses containing lead ammunition or that eat crippled animals or gut piles left in the field. Impacts of lead ammunition on populations of scavenging mammals are less clear than studies related to industrial sources of lead.

Rogers et al. (2012) investigated blood lead levels in large carnivores (grizzly bears, black bears; gray wolves, and mountain lions in the Yellowstone ecosystem) to determine if lead levels varied during hunting season. They did not detect a spike in blood lead levels during the fall hunting season, which would have been typical of lead ammunition ingestion. Observed patterns of blood lead levels in bears (particularly grizzly bears) may have resulted from a variety of factors, such as indirect lead exposure from other environmental sources such as mine tailings, exposure to carcasses of smaller animals such as rodents shot throughout the year and left in the field, or differences in the physiology of the bears.

Mammals exhibit similar physiological, physical, and behavioral responses to chronic lead poisoning as humans, which are discussed in Section 3.10.2.6.
The potential for lead exposure and risk to these types of scavengers is reduced when carcasses are removed and safely disposed of by APHIS-WS personnel. The current use of non-lead ammunition by APHIS-WS and WS-Nevada, when practical, and the transition to effective non-lead alternatives when available and cost-effective, further reduces the already low risk of lead exposure to terrestrial mammals and domestic animals.

3.10.2.6 *What are the Risks of Lead to Human Health?*

Humans can be exposed to lead through ingesting or breathing lead-based paint chips or particles, inhaling air-borne lead, drinking water contaminated with lead, eating root plants, being exposed to soil contaminated with lead, and eating meat containing lead fragments, as well as other pathways (EPA 2005b).

Lead can cause long-term effects in children whose bodies absorb lead more efficiently, at levels as low as 0.1 ppm. Lead can be transferred from the mother to the fetus through chelating lead from the mother's skeleton via the blood and from the mother to infants via maternal milk. The elimination half-lives for inorganic lead in blood and bone are approximately 30 days and 27 years, respectively (IARC 2005, EPA 2013, ATSDR 2016).

The primary risks of human exposure to lead from APHIS-WS actions would be through the consumption of lead ammunition fragments in animal meat. Studies are increasingly showing that lead fragments can be widely dispersed in wild game meat processed for human consumption, even though best attempts are made in the field to remove sections that are within the bullet wound channel (for example, Pain et al. 2010, Golden et al. 2016, NPS 2017).

Rapid-expanding ballistic tip lead bullets had the highest fragmentation rate compared with the shotgun slug and muzzleloader bullet, with an average of 141 lead fragments per carcass and an average maximum distance of 11 inches from the wound channel (Cornicelli and Grund 2009). Another study shows that humans can be exposed to bioavailable lead from bullet fragments through consumption of deer killed with standard lead-based rifle bullets and processed under normal procedures (Hunt et al. 2009, NPS 2017).

Potential dietary exposure from WS-Nevada activities is unlikely, as most carcasses are retrieved for proper disposal, where feasible, and, even if not retrieved in the field, are unlikely to be consumed by humans. WS-Nevada has not had edible meat in the past and does not anticipating having any to donate in the future. In APHIS-WS activities, lead exposure from inhalation of lead fumes and dust during firing is minimal because shooting occurs outdoors as opposed to within enclosed firing ranges.

Although lead can be toxic to humans, the low potential for exposure to small amounts of lead released into the environment due to APHIS-WS activities nationwide (approximately 0.0017% of the lead released into the environment from hunting) suggests that adverse health risk from human exposure to lead in the environment from WS-Nevada activities is highly unlikely.

Impacts to human health from WS-Nevada's IPDM are very low due to the unlikely consumption of carcasses taken by WS-Nevada. Additionally, the risk of contact with lead fragments from WS-Nevada activities is minimal.

3.10.2.7 *What are the Comparative Impacts of the Alternatives from Lead Used in Ammunition?*

3.10.2.7.1 Alternative 1. No Action Alternative: Continue WS-Nevada IPDM Assistance outside of WAs and WSAs

Impacts of lead to soils, water, plants, aquatic species, and invertebrates from WS-Nevada sources of lead from IPDM activities are negligible. Impacts of lead to birds and terrestrial mammal populations from WS-Nevada sources are low.

The primary contribution of lead is related to ingestion of leaded ammunition by individual animals and humans from eating meat (or gut piles and meat for scavenging animals) from an animal shot with lead ammunition, as lead bullets fragment into small pieces and spread, making them difficult to contain, find, and avoid in tissue. This is the primary reason for federal and state policies and regulations, and for the choices made by individual hunters to use non-leaded ammunition. Elevated blood lead levels in raptors have been found to contribute to behavioral changes and even death. The status of California condors is possibly dependent on decreased access to lead in carcasses and gut piles. Impacts on humans, especially during early childhood can cause long-term effects on the central nervous system, with behavioral, cognitive, and physiological adverse impacts throughout life. APHIS-WS and WS-Nevada use non-leaded ammunition in accordance with federal and state law and when available, cost-effective, and effective for IPDM purposes.

WS-Nevada field personnel either retrieve carcasses and discard at approved disposal sites or leave carcasses in the field out of sight of humans and predators and scavengers, when possible. Recreational hunters almost always leave gut piles in the field. Impacts on individual birds and mammals depend on the baseline lead load of an animal, and the volume of lead ingested by each animal from carcasses or gut piles left by WS-Nevada employees and hunters in the field. The cumulative load would determine if an individual animal would exhibit behavioral, physiological, or neurological symptoms of lead poisoning. The level of lead available in the environment contributed by WS-Nevada through carcass disposal in the field is extremely low in comparison to that deposited from industrial sources and hunters. The overall BBS data basically shows stable or increasing trends for species that typically scavenge carcasses, and it is likely that lead contributed by WS-Nevada is likely not impacting any populations, particularly as WS-Nevada used non-lead shot for aerial shooting from 1996-2017. However, due to a change in policy because of ricochet/safety issues after the analysis period, WS-Nevada is required to use copper plated lead shot until such time as appropriations/funding allow for the increased cost associated with safe effective and humane non-steel and non-lead alternatives (such as Hevi-Shot®).

Risks to human health and safety, including recreationists, hunters and domestic animals, from WS-Nevada sources of lead is very low. WS-Nevada employees are professionals who routinely follow WS' Directives and standard safety practices, especially the use of PPE and safety requirements, which substantially reduce the risk of major or even minor injury during trapping and snaring activities, based on historical records. Therefore, the risk to field employees is considered very low. Other commercial, governmental, and private entities and landowners will continue to conduct IPDM activities as described in Section 3.4.

As humans are very unlikely to eat carcasses discarded in the field by WS-Nevada, the risk of ingesting lead from WS-Nevada activities is negligible. Lead from ammunition would be more likely to be ingested by humans from meat obtained by recreational hunting. Therefore, the risk to humans and domestic animals from WS-Nevada's use of lead is very low.

3.10.2.7.2 Alternative 2. Proposed Action/Modified Current Program. A Continuance of the Current Program as modified to include IPDM in WAs and WSAs

Under this alternative, similar to Alternative 1 (No Action), WS-Nevada would extend IPDM to livestock with valid grazing permits, and natural resources, at the request of NDOW, in WAs and WSAs. As indicated in table Table G.1 (Appendix H), WS-Nevada does very little shooting in WAs or WSAs, and as such, any changes in effects of lead in comparison to Alternative 1 would be insignificant.

Impacts of lead to soils, water, plants, aquatic species, and invertebrates from WS-Nevada sources of lead from IPDM activities are negligible. Impacts of lead to birds and terrestrial mammals from WS-Nevada sources are low.

The primary contribution of lead is related to ingestion of leaded ammunition by individual animals and humans from eating meat (or gut piles and meat for scavenging animals) from an animal shot with lead ammunition, as lead bullets fragment into small pieces and spread, making them difficult to contain, find, and avoid in tissue. This is the primary reason for federal and state policies and regulations, and for the choices made by individual hunters to use non-leaded ammunition. Heavy lead loads in raptors have been found to contribute to behavioral changes and even death, with the status of California condors possibly dependent on decreased access to lead in carcasses and gut piles. Impacts on humans, especially during early childhood can cause long-term effects on the central nervous system, with behavioral, cognitive, and physiological adverse impacts throughout life. APHIS-WS and WS-Nevada use non-leaded ammunition when in accordance with federal and state law and when available, cost-effective, and effective for IPDM purposes.

WS-Nevada field personnel either retrieve carcasses and discard at approved disposal sites or leave carcasses in the field out of sight of humans and predators and scavengers, when possible. Recreational hunters almost always leave gut piles in the field. Impacts on individual birds and mammals depend on the baseline lead load of an animal, and the volume of lead ingested by each animal from carcasses or gut piles left by WS-Nevada employees and hunters in the field. The cumulative load would determine if an individual animal would exhibit behavioral, physiological, or neurological symptoms of lead poisoning. The level of lead available in the environment contributed by WS-Nevada through carcass disposal in the field is extremely low in comparison to that deposited from industrial sources and hunters, particularly as WS-Nevada used non-lead shot for aerial shooting from 1996-2017. However due to a change in policy because of ricochet/safety issues after the analysis period, WS-Nevada was forced to use copper plated lead shot until such time as appropriations/funding allow for the increased cost associated with safe effective and humane non-steel and non-lead alternatives (such as Hevi-Shot®).

Risks to human health and safety, including recreationists, hunters and domestic animals, from WS-Nevada sources of lead is very low. WS-Nevada employees are professionals who routinely follow WS' Directives and standard safety practices, especially the use of PPE and safety requirements, which substantially reduce the risk of major or even minor injury during trapping and snaring activities, based on historical records. Therefore, the risk to field employees is considered very low. Other commercial, governmental, and private entities and landowners will continue to conduct IPDM activities as described in Section 3.4.

As humans are very unlikely to eat carcasses discarded in the field by WS-Nevada, the risk of ingesting lead from WS-Nevada activities is negligible. Lead from ammunition would be more likely to be ingested by humans from meat obtained by recreational hunting. Therefore, the risk to humans and domestic animals from WS-Nevada's use of lead is very low.

3.10.2.7.3 Alternative 3. *Non-lethal PDM Required Before Applying Lethal Assistance (No Preventive Lethal PDM)*

Under Alternative 3, WS-Nevada would provide technical assistance for both lethal and non-lethal activities, but the cooperator would need to apply reasonable non-lethal methods before WS-Nevada would provide lethal assistance. The APHIS-WS Decision Model may not be fully effective because lethal actions could not be used by WS-Nevada during the time that non-lethal methods are attempted to address the immediate problems. Other commercial, governmental, and private entities and landowners would continue to conduct IPDM activities as described in Section 3.4.

During (or instead of) WS-Nevada's non-lethal assistance, landowners could still choose to address the problem themselves. If landowners determined that lethal PDM is immediately necessary, they may implement lethal methods before applying all reasonable non-lethal methods. Landowners could use trained and experienced WCOs or may implement lethal methods themselves. Other entities would likely increase lethal PDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada.

Entities requesting lethal assistance would have to determine if a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Assuming that commercial WCOs are experienced and proficient, effects of lead on the environment, humans, or domestic animals are probably low. However, landowners or other private entities could use more lead, taking more shots per animal, and improperly disposing of carcasses.

Effects on the environment, humans, and domestic animals from WS-Nevada's use of lead would be slightly less under Alternative 3 than Alternatives 1 and 2. Other entities would be expected to have greater effects on the environment, humans, and domestic animals from the use of lead in this alternative compared to Alternatives 1 and 2.

3.10.2.7.4 Alternative 4. WS-Nevada Provides PDM Lethal Assistance Only for Cases of Human/Pet Health or Safety

Under Alternative 4, WS-Nevada would provide full PDM technical and operational assistance (Appendix A), but lethal control, including the use of firearms with lead ammunition, could only be included as an option when responding to requests to protect human/pet health or safety, or federally-listed T&E species. WS-Nevada could not use lethal methods as part of IPDM to respond to other types of requests (e.g., agriculture, property, and game species). For threats to human and pet health or safety, the primary predator species of concern would be mountain lions, black bears, or coyotes in residential areas, or disease vector species. All predator species have the potential to be threats to T&E species. However, other commercial, governmental, and private entities and landowners would continue to conduct or increase their IPDM activities as described in Section 3.4.

Entities requesting lethal assistance would have to determine if a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Other entities would likely increase lethal PDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada. Assuming that commercial WCOs are experienced and proficient, effect of lead on the environment or their safety are probably low. However, landowners or other private entities could use more lead, take more shots per animal, and improperly dispose of carcasses.

Effects on the environment, humans, and domestic animals from WS-Nevada's use of lead would be less than Alternatives 1, 2 and 3. Other entities would be expected to have greater effects on the environment, humans, and domestic animals from the use of lead compared to Alternatives 1 and 2.

3.10.2.7.5 Alternative 5. No WS-Nevada IPDM activities

WS-Nevada would have no effect on the environment, humans, and domestic animals from the use of lead. Landowners experiencing damage or threats could only depend on advice and responses from NDA-Wildlife Services, commercial WCOs, NDOW, other entities or attempt lethal control in addition to non-lethal PDM already being conducted on their own (e.g. Appendix B).

Entities requesting lethal assistance would have to request assistance from NDA-Wildlife Services or determine if a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Other entities such as NDA-Wildlife Services would likely increase lethal PDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada. Assuming that commercial WCOs are experienced and proficient as is NDA-Wildlife Services, effect of lead on the environment or their safety are probably low. However, landowners or other private entities could use more lead, taking more shots per animal, and improperly disposing of carcasses making scavenging easier for predators and scavengers.

Therefore, effects on the environment, humans, and domestic animals by the use of lead by other entities would be expected to be similar to Alternatives 1-4.

3.10.3 *What are the Potential Impacts and Risks from the Use of Chemical Methods?*

In accordance with WS Directives 2.401 and 2.465 (Section 2.4.1.5), all hazardous materials and pesticides are applied, certified, stored, transported, shipped, disposed of and use supervised in compliance with applicable federal, state, tribal, and local laws and regulations. All restricted use pesticides used or recommended by WS-Nevada personnel must be registered with EPA and NDA. All hazardous materials and pesticides purchased, stored, and used must be carefully tracked and accounted for. Subject matter included in the annual physical inventories includes security, storage, warning signs, inventory, receipt and transfer documentation, handling, disposal, immobilization and euthanizing drugs, and pyrotechnics. All storage, transportation, inspections, training, and emergency procedures are conducted according to Appendix 1 of WS Directive 2.401.

3.10.3.1 *What are the Potential Impacts and Risks from the Use of Sodium Cyanide in M-44s?*

The M-44 is a spring-activated device that delivers a single dose of sodium cyanide powder directly into the mouth, eyes, or nose of targeted animals. It uses a cyanide capsule registered as a restricted use pesticide with the EPA, with APHIS-WS as the principle registration holder (USDA 2019). It can only be used by trained, certified applicators who are directly employed by APHIS-WS. The state departments of agriculture in South Dakota, Montana, Wyoming, New Mexico, and Texas, also have active long-term FIFRA registrations allowing applicators other than APHIS-WS to apply them (Chapter 7 of USDA (2019)).

Each APHIS-WS certified applicator must be trained in the safe handling of the capsule and device, the proper use of the antidote kit, proper placement of the device for safety and selectivity, and necessary recordkeeping. The devices and capsules cannot be sold, transferred, or entrusted to the care of any person not directly supervised by APHIS-WS or an agency working directly under an APHIS-WS or WS-Nevada cooperative agreement. However, cooperators under APHIS-WS supervision can monitor deployed M-44s.

The FIFRA label issued by EPA to APHIS-WS for the M-44 device has 26 use restrictions, and state regulatory agencies can require additional restrictions within the state. The label and 26 use restrictions outline required measures to protect threatened and endangered species, public and pet safety, applicator safety, and unintentional/non-target species (Section 2.4).

M-44 devices are only used in rural public and private settings by WS-Nevada for coyote and, rarely for red and gray fox, per EPA and APHIS-WS restrictions (WS Directive 2.415; Section 2.4.1.6). M-44s have only been used in 9 Nevada counties over the past 5 years for coyotes. M-44s may be used in other counties for coyotes and foxes when such applications meet the label and the 26 use restrictions discussed below. In Nevada, 52.7% of IPDM work involves coyotes, and 49.6% of that work is conducted on private land and 46.2% occurs on BLM land (Table 2.2).

From FY 2012 through 2016, using an average of 251 capsules per year, an average of 223 coyotes per year were taken with M-44s in Nevada (a total of 1,115 coyotes over 5 years out of a total of 21,030; Table 2.1, Table E.1), indicating high effectiveness and comparatively low use of the method. The use of M-44s in Nevada has been consistent over the last 5 years, with a low of 144 coyotes taken in FY 2012 and a high of 275 coyotes taken in FY 2016. Also a total of 5 free ranging/feral dogs were intentionally taken during the same time period (MIS data 2012 through 2016). Six non-target kit fox were taken in Nevada using M-44s between FY 2012 and 2016. WS-Nevada did not take any federally-listed threatened or endangered species from 2012 through 2016 by any means.

The risks to human health and safety and the environmental impacts and fate of sodium cyanide in M-44 devices are discussed below. Chapter 7 of the Risk Assessment (USDA 2019) is the peer-reviewed chapter on risks from "The Use of Sodium Cyanide in Wildlife Damage Management". Additional supporting analysis on the M-44s can be found in that publication, online, at https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/programs/nepa/ct-ws-risk_assessments.

3.10.3.1.1 What are the Potential Impacts on the Terrestrial and Aquatic Environment and Fish from the Use of Sodium Cyanide in M-44s?

Sodium cyanide is soluble in water, and is slowly decomposed by water and rapidly decomposed by acids to give off hydrogen cyanide, a flammable poisonous gas. It volatizes from water surfaces and does not persist in surface waters. Hydrogen cyanide does not bioaccumulate in aquatic or terrestrial or terrestrial organisms (Dzombak et al. 2006). The EPA registration and WS Directive 2.415 (Section 2.4.1.6) for M-44 devices prohibit its use within 200 feet of a water source.

The toxicity of sodium cyanide and hydrogen cyanide in aquatic environments depends on the size of the water body (degree of dilution), physical and chemical characteristics (temperature, pH, and oxygen concentrations), closeness of the organism to the source of contamination, and the rate of degradation of the cyanide (Towill et al. 1978). Although studies have demonstrated deleterious effects from cyanide in fish (Ketcheson and Fingas 2000), the low risk of a cyanide capsule actually spilling, the small quantity of powdered cyanide in each capsule, and the distance from any water body (at least 200 feet) creates a negligible risk of cyanide poisoning occurring in fish and the aquatic phases of amphibians.

Sodium cyanide from M-44 capsules is released only when an animal of the proper size and strength is able to trigger the device, and the cyanide is released into the animal, not into the environment. A test firing or an accidental release to the environment of small amounts is restricted to the placement sites and rapidly degrades in soils and volatizes in water. Therefore, the risk of the small amount of sodium cyanide within a single capsule and the restriction of its use within 200 feet of a water source creates a negligible risk to terrestrial and aquatic organisms and water quality.

3.10.3.1.2 What are the Potential Impacts on Non-target Mammals and Birds from Sodium Cyanide in M-44s?

Despite the high toxicity of sodium cyanide to mammals and birds (Wiemeyer et al. 1986, Ketcheson and Fingas 2000, ATSDR 2006, EPA 2010), and because M-44s are highly selective for wild canids (for example, Shivik et al. 2014; Section 3.9.5.2.1), the risk of non-target wild mammals and birds triggering an M-44 and getting a lethal dose is very low. There were 6 non-target kit fox taken by WS-Nevada with an M-44 device during FY 2012- FY 2016 (Section 3.7).

3.10.3.1.3 What are the Potential Risks to Human Health and Safety of the Public, Recreationists, Sportsmen, and Domestic Animals from Sodium Cyanide in M-44s?

Sodium cyanide forms a highly toxic (to humans) gas when exposed to moisture. Symptoms of acute cyanide exposure includes high blood pressure, rapid heart rate, followed by low blood pressure and slow heart rate, a blue tint to the skin and cherry-red or bloody mucous membranes, pulmonary edema and lung hemorrhage, headaches, dizziness, agitation, dilated and unreactive pupils, convulsions, paralysis and coma, often with increased salivation, nausea, and vomiting (EPA 2010, NOAA 2017). Sodium cyanide is corrosive to the skin and eyes, but exposure of intact skin is less hazardous than exposure through other routes with permeable membranes.

Symptoms of chronic sublethal exposure may include lesions of the optic nerve, depressed thyroid function, and muscle weakness and lack of muscle control. A lethal dose for humans ranges from approximately 0.15 to 0.2 g (0.0068 ounces) for a 150-pound person (EPA 2010).

Per the label, applicators must wear gloves and eye protection to avoid exposures to the eyes and skin.

WS-Nevada use of sodium cyanide capsules poses negligible risk to the public who obey the law because the product label restricts use to only certified applicators, who are required to follow the label restrictions; the products are not commercially available to the public. The label also prohibits use of M-44s in WAs, so WS is not proposing that under any alternative.

3.10.3.1.4What are the Potential Risks to WS-Nevada Employees from Sodium Cyanide in M-44s?

The risk to applicators is slightly greater than the risk to the public because applicators handle the devices and capsules as part of their fieldwork. Applicators may be exposed either dermally or through inhalation. Risk from dermal exposure is low, unless the skin is moist or broken due to a wound or scratch. An LD_{50} for hydrogen cyanide adsorption through the skin is 100 mg/kg (100 ppm; Isom 1993). Moving away from the point source is unlikely to reduce the risk to applicators because hydrogen cyanide is lethal to humans at low concentrations and reacts rapidly in the human body. The symptoms of cyanide exposure may also interfere with the person's mobility.

Over the 32 years recorded, the majority of APHIS-WS exposures were from 24 accidental discharges that occurred while employees were setting, inspecting, or pulling (removing) M-44s; one discharge was an improper action of an employee involving transporting a set M-44 from one location to another. No WS-Nevada employee has been injured by using M-44s.

The risk to WS-Nevada certified applicators is low as applicators receive proper training in the product's use, follow label instructions and wear protective clothing, including gloves and face shields. Use of M-44 devices by WS-Nevada employees is consistent to decreasing.

3.10.3.1.5 Conclusion

Risks associated with the use of sodium cyanide are detailed in Chapter 7 of the Risk Assessments (USDA 2019) and was finalized after peer review in 2019. The Risk Assessment concluded:

> *The [sodium cyanide] capsules WS uses to manage canid species that prey on livestock, poultry, and threatened or endangered species or animals that are vectors of disease contain enough cyanide to be lethal to humans and animals. However, the WS use pattern reduces the risk to negligible for the public. The risk to WS applicators is low because they receive training in the product's use, are certified by the State, follow label instructions, including the appropriate personal protective equipment. The release of a [sodium cyanide] capsule in the environment will result in its breakdown and dissociation into less toxic or non-toxic compounds relatively rapidly reducing the potential for any environmental impacts.*
>
> *The risk to aquatic animals and plants is negligible because the label prohibits the use of the product within 200 feet of a water source. The risk to nontarget terrestrial vertebrates is low. The WS use pattern, precautions, and label restrictions reduces exposure to most terrestrial vertebrates.*

3.10.3.2 *What are the Impacts and Risks from DRC-1339 Treated Hardboiled Chicken Eggs?*

3.10.3.2.1 What are the Potential Risks to the Public, Recreationists, Sportsmen, and Domestic Animals from DRC-1339 Treated Hardboiled Chicken Eggs?

The issue of using chemical methods as part of managing damage associated with wildlife relates to the potential for human and pet exposure either through direct contact with the chemical or exposure to the chemical from wildlife that have been exposed (known as secondary exposure). Chapter 16 of the APHIS-WS Risk Assessment analyzes the human an ecological risks of DRC-1339 in detail. Under the alternatives identified, the use of chemical methods may include avicides, immobilizing drugs and repellents. Avicides are those chemical methods used to lethally remove birds. DRC-1339 is a restricted use avicide currently being considered for use to manage damage in this EA. DRC-1339, in the concentrated formulation, is registered for use exclusively by WS-Nevada and NDA-Wildlife Services for damage management associated with common ravens.

DRC-1339 is the only avicide used by WS-Nevada for BDM. This chemical is one of the most extensively researched and evaluated pesticides ever developed. More than 30 years of studies have demonstrated the safety and efficacy of this compound. Factors that help eliminate any risk of public health problems from possible future use of this chemical are:

- WS-Nevada personnel monitor the common raven numbers at bait sites prior to placing the appropriate number of eggs needed to reduce the local common raven numbers and stop or reduce further damage. At the conclusion of the treatment period, WS-Nevada personnel collect the unconsumed eggs and dispose of them in accordance with label directions.
- Its use is prohibited within 50 feet of standing water and cannot be applied directly to food or feed crops (contrary to some misconceptions, DRC-1339 is not applied to feed materials that livestock can access).
- DRC-1339 is highly unstable and degrades rapidly when exposed to sunlight, heat, or ultraviolet radiation. The half-life is about 25 hours; in general, treated bait material is nearly 100% broken down within a week.
- It is more than 90% metabolized in target birds within the first few hours after they consume the bait. Therefore, little or no active material is left in bird carcasses that may be found or retrieved by people or pets.
- A human or pet would need to ingest the internal organs of birds found dead from DRC-1339 to have any chance of receiving even a minute amount of the chemical or its metabolites into his/her system. This is highly unlikely to occur. Additionally, most non-target animals are not as sensitive to DRC-1339 as target species.
- The EPA has concluded that, based on a mutagenicity (the tendency to cause gene mutations in cells) study, this chemical is not a mutagen or a carcinogen (i.e., cancer-causing agent) (EPA 1995). Regardless, the extremely controlled and limited circumstances in which DRC-1339 is used would prevent any exposure of the public to this chemical.

The risks to human and pet safety from the use of DRC-1339, when used according to the label by trained personnel, is considered low.

3.10.3.2.2 What are the Potential Risks to APHIS-WS and WS-Nevada Field Employees from DRC-1339 Treated Hardboiled Chicken Eggs?

The risk to applicators is greater than the risk to the public because applicators handle and mix the concentrated dry powder then inject in hardboiled chicken eggs. The dry powder concentrate has high acute inhalation toxicity and eye and skin corrosiveness to humans. Applicators may be exposed either dermally or through inhalation. Risk from dermal or inhalation exposure is low as EPA section 3 label (EPA 2019) requires the use of personal protective equipment (PPE) when mixing and handling. Specifically, handlers mixing one pound or more of concentrate must wear: coveralls that cover arms; chemical resistant gloves and footwear; protective eyewear; and a NIOSH approved particulate respirator with N, R or P filter. Handling less than one pound requires the same PPE with the exception of a respirator.

No WS-Nevada employee has been injured by using DRC-1339. The risk to WS-Nevada certified applicators is low as applicators receive proper training in the product's use, follow label instructions and wear protective clothing, including gloves and goggles/face shield and respirator.

3.10.3.2.3 Conclusion

Risks associated with the use of DRC-1339 are detailed in Chapter 17 of the Risk Assessments (USDA 2019) and is currently out for peer review. The Risk Assessment concluded:

> *DRC-1339 poses little risk of secondary poisoning to nontarget animals, including avian scavengers. DRC-1339 poses no risk to aquatic nontarget wildlife. Nontarget birds and mammals that are sensitive to DRC-1339 may be at risk to DRC-1339, but this risk can be reduced through label language designed to reduce exposure. Risks to pollinators and terrestrial plants is negligible based on the use pattern of DRC-1339 and available limited effects data. The WS use pattern, application rates that are mostly on private lands, results in negligible risk for the public. Dietary risk from DRC-1339 exposure to the public is low since the avicide has no registered food uses and does not pose a threat to drinking water. The risk to WS applicators is also low because they receive training in the product's use, are certified by the State to use restricted use pesticides, and follow label instructions, including the use of appropriate PPE. The release of DRC-1339 into the environment is expected to have no or negligible cumulative impacts to nontarget species, the public, and the environment.*

3.10.3.3 *What are the Impacts and Risks of Sodium Nitrate as Used in Gas Cartridges?*

Chapter 8 of the Risk Assessment (USDA 2019) analyzes the human health and ecological risks of carbon monoxide production from the use of gas cartridges. That chapter completed peer review in 2019.

Gas cartridges are pyrotechnic fumigants used to target animals that live in burrows or dens, such as coyotes, skunks, and badgers. The cartridges contain the active ingredients sodium nitrate ($NaNO_3$) and charcoal, combined with two inert ingredients, Fuller's earth and borax. The sodium nitrate supports the combustion of the charcoal, which emits carbon monoxide (CO) during the burning, as well as lesser chemicals, such as sodium carbonate (Na_2CO_3 and nitrogen gas (N_2). The Fuller's earth and borax control the rate of the burn. After clearly identifying the species currently using the den as required by the label and before treating an active burrow or den of the target species, the certified applicator blocks all identifiable den or burrow openings so that the CO is fully enclosed in the den. The cartridges are cardboard tubes with cardboard caps that are punctured just prior to use, the fuse inserted into the end of the tube containing the formulation, the fuse is lit, inserted deep into the burrow, and the opening to the burrow blocked to provide for sufficiently high levels of CO to be rapidly lethal. One or two cartridges may be used, depending on the size of the animal and burrow, including burrows suspected to have multiple runways.

The CO created by the combustion of sodium nitrate and charcoal is a clear odorless, colorless gas and poisonous to all animals that use hemoglobin to transport oxygen from the lungs to the cells of the body because the carbon monoxide attaches to the hemoglobin, replacing oxygen and causing the animal to quickly suffocate. The American Veterinary Medical Association (AVMA 2013) recommends the use of CO for euthanasia because it quickly induces unconsciousness without pain, and death occurs rapidly (Section 3.9.5.2.2).

Sodium nitrate dissolves in moist air and is very soluble in water. Charcoal is created from charring peat or wood into a solid or powder and is non-hazardous, biodegrading in the environment. It is not soluble in water, and is stable unless exposed to an ignition source, whereupon it creates CO. CO is flammable and highly toxic, and is also created by burning fossil fuels for energy and vehicles (EPA 2010). Sodium carbonate is also created by the burning process, is naturally occurring in soil and water, and is used to make glass and soaps. Nitrogen gas (N_2) is a byproduct of the combustion, occurs naturally in the environment, and comprises 78% of the earth's atmosphere. Fuller's earth is a natural clay material and borax is a salt that is a common ingredient in detergents and cosmetics.

The EPA registration is a general use or not restricted use pesticide for use by any member of the public over the age of 16, similar to any other pesticide available for retail sale.

The cardboard cartridge burns in the burrow or degrades when exposed to soil moisture. Sodium nitrate that is not burned is not volatile and remains as a particulate in the soil until it degrades through microbial activity, converting it to N_2, which enters the nitrogen cycle and does not produce any hazards. Burning sodium nitrate creates simple organic and inorganic compounds, mostly in the form of gases, which diffuse through the soil. Sodium carbonate dissociates in water to sodium, a salt, and carbonate ions, neither of which adsorb on soil particles or bio-accumulate in living tissues. The CO created by burning charcoal in the burrow is inhaled by the animals, degraded by soil microorganisms, is converted to carbon dioxide, or fixed by bacteria (ATSDR 2012).

Because these chemicals are widespread and naturally occurring in the environment, are localized inside the burrows, and impacts are negligible, EPA waived the requirement for conducting environmental fate studies (EPA 2008).

The method is often recommended in the literature for taking coyote pups to reduce the potential that the alpha pair will cause livestock depredations to provision the pups (Section 1.12.3). It is the only way to be certain that the alpha pair is being targeted, and studies have suggested that the alpha pair may start or increase livestock depredation during the pupping season in the spring that overlaps with the lambing or calving season for providing ready and sufficient food for growing pups. Removing the pups removes the need to provision the pups, typically resulting in reducing livestock depredation.

WS-Nevada uses gas cartridges sparingly during IPDM activities, exclusively for coyote dens during FY 2012-2016 (Table 2.1, Table E.1).

Further details on the risks to human health and safety and the environmental impacts and fate of carbon monoxide from gas cartridges and forced gas fumigation systems are found in the following sections. Predator burrows are easy to identify based on tracks, observed activity, and presence of scat. The risk of non-target birds or mammals co-occurring in an active predator burrow is very low, as they could become readily accessible prey. It is highly unlikely that another bird or mammal would co-occur with a skunk in a burrow. The potential risk to the environment from the component chemicals and resulting chemicals after pyrolysis is minimal. The potential to take non-target species when using gas cartridges for coyote or fox is very low.

3.10.3.3.1 What are the Potential Risks to the Public, Recreationists, Sportsmen, and Domestic Animals from Sodium Nitrate as Used in Gas Cartridges?

Sodium nitrate is an eye irritant and can irritate the skin. Acute oral toxicity is very low, with the LD_{50} for domestic rabbits at 2,680 mg/kg respectively (OECD 2007). Sodium carbonate has low toxicity to humans and low or no skin irritation potential (OECD 2002). CO rapidly causes asphyxiation and death.

All components and combustion byproducts are enclosed in the cardboard gas cartridges that are further enclosed in sealed burrows, and the applicators conduct burrow treatments when no people are present. Therefore, the risk for health and safety impacts and impacts on a recreational or hunting experience are minimal.

3.10.3.3.2 What are the Potential Risks to APHIS-WS and WS-Nevada Field Employees from Sodium Nitrate as Used in Gas Cartridges?

Exposure risk for WS-Nevada gas cartridge applicators has the potential to be higher than for the public, recreationists, sportsmen, and domestic animals because the employees actually handle the gas cartridges. Because gas cartridges are ignited using a timing fuse, the applicator has sufficient time to move away before ignition occurs and CO is created. All components and combustion by-products are enclosed in cardboard gas cartridges that are enclosed in sealed burrows. No APHIS-WS or WS-Nevada employee has been injured by using gas cartridges. These cartridges are used by WS-Nevada an average of 41 times a year (Table 2.1, Appendix E, Table E.1). Therefore, the risk of any adverse impacts to WS-Nevada employees is minimal.

3.10.3.3.3 Conclusion

Risks associated with the use of firearms is detailed in Chapter 8 of the Risk Assessments (USDA 2019) and completed peer review in 2019. The Risk Assessment concluded:

> *An analysis of human health and ecological effects from gas cartridges…pose low risk to human health, nontarget fish and wildlife, and the environment because of the WS use pattern and the environmental fate of the cartridge formulation and byproducts. In addition, label instructions further reduce risk to nontarget species by requiring applicators to confirm target*

3.10.3.4 *What are the Potential Impacts and Risks from Use of Immobilization and Euthanasia (Humane Killing) Drugs?*

Immobilization and euthanasia (I&E) chemicals are described in Appendix A, and evaluated for humaneness in Section 3.9.5.2.

WS Directives 2.505 and 2.430 (Section 2.4.1.10) provide guidance for euthanizing and immobilizing animals. All WS-Nevada personnel using I&E drugs must undergo full training and certification as described in Attachment 1 of WS Directive 2.430. Only I&E drugs approved by the APHIS-WS I&E committee may be used by APHIS-WS personnel, unless under emergency situations. Attachment 2 of WS Directive 2.430 lists the approved I&E drugs. Under an emergency situation, a drug not listed in Attachment 2 may be used, but only when approved on a one-time or limited basis by an attending/consulting veterinarian and the State Director or designee, provided that such use is in compliance with all applicable laws.

WS Directive 2.515 (Section 2.4.1.9) directs that animals euthanized with drugs such as sodium pentobarbital (Beuthasia D), that may pose secondary hazards to scavengers, must be disposed of according to federal, state, county, and local regulations, drug label instructions, or, lacking such guidelines, by incineration or at a landfill approved for such disposal.

Inventories of all I&E drugs are conducted at least once per year for correct storage, inventorying, and documentation to ensure that all drugs purchased are accounted for (WS Directive 2.465, Section 2.4.1.5).

WS-Nevada uses very few I&E drugs (no use since 5/21/2014). Euthanasia is primarily performed by shooting at close range. Immobilization drugs are applied only when an animal must be transferred/transported safely and humanely or when captured in a public area with high visibility, both of which are rare. Use of immobilization drugs also requires the direction and approval of NDOW because all wildlife relocated in the state must be approved by NDOW prior to relocation. Immobilization would occur primarily for mountain lion under limited circumstances; all other animals are euthanized per state law and regulation and state and APHIS-WS policies. The immobilization drug would be administered directly by either hand syringe, pole syringe, or dart gun at close range (Appendix A).

3.10.3.4.1 What are the Overall Environmental Impacts and Health and Safety Risks Associated with Use of I&E Drugs?

As only small amounts of I&E drugs are used by WS-Nevada in a year, a highly trained field employee performs any use of drugs. Drugs are administered at close range or by hand so there is negligible risk to release into the environment. Also, as all drugged animals are either marked or disposed of in compliance with law and APHIS-WS policy. Therefore, the risk of adverse impacts from I&E drugs on the environment, animals, the public, recreationists, hunters, and WS-Nevada field employees is negligible. No other entities would be expected to use I&E drugs.

3.10.3.5 *What are the Comparative Impacts of the Alternatives from the Use of Chemical Methods?*

3.10.3.5.1 Alternative 1. No Action Alternative: Continue WS-Nevada IPDM Assistance Outside of WAs and WSAs

M-44s: WS-Nevada's compliance with EPA's use restrictions reduce the risk of impacts on the environment from M-44s. The risk to WS-Nevada employees is low because all certified APHIS-WS employees must demonstrate their proficiency in the safe and effective use of M-44s consistent with the label restrictions, and their field supervisor conducts at least 1 field inspection a year for verification. All applicators receive proper training in the product's use, follow label instructions, and wear PPE (including gloves and face protection). All sodium cyanide capsules not deployed in a device are always locked and secured at all times, restricting the potential for a person to contact an isolated sodium cyanide capsule. No WS-Nevada employee has been injured by using M-44s.

WS-Nevada's compliance with EPA use restrictions also reduces the risk to the public. For example, per the EPA registration, 26 use restrictions, and WS Directive (Section 2.4.1.6), the setting of M-44s is restricted in recreation areas, areas where exposure to the public and pets is probable, and from WAs. Additionally, setting of M-44s is limited to areas within 7 miles of properties where livestock losses have occurred (when used for protecting livestock) and are removed from an area if after 30 days there has been no sign that the target animal has visited the area.

Any use of M-44s on federal land must be documented with the federal land management agency. Label restrictions also limit the potential for humans or domestic animals to encounter a device set on public land. On private land, use of M-44s requires the consent of the landowner, who is requesting the use of M-44s.

APHIS-WS will notify the owner or lessee occupying any residence at or near 0.5 mile perimeter of an M-44 device of their use in the area. On all lands with M-44s set, elevated bilingual device signs are placed within 15 feet of the device. Additionally, entry signs are placed to alert the public to the presence of M-44 devices and warn not to tamper with them. Individuals in remote areas away from paths or trails may encounter an M-44, but the risk is low, given that EPA requires that a maximum of 10 to 12 devices may be placed in any one square mile.

As described in Section 3.4, the risk to the public is further reduced because the EPA label restricts the potential for use of M-44s by other entities. The EPA product labels restrict use to only certified applicators, who are required to follow the label restrictions; the products are not commercially available to the public. WS-Nevada complies with the use restrictions on the product label.

A person finding a dead coyote is highly unlikely to either eat it or let their pet dog eat it. Any cyanide in the carcass would be distributed throughout tissues, resulting in low potential for any lethal dose to be obtained from scavenging on a carcass. A sub-lethal dose obtained by a dog would break down into a nontoxic chemical and be excreted in the urine within 12 hours.

WS-Nevada's compliance with the EPA use restrictions also reduces the risk to non-target species. The small amount of sodium cyanide within a single capsule, and the restriction of its use within 200 feet of a water source, result in a negligible risk to terrestrial and aquatic organisms and water quality. The selectivity of M-44s to canids and low use by WS-Nevada indicate that there is low risk of non-target wild mammals or birds triggering an M-44 and getting a lethal dose. The fate of sodium cyanide and hydrogen cyanide in the environment suggest the cyanide from a capsule would undergo biotic and abiotic degradation to non-lethal compounds.

Therefore, the risk to the environment, humans, and domestic animals is very low when used according to the restrictions in the EPA label and APHIS-WS directives.

3-Chloro-p-Toluidine Hydrochloride: The risk of impacts on the environment, humans, and domestic animals from 3-Chloro-p-Toluidine Hydrochloride (DRC-1339) is negligible because the chemical: has low toxicity; use is prohibited within 50 feet of standing water and cannot be applied directly to food or feed crops; the toxicant is contained within the egg until consumed and uneaten eggs are picked up and disposed of in accordance with the label; is highly unstable and degrades rapidly when exposed to sunlight, heat, or ultraviolet radiation; the half life is about 25 hours (nearly 100% broken down within a week); and is more than 90% metabolized in target birds within the first few hours after consumption. No APHIS-WS or WS-Nevada employee has been injured by using DRC-1339.

Sodium nitrate: The risk of impacts on the environment, humans, and domestic animals from sodium nitrate (gas cartridges) is negligible because the chemical has low toxicity and is used entirely within an enclosed burrow. No APHIS-WS or WS-Nevada employee has been injured by using gas cartridges, and the use of these cartridges by WS-Nevada field personnel is infrequent.

I&E Drugs: Only small amounts of I&E drugs are used by WS-Nevada in a year (no use since 5/21/2014), and only highly trained field employees administer I&E drugs. Drugs are administered at close range or by hand, resulting in negligible effects on the environment, people, and domestic animals. Also, as all drugged animals are either marked or disposed of in compliance with law and APHIS-WS policy, the risk of adverse impacts on the environment, animals, the public, recreationists, hunters, and WS-Nevada field employees is negligible.

Therefore, the incorporation of protective measures (Section 2.4), the analysis of impacts on soil, water, and terrestrial and aquatic species indicates there would be little to no effect on the environment from WS-Nevada's use of chemical methods. Additionally, risks to humans and domestic animals from WS-Nevada's use of chemical methods are very low to negligible due to protective measures (Section 2.4).

3.10.3.5.2 Alternative 2. Proposed Action/Modified Current Program. A Continuance of the Current Program as modified to include IPDM in WAs and WSAs

Under this alternative, similar to Alternative 1 (No Action), WS-Nevada would extend IPDM to livestock with valid grazing permits, and natural resources, at the request of NDOW, in WAs and WSAs. WS-Nevada's use of chemicals would not increase much, if all, as WS-Nevada would not use M-44s, DRC-1339, sodium nitrate, or chemical I&E drugs in WAs. M-44s and DRC-1339 could be used in WSAs, if approved by the land managing agency (Section 1.8.2.3). Use of chemical I&E drugs could be used in WSAs, although WS-Nevada has not used chemical I&E drugs in WAs or WSAs since at least June, 2005.

Effects on the environment, humans, and domestic animals from WS-Nevada's use of chemical methods would be similar to Alternative 1 as the only difference would be the potential use of some chemical methods in WSAs.

3.10.3.5.3 *Alternative 3. Non-lethal PDM Required Before Applying Lethal Assistance (No Preventive Lethal PDM)*

Under Alternative 3, WS-Nevada would provide technical assistance for both lethal and non-lethal activities, but the cooperator would need to apply reasonable non-lethal methods before WS-Nevada would provide lethal assistance. The APHIS-WS Decision Model may not be fully effective because lethal actions could not be used by WS-Nevada during the time that non-lethal methods are attempted to address the immediate problems. Other commercial, governmental, and private entities and landowners would continue to conduct IPDM activities as described in Section 3.4.

During (or instead of) WS-Nevada's non-lethal assistance, landowners could still choose to address the problem themselves. If landowners determined that lethal IPDM is immediately necessary, they may implement lethal methods before applying all reasonable non-lethal methods. Landowners could use trained and experienced WCOs or may implement lethal methods themselves. Other entities would likely increase lethal IPDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada.

However few individuals would have the training and authorization to use chemicals that WS-Nevada could use under Alternative 1. M-44s are not registered for use by non-WS-Nevada entities in Nevada. Private individuals are not likely to have the training and authorization to use immobilization and euthanasia drugs and it is unlikely that WCOs will have access to them. NDOW, USFWS, or other agencies are likely the only ones to use I&E drugs, and will have the necessary training, expertise, and protocols (similar to WS-Nevada) to reduce effects on the environment, humans, and domestic animals. Sodium nitrate in large gas cartridges isn't a restricted-use pesticide and is currently registered in Nevada for use other than for WS-Nevada and may be used by private individuals and or public agencies and applicators are required to follow the label restrictions from the EPA, and follow ESA guidelines for minimizing risks to the environment, people, and domestic animals.

Effects on the environment, humans, and domestic animals from the use of chemical methods would be slightly less under Alternative 3 than Alternative 1 or 2. Since chemical methods are limited for use by other entities, effects on the environment, humans, and domestic animals from the use of chemical methods by other entities would be less than under Alternative 1 or 2.

3.10.3.5.4Alternative 4. WS-Nevada Provides IPDM Lethal Assistance Only for Cases of Human/Pet Health

Under Alternative 4, WS-Nevada would provide full IPDM technical and operational assistance (Appendix A), but lethal management could only be included as an option when responding to requests to protect human/pet health or safety, or federally-listed T&E species. WS-Nevada could not use lethal methods as part of IPDM to respond to other types of requests (e.g., agriculture, property, and game species). For threats to human and pet health or safety, the primary predator species of concern would be black bears, mountain lions, or coyotes in residential areas, or disease vector species. Any predator species has the potential to be a threat to T&E species. Other commercial, governmental, and private entities and landowners would continue to conduct IPDM activities as described in Section 3.4.

During (or instead of) WS-Nevada's limited lethal assistance, landowners could still choose to address the problem by implementing IPDM methods themselves. Landowners could use trained and experienced WCOs or may implement lethal methods themselves. Other entities would likely increase lethal IPDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada.

However, few individuals would have the training and authorization to use chemicals that WS-Nevada could use under Alternative 1. M-44s are not registered for use by non-WS-Nevada entities in Nevada. DRC-1339 is not registered for use by non-WS-Nevada/NDA-WS entities in Nevada. Private individuals are not likely to have the training and authorization to use immobilization and euthanasia drugs and it is unlikely that WCOs will have access to them. NDOW, USFWS, or other agencies are likely the only ones to use I&E drugs, and will have the necessary training, expertise, and protocols (similar to WS-Nevada) to reduce effects on the environment, humans, and domestic animals. Sodium nitrate in large gas cartridges isn't a restricted-use pesticide and is currently registered in Nevada for use other than by WS-Nevada and may be used by private individuals and or public agencies. Applicators are required to follow the label restrictions from the EPA, and follow ESA guidelines for minimizing risks to the environment, people, and domestic animals.

Effects on the environment, humans, and domestic animals from WS-Nevada's use of chemical methods would be less than Alternatives 1, 2, and 3. Since chemical methods are limited for use by other entities, effects on the environment, humans, and domestic animals from the use of chemical methods by other entities would be less than under Alternatives 1, 2 and 3.

3.10.3.5.5Alternative 5. No WS-Nevada IPDM Activities

WS-Nevada would have no effect on the environment, humans, and domestic animals from the use of chemical methods. Landowners experiencing damage or threats could only depend on advice and responses from NDA-WS, commercial WCOs, NDOW, or other entities.

Entities requesting lethal assistance would have to determine if NDA-WS, a commercial WCO or other private individual with the capabilities, approvals, and interest is available, or attempt to address their IPDM needs themselves (as discussed in Section 3.4). Relatively few WCOs are available for large predator or common raven damage management, but landowners can request someone to work as their agent.

There is a potential for other entities (as discussed in Section 3.4) to attempt to fill the need for lethal IPDM activities in the absence of lethal operational assistance from WS-Nevada. However few individuals would have the training and authorization to use chemicals that WS-Nevada could use under Alternatives 1 and 2. M-44s are not registered for use by non-WS entities in Nevada. DRC-1339 (EPA Special Local Need No. NV-150001) is currently registered for use by NDA-WS and as such NDA-WS use of DRC-1339 would be similar to Alternatives 1 and 2. Private individuals are not likely to have the training and authorization to use immobilization and euthanasia drugs and it is unlikely that WCOs will have access to them. NDOW, NDA-WS, USFWS, or other agencies are likely the only ones to use I&E drugs, and will have the necessary training, expertise, and protocols (similar to WS-Nevada) to reduce effects on the environment, humans, and domestic animals. Sodium nitrate in large gas cartridges isn't a restricted-use pesticide and is currently registered in Nevada for use other than by WS-Nevada and may be used by private individuals and or public agencies. Applicators are required to follow the label restrictions from the EPA, and follow ESA guidelines for minimizing risks to the environment, people, and domestic animals.

Since chemical methods are limited for use by other entities, effects on the environment, humans, and domestic animals from the use of chemical methods by other entities would be less under Alternative 5 than under Alternatives 1 and 2.

3.11 How Might WS-Nevada IPDM Activities Affect WAs and WSAs?

Wilderness areas (WAs) and wilderness study areas (WSAs) are congressionally designated areas that are managed by 1 of 4 land management agencies (USFS, BLM, NPS, or USFWS). These areas are subject to special management restrictions, as discussed in Section 1.10.3.10 and 1.10.3.11. The breakdown in land ownership/management in Nevada, by acres, is illustrated in Figure 3.2. WAs and WSAs are approximately 9% of the land in Nevada.

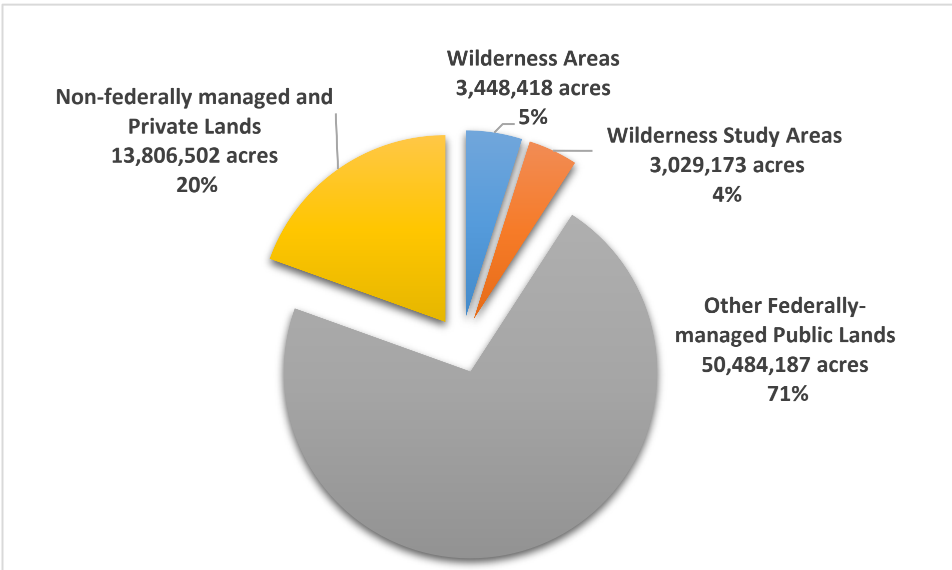


Figure 2. Land ownership/management in Nevada by Acres and Percent.

WS-Nevada's work in WAs and WSAs may range from no activity to seasonal IPDM activities, based upon requests for assistance. While requests for assistance in WAs and WSAs occur on an infrequent basis, the potential exists that WS-Nevada may be requested to work almost anywhere in the state for one of the 3 reasons for which PDM may be allowed in WAs and WSAs. When requested, WS-Nevada would follow all applicable laws, APHIS-WS policies, MOUs, regulations, AWPs, Minimum Requirement Analyses (MRAs), and land management agency policies. WS-Nevada coordinates all activities in WAs and WSAs with the appropriate land management agencies in Annual Work Plans. WS-Nevada could also provide technical assistance to producers on non-lethal methods that they could implement to reduce damage and conflicts (which would include referral to land management agency to ensure actions would be in compliance with law and policy).

At the beginning of each year, WS-Nevada, BLM, and USFS meet to establish the AWP for lands managed by those agencies. WS-Nevada informs the land managing agencies as to which public lands, including WAs or WSAs, where PDM is likely to be requested. This information comes from coordination with livestock producers and wildlife management agencies (USFWS or NDOW). The AWP takes the anticipated PDM activities and applies the applicable land management policies to craft a work plan for the year. Whether or not work might need to occur on a WA or WSA, or what the minimum tools needed might be, are refined through interagency discussion and analysis. The work proposed in the plan that relates to WAs or WSAs are subject to further analysis by the land management agencies. In WAs, the managing agencies are responsible for preserving wilderness character. In WSAs, the managing agencies are responsible for maintaining the area's suitability for preservation as wilderness. WSAs possess wilderness characteristics. The necessary MRDG, MRA, or NEPA decisions are completed in accordance with agency policy as a condition for WS-Nevada stating work in WAs or WSAs for the year.

Tables G-1-3 (Appendix G) provide a list of all the WAs and WSAs in Nevada, and information on the likelihood and duration of operational IPDM actions reasonably foreseeable in the next 10 years. Table 3-20 summarizes Table G-1, showing the estimated number of WA/WSA acres where PDM is likely to be conducted. This is based on WS-Nevada staff reviewing the list of all WAs and WSAs in the state and comparing them to historical requests for assistance and available information whether or not there are grazing allotments on the areas. The WAs and WSAs were divided into 6 categories

Table 3-20. Acres of WA and WSA divided by likelihood of WS-Nevada conducting PDM at least once in the next 10 years (2020-2030) displayed as percent of total WA and WSA acres and percent of total acres of Nevada.

Likelihood of PDM in next 10 Years		WA and WSA Acres Affected	Acres Affected as % of Total WA and WSA Acres in NV	Affected Acres and % of Total Acres in NV
Extremely High	(95-100%)	826,657	13%	1%
High	(66 - 95%)	0	0%	0%
Medium	(33 - 66%)	116,784	2%	0%
Low	(2 - 33%)	1,771,203	27%	3%
Extremely Low	(0 - 2%)	3,526,158	54%	5%
No PDM	(0%)	236,789	4%	0%
Total		6,477,591	100%	9%

Table 3-21 shows the duration of PDM that is anticipated for each likelihood category of WA and WSAs. For example, for all WAs in which PDM is extremely likely in the next 10 years, 53% of that PDM would be expected to last 41-60% of the year, while 47% is expected to last 81-100% at some level. For more perspective, Table 3-22 takes the "Extremely High" likelihood subset and calculates the percent of the total acres of WA and WSA and percent of the total acreage in Nevada potentially affected. So, the same WA acres in the "extremely high" likelihood category amount to 3.5% of all WAs in the state, and only 0.3% of the acres in Nevada.

Table 3-21. Percent of WA and WSA Acreage by Likelihood and Duration of Possible PDM.

	No PDM	Extremely Short	Short	Medium	Long	Nearly Year-round	Total
Wilderness Area Acres	**7%**	**69%**	**0%**	**17%**	**0%**	**7%**	**100%**
Extremely High				53%		47%	100%
Medium				100%			100%
Low		74%		26%			100%
Extremely Low		97%		2%		2%	100%
No PDM	100%						100%
Wilderness Study Area Acres	**0%**	**69%**	**2%**	**5%**	**4%**	**20%**	**100%**
Extremely High					20%	80%	100%
Low		67%	7%	4%		22%	100%
Extremely Low		85%		6%	3%	6%	100%
Total	**4%**	**69%**	**1%**	**11%**	**2%**	**13%**	**100%**

Table 3-22. Percent of Total Acres of WA and WSA and Total Acres of Nevada that are "Extremely Likely" to Receive PDM Nearly Year-round.

Likelihood and Land Type	Acres of WA and WSA where PDM may be conducted Nearly Year-round	Acres as a Percent of Total WA and WSA Acreage in NV	Acres as Percent of total Acres in Nevada
Extremely High			
WA	223,840	3.5%	0.3%
WSA	283,341	4.4%	0.4%
Total	507,181	7.8%	0.7%

The percentages presented are based on the total acreage of each WA or WSA. So a WA with a larger number of acres that is worked once in 10 years will increase the apparent number of potential acres worked, when only a few acres of out hundreds of thousands may be affected. This results in an overestimation of the potential effects of PDM in WAs and WSAs. Restriction on PDM strategies and methods allowed in WAs and WSAs that reduce the potential effects of any PDM are discussed in Section 3.11.1.2, below.

3.11.1 *What are the Comparative Impacts of the Alternatives on WAs and WSAs?*

Some applications of PDM cannot be fully analyzed for WAs in this EA (i.e. protection of T&E species, non-emergency disease transmission, and non-emergency protection of human health and safety) due to the lack of information on any future projects. WS-Nevada may be requested to assist with PDM for those reasons listed above, however, the appropriate additional NEPA would be prepared as part of the MRA process prior to that work. WS-Nevada worked closely with land management agency staff to prepare the following analysis.

For designated wilderness, based on the information contained in the document, the following analysis assumes:

- Non-lethal methods proposed for use in WAs include: shifts in breeding schedules, guard dogs, herd dogs, herders, range riders, benching of sheep, altering livestock behavior, and harassment with firearms
- Lethal methods proposed for use in WAs include: ground shooting, calling, trained tracking/trailing/decoy dogs, and snares, and foothold traps
- Modes of transportation proposed for use in wilderness include: hiking, pack stock

PDM activities proposed in wilderness for the purpose of preventing serious losses of domestic livestock are the most common requests for assistance that WS-Nevada receives, and the impacts to wilderness character of these activities would be consistent across wilderness areas in Nevada such that they could be analyzed on a programmatic, statewide basis in this EA. The Wilderness Act of 1964 states that "the grazing of livestock, where established prior to the effective date of this Act, shall be permitted to continue subject to such reasonable regulations as are deemed necessary" (Section 4.d.4.2). The Congressional Grazing Guidelines further emphasize Congressional intent related to grazing activities in wilderness: "the general rule of thumb on grazing management in wilderness should be that activities or facilities established prior to the date of an area's designation as wilderness should be allowed to remain in place and may be replaced when necessary for the permittee to properly administer the grazing program" (House Report 101-405). Prevention of serious losses of domestic livestock in wilderness through PDM activities, with limitations that are consistent with law, regulations, and policy, is appropriate under this Congressional direction.

About Wilderness Character

The following description of wilderness character is excerpted from Keeping It Wild 2: An Updated Interagency Strategy to Monitor Trends in Wilderness Character Across the National Wilderness Preservation System (Landres et al. 2015, page numbers from the publication are provided in parenthesis):

> *Wilderness character is a holistic concept based on the interaction of (1) biophysical environments primarily free from modern human manipulation and impact, (2) personal experiences in natural environments relatively free from the encumbrances and signs of modern society, and (3) symbolic meanings of humility, restraint, and interdependence that inspire human connection with nature. Taken together, these tangible and intangible values define wilderness character and distinguish wilderness from all other lands…*

[W]ilderness character is the capacity of an area to elicit humility, to awaken a sense of relationship and interconnectedness with the community of life, and to evoke a feeling of restraint and obligation toward nature.

(p. 7)

There are four, sometimes five, qualities that are considered when analyzing impacts to wilderness character.

These qualities are derived from the entire statutory definition of wilderness, Section 2(c) of the Wilderness Act, which expresses congressional intent, both ideal and practical, for the meaning of wilderness and wilderness character… Taken together, these qualities represent the primary tangible aspects of wilderness character that link on-the-ground conditions in wilderness and the outcomes of wilderness stewardship to the statutory definition of wilderness.

(p. 10)

Untrammeled

The Wilderness Act states that wilderness is "an area where the earth and its community of life are untrammeled by man," that "generally appears to have been affected primarily by the forces of nature" and "retain[s] its primeval character and influence." This means that wilderness is essentially unhindered and free from the intentional actions of modern human control or manipulation. The quality directly relates to "biophysical environments primarily free from modern human manipulation and impact" and "symbolic meanings of humility, restraint, and interdependence that inspire human connection with nature" described in the above definition of wilderness character. The Untrammeled Quality is preserved or sustained when actions to intentionally control or manipulate the components or processes of ecological systems inside wilderness (for example, suppressing fire, stocking lakes with fish, installing water catchments, or removing predators) are not taken. This quality is improved when suppression of wildfire or manipulation of habitat is stopped or significantly reduced.

Natural

The Wilderness Act states that wilderness is "protected and managed so as to preserve its natural conditions." This means that wilderness ecological systems are substantially free from the effects of modern civilization. Within a wilderness, for example, indigenous plant and animal species predominate, or the fire regime is within what is considered its natural return interval, distribution over the landscape, and patterns of burn severity. This quality directly relates to "biophysical environments primarily free from modern human manipulation and impact" described in the above definition of wilderness character. The Natural Quality is preserved when there are only indigenous species and natural ecological conditions and processes, and may be improved by controlling or removing non-indigenous species or by restoring ecological conditions.

Undeveloped

The Wilderness Act states that wilderness is "an area of undeveloped Federal land… without permanent improvements or human habitation," "where man himself is a visitor who does not remain" and "with the imprint of man's work substantially unnoticeable." This means that wilderness is essentially without permanent improvements or the sights and sounds of modern human occupation. This quality is affected by "prohibited" or "nonconforming" uses (Section 4(c) of the Wilderness Act), which include the presence of modern structures, installations, and habitations, and the administrative and emergency use of motor vehicles, motorized equipment, or mechanical transport. Some of these uses are allowed by special provisions required by legislation. This quality directly relates to "personal experiences in natural environments relatively free from the encumbrances and signs of modern society" and "symbolic meanings of humility, restraint, and interdependence that inspire human connection with nature" described in the above definition of wilderness character. The Undeveloped Quality is preserved or sustained when these nonconforming uses are not used by the agency for administrative purposes or by others authorized or not authorized by the agency. It is improved when the prohibited use is removed or reduced.

Solitude or Primitive and Unconfined Recreation

The Wilderness Act states that wilderness has "outstanding opportunities for solitude or a primitive and unconfined type of recreation." This means that wilderness provides outstanding opportunities for recreation in an environment that is relatively free from the encumbrances of modern society, and for the experience of the benefits and inspiration derived from self-reliance, self-discovery, physical and mental challenge, and freedom from societal obligations. This quality focuses on the tangible aspects of the setting that affect the opportunity for people to directly experience wilderness. It directly relates to "personal experiences in natural environments relatively free from the encumbrances and signs of modern society" described in the above definition of wilderness character. The Solitude or Primitive and Unconfined Recreation Quality is preserved or improved by management actions that reduce visitor encounters, reduce signs of modern civilization inside wilderness, remove agency-provided recreation facilities, or reduce management restrictions on visitor behavior.

Other Features of Value

The Wilderness Act states that wilderness "may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value." This quality captures important elements or "features" of a particular wilderness that are not covered by the other four qualities. Typically these occur in a specific location, such as archaeological, historical, or paleontological features; some, however, may occur over a broad area such as an extensive geological or paleontological area, or a cultural landscape. The

> *Other Features of Value Quality directly relates to "personal experiences in natural environments relatively free from the encumbrances and signs of modern society" and "symbolic meanings of humility, restraint, and interdependence that inspire human connection with nature" described in the above definition of wilderness character. This quality may or may not occur within a specific wilderness, and is therefore different from the other four qualities that, by law, occur in every wilderness. This quality is preserved when these "other features of value" are preserved.*
>
> *(p. 10-12)*

Projects Possibly Requiring Additional NEPA Analysis

This EA does not contain sufficient information to analyze the effects of programmatic PDM activities for the purpose of protecting federally listed threatened, endangered, or candidate species on designated WAs in Nevada. The conditions of such a proposal would vary depending on protected species, predator species, habitat, and site-specific issues, and the resulting impacts to wilderness character, especially the untrammeled and natural qualities, would likely be different depending on the circumstances. The impacts to wilderness character from these types of proposals would need to be analyzed on a more limited, possibly case-by-case – basis. However, the impacts to WAs from the use of the methods proposed in this EA, unlike the broader impacts related to the purpose and need for such a proposal, are analyzed below.

This EA also does not contain sufficient information to analyze the effects of programmatic PDM activities for the purpose of preventing transmission of diseases or parasites affecting wildlife and humans in designated WAs in Nevada. A proposal for PDM activities made for this purpose in a non-emergency situation that would protect a wildlife species other than one that is federally listed, could only be made for BLM-managed wilderness areas, as the USFS wilderness policy (FSM 2320) does not include this purpose as one for which PDM activities could be approved. The conditions of a proposal for this purpose would vary depending on the disease or parasite, the species affected by it, the nature of transmission, habitat, and site-specific issues. The resulting impacts to wilderness character, especially the untrammeled and natural qualities, would likely be different depending on the circumstances. The impacts to wilderness character from these types of proposals would need to be analyzed on a more limited – likely case-by-case – basis. However, the impacts to WA from the use of the methods proposed in this EA, as opposed to the broader impacts related to the purpose and need for the proposal, are analyzed below. If the threat of disease or parasite transmission met the definition of an emergency under BLM or USFS wilderness policies, land managers could choose to authorize PDM activities to protect an imminent threat to public health or safety under emergency-response procedures rather than administrative procedures involving approval of the action through an extensive planning process.

This EA also does not contain sufficient information to analyze the effects of programmatic PDM activities for the purpose of protecting human health and safety in non-emergency situations in Nevada. Both BLM and USFS wilderness policies allow for managers to authorize actions in emergency situations, and USFS wilderness policy specifies the protection of public health and safety as one reason that PDM activities could be approved in USFS-managed wilderness areas. The conditions of a proposal for this non-emergency purpose could span a variety of unforeseen needs and conditions, and thus would need to be analyzed on a more limited – likely case-by-case – basis. However, the impacts to WA from the use of the methods proposed in this EA, as opposed to the broader impacts related to the purpose and need for the proposal, are analyzed below.

Should WS-Nevada be requested to assist in a project in a WA related to one of those needs for actions in this section (protection of T&E species, non-emergency protection of Human health and safety, or non-emergency prevention of disease/parasite transmission), the land managing agency (BLM of USFS) would complete a MRA. WS-Nevada would cooperate with the land managing agency for any additional NEPA analysis and decisions that may be needed for use work in WAs. However, if relevant, the information in this EA may be used to inform subsequent NEPA decisions for work in WAs.

PDM activities proposed in wilderness in emergency situations may be approved by land managers through emergency-response procedures rather than administrative procedures (that include an extensive planning process) under conditions that meet the land managing agency's definition of emergency. BLM MS-6340 defines an emergency as "a situation that requires immediate action because of imminent danger to the health or safety of people or livestock." USFS FSM 2320 does not distinctively define an emergency, though with regard to the conditions under which the use of motorized equipment or mechanical transport may be allowed, the policy states that "emergencies where the situation involves an inescapable urgency and temporary need for speed beyond that available by primitive means" are appropriate for approval of a use prohibited by Section 4(c) of the Wilderness Act (p. 53). Other mentions of emergency situations in FSM 2320 reference actions to protect life and property (p. 35) and to protect public safety (p. 38).

About Wilderness Study Area Characteristics

WSAs were designated through direction in FLPMA because they were determined to possess wilderness characteristics that indicated the presence of the wilderness resource; these areas are suitable for designation as wilderness by Congress. The wilderness characteristics of a WSA are identified in BLM MS-6330, following from definitions found in the Wilderness Act:

Size: A roadless area of contiguous public lands that "has at least 5,000 acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition.

Naturalness: An area that "generally appears to have been affected primarily by the forces of nature, with the imprints of man's work substantially unnoticeable."

Outstanding opportunities: An area that "has outstanding opportunities for solitude or a primitive and unconfined type of recreation."

Supplemental values: An area that may contain "ecological, geological, or other features of scientific, educational, scenic, or historical value." Threatened, endangered, and candidate species (such as sage grouse) should be considered supplemental values.

(p. 1-44)

3.11.1.1 *Alternative 1. No Action Alternative: Continue WS-Nevada IPDM Assistance outside of WAs and WSAs*

Under this alternative, WS-Nevada would be unlikely to have an effect on WAs or WSAs. WS-Nevada would provide technical assistance to individuals, but would only conduct PDM when requested for the protection of human health and safety in an emergency situation, at the request of NDOW. This type of event has only occurred once in the past 10 years and is expected to be a very rare occurrence. Other entities are expected to fill the need for lethal IPDM to some degree through other legal methods, as authorized by state agencies in coordination with land management agencies. Landowners experiencing damage or threats could only depend on advice and responses from commercial WCOs, NDOW, or other entities. Entities requesting lethal assistance would have to determine if a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Other entities would likely increase IPDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada. Without WS-Nevada's operational assistance, other entities may be less efficient and effective, potentially resulting in more impacts to WAs and WSAs. Private individuals are not likely to have the consistent training with lethal methods, the experience to confirm the cause of damage, or the level of selectivity possessed by WS-Nevada employees. Additionally, action by private entities may not be as closely coordinated with land management agencies. WCOs may not have the experience or response capability with some of the species and methods if they are not already conducting IPDM activities for those particular species (Section 3.4.2). Additionally, greater presence of people and equipment may occur on WAs or WSAs when conducted by private entities, due to less efficiency and experience with lethal methods.

3.11.1.2 *Alternative 2. Modified Current Program/Proposed Action*

Under this alternative, WS-Nevada would continue the current program and include PDM in WAs and WSAs to protect livestock, human health and safety/disease transmission, or federally-listed species. WS-Nevada's work in most WAs and WSAs would range from no activity to seasonal IPDM activities, based upon prior requests for assistance. When requested to respond, WS-Nevada would follow all applicable laws, APHIS-WS policies, MOUs, regulations, management plans, MRAs, AWPs, and land management agency policies.

WS-Nevada coordinates with WA and WSA land managers so that proposed IPDM activities are consistent with the management needs for each individual area. Work in WAs must be consistent with (a) the Wilderness Act, (b) each area's wilderness management plan, (c) the land management agency's wilderness management policies, (d) each area's individual wilderness legislation (which might contain special provisions applicable only to that particular WA), (e) annual work plans prepared approved by WS-Nevada and the lad management agencies, and (f) IWDM MOUs between APHIS-WS and the wilderness management agency. Proposed activities in WAs must be considered against the qualities that define wilderness, derived from Section 2(c) of the Act. Proposed activities in WSAs must be consistent with the Federal Land Policy Management Act, BLM policy and management plan in which WSAs are managed to preserve wilderness characteristics for possible future wilderness designations.

3.11.1.2.1 Impacts to the Untrammeled Quality of Wilderness Character

Predator removal in wilderness for the purpose of preventing serious losses of domestic livestock or in emergency situations of imminent danger or inescapable urgency to protect public health and safety would impact the untrammeled quality of wilderness character. The removal of a predator from its native habitat is a trammeling action that may manipulate the natural ecosystem within wilderness.

The proposed modes of transportation under Alternative 2, by foot or pack stock, would not impact the untrammeled quality of wilderness character.

Non-lethal methods proposed for use in the implementation of PDM activities would not cause impacts to the untrammeled quality of wilderness character. Most proposed non-lethal methods are meant to alter the behavior of the livestock, and are therefore not trammeling activities. Non-lethal methods that alter predator behavior, including the use of guard dogs and harassment with firearms are not trammeling activities because they alter the predators' behavior to avoid the livestock, as opposed to an area of the wilderness. Teaching a predator to avoid a place within wilderness may alter the predator's behavior even without the presence of livestock, and would therefore be a manipulation of the natural ecological conditions or processes. However, teaching a predator to avoid livestock alters the predator's behavior to avoid a non-native species that is not a component of the predator's natural diet.

Lethal methods proposed for use in the implementation of PDM activities would not cause impacts to the untrammeled quality of wilderness character that are additional to the impact of the action of removing a predator from the wilderness. It is the predator removal, not the method, which causes the trammeling. Because the PDM activities would target only the offending animal or group of animals, impacts to the untrammeled quality of wilderness character would be minimized to the extent possible to protect livestock and as appropriate in emergencies to protect human health and safety. While a small number of individual animals may be removed from any one WA annually, the overall landscape-scale predator-prey relationships and natural ecological conditions and processes within wilderness would not be substantially affected.

3.11.1.2.2 Impacts to the Natural Quality of Wilderness Character

Predator removal in wilderness for the purpose of preventing serious losses of domestic livestock or in emergency situations of imminent danger or inescapable urgency to protect public health and safety would impact the natural quality of wilderness character. Where the untrammeled quality of wilderness character is impacted by the actions taken, the natural quality of wilderness character is impacted by the effects of the actions on the ecosystem and environment. The removal of a predator from its natural environment for administrative purposes (as opposed to recreational hunting, which is a traditional use in wilderness) does not result in an ecological system entirely free from the effects of modern civilization.

The proposed modes of transportation by foot or pack stock would not impact the natural quality of wilderness character.

Non-lethal methods proposed for use in the implementation of PDM activities would not cause impacts to the natural quality of wilderness character. While livestock behavior will have been altered through the use of most non-lethal methods, predator behavior would not be affected by actions such as shifts in breeding schedules or use of herd dogs. The use of non-lethal methods such as guard dogs and predator harassment with firearms would have the effect of altering the predator's behavior to avoid livestock, but not to avoid a place within the predator's natural environment. Because the predator would learn to avoid an unnatural food source, the wilderness ecological system would be largely free of the effects of modern civilization.

Lethal methods proposed for use in the implementation of PDM activities would not cause impacts to the natural quality of wilderness character that are additional to the impacts to the biophysical environment of the removal of a predator from the wilderness. The result of the action of removing a predator causes the impact to the natural quality of wilderness character, not the method. Because the PDM activities would remove only the offending animal or group of animals, impacts to the natural quality of wilderness character would be minimized to the extent possible to protect livestock and as appropriate in emergencies to protect human health and safety. While a small number of individual animals may be removed, the overall landscape-scale ecology of predator-prey relationships in the ecosystem would not be substantially affected.

3.11.1.2.3 Impacts to the Undeveloped Quality of Wilderness Character

Predator removal in wilderness for the purpose of preventing serious losses of domestic livestock or in emergency situations of imminent danger or inescapable urgency to protect public health and safety would not impact the undeveloped quality of wilderness character, nor would the proposed modes of transportation by foot or pack stock.

Non-lethal methods proposed for use in the implementation of PDM activities would not involve any structures, installations, use of motorized equipment, or use of mechanical transport. These methods would not impact the undeveloped quality of wilderness character.

Lethal methods proposed for use in the implementation of PDM activities would not impact the undeveloped quality of wilderness character. Proposed lethal methods would not involve any structures, installations, use of motorized equipment, or use of mechanical transport. Hunting and trapping are appropriate and traditional uses in wilderness. According to BLM MS-6340, "traps and snares may be left behind, for a reasonable period of time, when the trapper leaves the wilderness without being considered an 'installation'". While the purpose of the trapping or snaring in the case of the proposed action is administrative and not a traditional recreational use, the impacts related to the administrative nature of the action are related to the untrammeled quality of wilderness character, not the undeveloped quality.

3.11.1.2.4 Impacts to Opportunities for Solitude or Primitive and Unconfined Recreation

Predator removal in wilderness for the purpose of preventing serious losses of domestic livestock or in emergency situations of imminent danger or inescapable urgency to protect public health and safety would not impact solitude. It may, however, impact opportunities for primitive and unconfined recreation, particularly in some cases of emergency removal for the purpose of protection of human health and safety. If an emergency request for PDM activities is received by WS-Nevada for human health and safety, the most likely scenario would be a habituated predator that has demonstrated behavior that would suggest it is likely to attack a human, or a predator that has posed a serious threat to a human. Opportunities for primitive and unconfined recreation include opportunities for self-reliance and experiencing risks associated with a primitive existence in the natural world, which includes a sense of traveling through a landscape where predators are present and could even include instances of threat from predators. While the removal of a predator threatening people visiting a wilderness is very likely to be considered the most appropriate management action to protect public safety, it would still negatively impact opportunities for primitive and unconfined recreation.

The proposed modes of transportation by foot or pack stock would not impact opportunities for solitude or primitive and unconfined recreation.

Both non-lethal and lethal methods of PDM proposed for use in the implementation of PDM activities have the potential to impact solitude for wilderness visitors. While only 1-2 WS-Nevada personnel would respond to a request for assistance in wilderness and would be unobtrusive for wilderness visitors that might encounter them, they are conducting administrative, not recreational, activities in the wilderness, which would affect the visitors' sense that they are experiencing an environment that is relatively free from the encumbrances of modern society. The presence of non-lethal method implementers like guard dogs, herd dogs, herders, and range riders would disturb a wilderness visitors' sense of solitude, as would the presence of traps, snares, tracking/trailing/decoy dogs, and the activities of ground shooting and calling when implementing lethal methods. Impacts to solitude would be short-term, and in some cases very minimal, as some of the administrative PDM activities may appear to a visitor to be identical to traditional recreational hunting activities.

3.11.1.2.5 Impacts to other Features of Value

Predator removal in wilderness for the purpose of preventing serious losses of domestic livestock or in emergency situations of imminent danger or inescapably urgency to protect public health and safety would generally not impact other features of value nor would the proposed modes of transportation by foot or pack stock. Non-lethal and lethal methods proposed for use in the implementation of PDM activities would not impact other features of value. If a wilderness area where PDM activities were proposed through an AWP had special areas or sites, such as cultural sites, within its boundaries, these areas or sites would be discussed as part of the AWP meeting and MRDG process and avoided, especially for activities such as benching of sheep or placement of traps or snares where livestock may be concentrated in an area or PDM equipment may be placed on the ground.

3.11.1.2.6 Impact to WSA Characteristics

The primary mandate of the managing agency is to prevent impairment to WSAs' suitability for designation as wilderness. Prevention of impairment means that WSAs are managed such that their wilderness characteristics remain intact at the same level as or improved over the conditions of those characteristics in October 1976 (except in special circumstances in which a WSA was designated after 1993 under the authority in Section 202 of FLPMA). If conditions of wilderness characteristics of a WSA have improved since 1976, the managing agency is required to maintain those conditions or improve them. To meet the non-impairment standard, any action the managing agency approves in a WSA, unless excepted, must be both temporary and not create surface disturbance. Excepted actions include emergencies, public safety, restoration of impacts from violations and emergencies, valid existing rights, grandfathered uses, other legal requirements, and actions that protect or enhance wilderness characteristics or values.

The removal of a predator or target group of predators from a WSA would not impact the size of the WSA. Removal of a predator from its native ecosystem would have a small impact on the naturalness of a WSA, but not to a degree so substantial that it would impair the suitability of that WSA for designation. Supplemental values would not be impacted, as, if a WSA where PDM activities were proposed through an AWP had special areas, species populations, or sites, such as cultural sites, within its boundaries, those features would be discussed as part of the AWP meeting and avoided during implementation. Potential benefits to a threatened, endangered, or candidate species as result of the removal of a threatening predator or group of offending animals would be analyzed on a more limited basis under any relevant proposals that might be submitted. Removal of a predator from its native habitat could impact opportunities for primitive and unconfined recreation, similar to the impacts that would be seen in wilderness. Removal of a predator would not affect opportunities for solitude, although the methods used for that removal or for non-lethal PDM activities would cause short-term impacts to solitude for wilderness visitors exposed to the activities and the personnel conducting them. While short-term and/or minor impacts to wilderness characteristics would result from the removal of predators from WSAs and from the methods used in PDM, wilderness suitability would not be impaired by the proposed actions because those actions are temporary and would not create surface disturbance.

As analyzed in Section 3.5, WS-Nevada has low or negligible impacts on predator species populations, T&E species populations, species taken unintentionally, trophic cascades, humaneness, the environment, humans, or domestic animals from its activities. Due to the low likelihood and duration of most PDM in WAs or WSAs, WS-Nevada would have negligible effect on WSAs.

3.11.1.3 *Alternative 3. Non-lethal PDM Required Before Applying Lethal Assistance (No Preventive Lethal PDM)*

Under Alternative 3, WS-Nevada would provide technical assistance for both lethal and non-lethal activities, but would use non-lethal methods first, and until proven ineffective, before WS-Nevada would provide lethal assistance. WS-Nevada would not conduct and preventive PDM. The APHIS-WS Decision Model may not be fully effective because, even if lethal methods are deemed necessary and are considered the "minimum tools necessary" in the case of wilderness evaluations, they could not be used by WS-Nevada during the time that non-lethal methods are attempted to address the immediate problems. Delaying implementation of lethal management could increase the amount of PDM that must be conducted later, if non-lethal methods fail. Increased use of some non-lethal methods may result in a reduction in the WA characteristics (as analyzed for Alternative 2) beyond what would be expected to occur under normal application of the Decision Model process utilized in Alternative 2 for WAs.

3.11.1.3.1 Impacts to Wilderness Character

Alternative 3 is anticipated to have some slightly greater impacts to wilderness character when compared to Alternative 2. Alternative 2 allows WS-Nevada to prioritize the use of non-lethal methods while still selecting lethal methods where they are known to be more effective. Alternative 3 requires additional time be invested in applying non-lethal methods that are possible already known to not be effective for a specific situation. This increases the time the WS-Nevada or the cooperator must engage in PDM, which increases any undesirable effects of human activity in WAs. While the methods themselves are not defined as trammeling, delaying the implementation of effective PDM may result in increased predators engaging in predation activity and being removed.

3.11.1.3.2 Impact to WSA Characteristics

Similarly, Alternative 3 would likely have some greater effects on WSAs, because WS-Nevada could not always use the most effective methods to resolve the damage. AS noted for Alternative 2, removal of a predator would not affect opportunities for solitude, although the methods used for that removal or for non-lethal PDM activities would cause short-term impacts to solitude for wilderness visitors exposed to the activities and the personnel conducting them. Alternative 3 requires the use of non-lethal methods that may be known not to be effective in a given situation, therefore increasing the amount of time WS-Nevada must conduct PDM in WSA.

Other commercial, governmental, and private entities and landowners would be likely to continue to conduct IPDM activities as described in Section 3.4. During (or instead of) WS-Nevada's non-lethal assistance, grazing permit-holders could still choose to address the problem themselves. If grazing permit-holders determined that lethal PDM is immediately necessary, they may implement lethal methods before applying all reasonable non-lethal methods. Producers experiencing damage could use trained and experienced WCOs or may implement lethal methods themselves. However, entities requesting lethal assistance would have to determine if a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4).

Action by private entities may not be as closely coordinated with land management agencies. WCOs may not have the experience or response capability with some of the species and methods if they are not already conducting PDM activities for those particular species (Section 3.4.2). A greater presence of people and equipment may occur on WA or WSA when conducted by private entities, due to less efficiency and experience with lethal methods.

3.11.1.4 *Alternative 4. WS-Nevada Provides IPDM Lethal Assistance Only for Cases of Human/Pet Health or Safety*

Under Alternative 4 in WAs and WSAs, WS-Nevada could only provide lethal PDM when responding to requests to protect human health and safety or T&E species in WAs or WSAs. All other requests for assistance, including protection of livestock, could only be addressed using technical assistance or by WS-Nevada implementing non-lethal methods. WS-Nevada expects that requests for assistance in WAs or WSAs for emergency protection of human health and safety to be a rare occurrence and WS-Nevada does not anticipate conducing and PDM for T&E protection. This Alternative would reduce WS-Nevada's ability to use lethal methods in WAs and WSAs to almost none, with the only exception being emergency human health and safety situations.

While WS-Nevada would be largely restricted from using lethal PDM under Alternative 4, other commercial, governmental, and private entities and landowners would be likely to continue to conduct IPDM activities as described in Section 3.4. During (or instead of) WS-Nevada's non-lethal assistance, grazing permit-holders could still choose to address the problem themselves. If grazing permit-holders determined that lethal PDM is immediately necessary, they may implement lethal methods before applying all reasonable non-lethal methods. Producers experiencing damage could use trained and experienced WCOs or may implement lethal methods themselves. However, entities requesting lethal assistance would have to determine if a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4).

3.11.1.4.1 Impacts to Wilderness Character

Under Alternative 4, WS-Nevada is anticipated to have less impact on wilderness character when compared to Alternative 2 or 3. Alternative 4 severely limits the options WS-Nevada has to assist entities requesting assistance in WAs. This may increase the amount of effort that is put into utilizing nonlethal methods by both WS-Nevada and those entities experiencing predation issues, which also increases the effect those methods are likely to have on the solitude qualities of a WA.

3.11.1.4.2 Impact to WSA Characteristics

Alternative 4 would likely have less effect on WSAs, because neither WS-Nevada nor the public would be able to use aerial shooting for M-44s on WSAs, except for emergency protection of human health and safety. Producers or other entities could take conduct lethal PDM on their own, and may increase their use of nonlethal strategies.

Private individuals are not likely to have the consistent training with lethal methods, the experience to confirm the cause of damage, or the level of selectivity possessed by WS-Nevada employees. Additionally, action by private entities may not be as closely coordinated with land management agencies. WCOs may not have the experience or response capability with some of the species and methods if they are not already conducting IPDM activities for those particular species (Section 3.4.2). Additionally, greater presence of people and equipment may occur on WA or WSA when conducted by private entities, due to less efficiency and experience with lethal methods.

Action by private entities may not be as closely coordinated with land management agencies. WCOs may not have the experience or response capability with some of the species and methods if they are not already conducting PDM activities for those particular species (Section 3.4.2). A greater presence of people and equipment may occur on WA or WSA when conducted by private entities, due to less efficiency and experience with lethal methods.

3.11.1.5 *Alternative 5. No WS-Nevada IPDM Activities*

Under this alternative, WS-Nevada would have no effect on WAs or WSAs. WS-Nevada would not provide technical or operational assistance for any purpose or need to individuals or agencies in WAs or WSAs. Other entities are expected to fill the need for lethal PDM to some degree through other legal methods, as authorized by state agencies in coordination with land management agencies. Landowners experiencing damage or threats could only depend on advice and responses from commercial WCOs, NDA-WS, NDOW, or other entities. Entities requesting lethal assistance would have to determine if NDA-WS, NDOW or a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Other entities would likely increase IPDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada.

3.11.1.5.1 Impacts to Wilderness Character

Under Alternative 5, WS-Nevada would have no impact on wilderness character.

However, private individuals are not likely to have the consistent training with lethal methods, the experience to confirm the cause of damage, or the level of selectivity possessed by WS-Nevada employees. Additionally, action by private entities may not be as closely coordinated with land management agencies. WCOs may not have the experience or response capability with some of the species and methods if they are not already conducting IPDM activities for those particular species (Section 3.4.2). Greater presence of people and equipment may occur on WA or WSA when conducted by private entities, due to less efficiency and experience with lethal methods.

3.11.1.5.2 Impact to WSA Characteristics

Under Alternative 5, WS-Nevada would have no impact on WSA characteristics. Producers or other entities would likely conduct non-lethal and lethal PDM on their own.

Without WS-Nevada's technical and operational assistance, other entities may be less efficient and effective, potentially resulting in more impacts to WAs and WSAs, particularly because WS-Nevada would not provide federal oversight of IPDM. Private individuals are not likely to have the consistent training with lethal methods, the experience to confirm the cause of damage, or the level of selectivity possessed by WS-Nevada employees, although NDA-WS would, though they would not have WS-Nevada's federal oversight. Additionally, action by private entities may not be as closely coordinated with land management agencies. WCOs may not have the experience or response capability with some of the species and methods if they are not already conducting IPDM activities for those particular species (Section 3.4.2). Additionally, greater presence of people and equipment may occur on WA or WSA when conducted by private entities, due to less efficiency and experience with lethal methods.

3.12 How Might WS-Nevada IPDM Activities Affect Cultural Uses of Wildlife?

Cultural use of natural resources includes a variety of ways to recreate and or interact with the environment, including recreation, aesthetic, and spiritual connections or uses. Recreation encompasses a wide variety of outdoor entertainment in the form of consumptive and non-consumptive uses. Consumptive uses of public lands include, but are not limited to, hunting, fishing, gathering, and rock-hounding. Non-consumptive uses include activities of directly or indirectly (spiritually or emotionally) connecting with or enjoying natural resources such as bird watching, photography, camping, hiking, biking, rock climbing, winter sports and water sports. Participants for these activities include Tribal members, the general public, and their pets, which includes hunting dogs. Aesthetics is the philosophy dealing with the nature of beauty or the appreciation of beauty. Therefore, aesthetics is truly subjective in nature, dependent on what an observer regards as beautiful.

Wildlife populations provide a range of direct and indirect social and economic benefits. Direct benefits are derived from a user's personal relationship or direct contact with wildlife and may include both consumptive (e.g. hunting), or non-consumptive (e.g., observing or photographing wildlife). Indirect benefits, or indirect exercised values, arise without a human being in direct contact with an animal and are derived from experiences such as looking at pictures or videos of wildlife, reading about wildlife or benefiting from activities or contributions of animals such as their use in research (Decker and Goff 1987). According to the authors, two forms of indirect benefits exist; bequest and pure existence. Bequest benefits arise from the belief that wildlife should exist for future generations to enjoy, and pure existence benefits accrue from the knowledge that the animals exist in the human environment (Decker and Goff 1987) or that they contribute to the stability of natural ecosystems (e.g. ecological, existence, bequest values; (Bishop 1987)).

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. According to a 2016-2017 report by the Outdoor Industry Association (OIA 2017), on a national level, over $166.8 billion is spent on camping, over $30.2 billion on wildlife watching and $27.3 billion is spent on hunting. Based on surveys conducted in 2010 and 2011 for the Outdoor Industry Association, outdoor recreation generates $14.9 billion in consumer spending, $4.8 billion in wages and salaries, $1 billion in state and local tax revenue and 148,000 direct Nevada jobs (OIA 2012). In 2011, a USFWS Survey found that 734,000 Nevadans and nonresidents (16 yrs old and older) fished, hunted or wildlife watched in Nevada in 2011. Of that total, 147,000 fished, 43,000 hunted and 643,000 participated in wildlife watching activities (including those that also fished and/or hunted). Expenditures for each category are as follows: Those that fished=$139 million; those that hunted=$204 million; those that fished, hunted and watched wildlife=$682 million (including those that also fished and hunted) (USDI, USFWS and USDC, USCB 2011). The report can be viewed in its entirety at https://www.census.gov/prod/2013pubs/fhw11-nv.pdf. These expenditures occurred with the current IPDM activities in place. 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.

Public opinion about the best ways to reduce conflicts between humans and wildlife is highly variable, making the implementation of damage management actions extremely complex. Ideas about how these actions are implemented and conducted are as unique as the almost infinite combinations of philosophies, psyches, aesthetic values, personal attitudes and opinions found in humans. These differences in opinion result in concerns that the proposed action or the alternatives would result in the loss of aesthetic, recreational, spiritual, or otherwise referred to as cultural benefits to the general public, tribes, and resource owners.

3.12.1 *What are the Potential Impacts of WS-Nevada IPDM Activities Reducing Wildlife Interactions?*

Some individuals may believe their recreational experiences on public lands are impaired by knowing that any lethal IPDM 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-Nevada IPDM actions. Occasionally, individuals may have formed an attachment to a specific coyote pack or individual animal. Removal of these packs or animals can be a cause of distress and sorrow for these individuals.

Some commenters have stated that witnessing aerial hunting activities or encountering WS-Nevada warning signs for IPDM devices or animals captured in traps is distressing and has a profound negative impact on their aesthetic and recreational enjoyment of a site. Some individuals may be reluctant to use areas or walk pets in areas where signs are posted. Disturbance (noise) associated with aerial hunting activities has also been reported as adversely impacting some individuals' recreation.

Potential for adverse impacts on recreation is not limited to use of lethal methods. The flashing lights and sounds associated with frightening devices have the potential to adversely impact individuals' outdoor experiences, especially given that these devices are deployed at night when individuals may desire to sleep or enjoy the quiet night sounds of a natural setting. Safety concerns have also been expressed regarding the use of livestock guarding dogs. Livestock guarding dogs may approach people who come near their flocks which, given the large size of the dogs, can be alarming for some people. In rare instances, livestock guarding dogs may perceive recreationists as a threat and behave aggressively, or they may prey on wildlife, or exclude wildlife species other than undesirable predators, from the area near the sheep (Timm and Schmidtz 1989, Frank 2011).

Opinions regarding the impact of IPDM on recreation and aesthetic values vary among individuals. An adverse impact associated with IPDM actions, such as the use of foothold traps, may be perceived by one individual in one way and may be perceived completely differently by an individual who hunts and traps recreationally. Some individuals believe that IPDM is acceptable because it can help bolster certain species populations such as game species (e.g. elk or mule deer) or sensitive/T/E species.

3.12.2 *What are the Potential Impacts to Native American Concerns and Values?*

Native American tribes have a unique cultural and spiritual relationship with wildlife and native ecosystems. The exact nature of this relationship varies among tribes, groups and families within tribes and among individuals. Native American tribes in Nevada use natural resources for food, income and cultural practices. Tribal members may also harvest wildlife for food or cultural uses or for income. Tribal members may also derive income from providing guide services. Actions which substantively impact wildlife species population density and distribution have the potential to adversely affect tribal members spiritually, culturally and economically. Tribal members may also be concerned that predator removal could result in impacts to trophic cascades that impact other species and plants valued by tribal members.

A draft of this EA was provided to all of the federal recognized tribes in Nevada in spring of 2019 by certified mail. WS-Nevada received 1 comment letter in response to the mailing, from the Summit Lake Paiute Tribe. In October 2019, WS-Nevada met with the Summit Lake Paiute Tribe to discuss their concerns and the contents of the draft EA. While WS-Nevada is unlikely to conduct PDM in the vicinity of the Tribe's reservation, their concerns extend to all aboriginal lands which cover a large portion of the State of Nevada (Appendix H)with a particular concern for WAs and

WSAs that surround the Summit Lake Paiute Reservation. Per the Summit Lake Paiute Tribe representatives, tribal reservation boundaries and property ownership are artificially created and do not fully define the tribe's interests, nor do they confine the wildlife or the effects of natural resource management. The Tribe's representatives expressed the Tribe's beliefs that human interference with nature was unacceptable. PDM activities, along with other uses of the land for activities such as grazing, are viewed as causing more damage to the natural world and not actually solving any problems. Many of the species proposed for management in this EA are also culturally significant to the Summit Lake Paiute Tribe. The Summit Lake Paiute Tribe expressed their preference for Alternative 5 of the EA – No WS-Nevada Involvement in PDM Activities.

The concerns and beliefs expressed by the Summit Lake Paiute Tribe would align them with most closely the Mutualists wildlife value orientation type, as defined in Manfredo et al. (2018, discussed in Section 1.4.2). Manfredo et al. (2018) found that, of all the ethnic groups, Native Americans nationwide had the highest proportion of Pluralists (36%), followed by Mutualists (28%), then Distanced (24%), and finally Traditionalists (23%).

3.12.3 *What are the Comparative Impacts of the Alternatives on Cultural Impacts?*

3.12.3.1 *Alternative 1. No Action Alternative: Continue WS-Nevada IPDM Assistance outside of WAs and WSAs.*

WS-Nevada IPDM activities occur on a relatively limited portion of the lands in Nevada (Section 1.11) and the proportion of individual predators removed through IPDM activities is small in comparison to their population (Section 3.5). This alternative does not include work in WAs or WSAs, except for emergency responses to Human health and safety incident.

3.12.3.1.1 Likelihood of WS-Nevada PDM Activities Reducing Wildlife Encounters for the Public

Furthermore, WS-Nevada actively works on only a small portion of all the available properties it is authorized to work at any given time. Of those properties being actively worked, IPDM activities are conducted on only a fraction of the total area which the property encompasses. In localized areas where WS-Nevada does remove some portion of the local 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 (Gese 2005). Most of the species potentially affected by WS-Nevada IPDM activities are relatively abundant, but are not commonly observed because of their secretive and largely nocturnal behavior. The likelihood of getting to see or hear a predator in some localized areas could be temporarily reduced as a result of WS-Nevada IPDM activities, 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. Additionally, many of the species which could be targeted in this EA may also be taken by hunters and trappers and WS-Nevada take is a small fraction of those taken by other harvest methods (Section 3.5).

Consequently, for most species, the presence or absence of impacts of WS-Nevada IPDM activities may not be discernable from impacts from other sources. Overall impacts on predator populations would be relatively low, and opportunities to view, hear or see evidence of predators would still remain. The potential minor reduction in local opportunity to view predators must be considered with all potential impacts, including the potential economic and emotional harm suffered by resource owners or others affected by predator damage, if management activities were not implemented.

3.12.3.1.2 Impacts to Game Species that May Affect Recreational or Cultural Uses

Game and non-game wildlife populations are not significantly impacted by WS-Nevada's IPDM activities (Section 3.7 and 3.8) on public or private lands, allowing hunters ample opportunities for pursuit. Recreationists interested in viewing and photography opportunities for wildlife also have ample areas in Nevada that are suitable for seeing abundant wildlife. WS-Nevada activities do not significantly impact animal populations and it does not remove a significant number of any one species. In fact, WS-Nevada activities could bolster local populations of wildlife and increase opportunities for cultural uses by implementing IPDM activities for the protection of wildlife species, or indirectly when implemented for the protection of other resources.

Procedures and policies designed to reduce WS-Nevada impacts on recreation are in place. As discussed in Chapter 1 (Section 1.9.4), 67.97% of the conflicts WS-Nevada responds to occurs on private lands. On private lands, the cooperators or landowners are aware that IPDM control tools are set and can alert visitors using the property of their presence. Landowners determine the areas and timing of equipment placement, thereby avoiding conflicts with recreationists. WS-Nevada personnel post signs in prominent places to alert the public (on both private and public lands) that IPDM tools are set in an area.

On public lands, WS-Nevada coordinates with the public land management agencies through AWPs or other means, and designates different work areas using GPS maps to reduce potential problems. For example, Human Safety Areas (HSA) are designated in the AWP as private lands located within or adjacent to the approved control areas. WDM activities will not be conducted on HSAs unless WS-Nevada has a written agreement signed by the land owner or manager having management authority for that HSA. To ensure that WS-Nevada is aware of the HSAs, all employees are issued a GPS unit that shows land ownership. WS-Nevada does not conduct IPDM in high use recreational areas except for the purposes of human health and safety protection and only after receiving a request from the applicable public lands official. High use recreation and other sensitive areas are identified at a site specific level in WS-Nevada AWPs and associated meetings or as new damage situations arise. Human safety areas, planned control areas and restricted or coordinated control areas are identified through interagency coordination.

3.12.3.1.3 Likelihood of Public Encountering WS-Nevada PDM Activities

To the extent practicable, when IPDM actions are necessary near areas with public use, WS-Nevada strives to schedule activities at times and in seasons when recreational activity is likely to be low. These areas are designated in AWPs and on maps so IPDM does not unnecessarily interfere with recreational activities. Other strategies used by WS-Nevada to reduce risk that IPDM activities would adversely impact an individual's recreational experience include setting capture devices well away from roads and trails.

Conflicts with recreationists are further reduced due to the inherent nature of IPDM. WS-Nevada conducts most IPDM on public lands for grazing allotments with sheep and cattle. These areas are generally not used extensively by recreationists during the spring and early summer months when WS-Nevada would be more likely to conduct IPDM. Most recreational areas are set aside or designated for recreation and grazing is not allowed. The highest seasonal IPDM activity for the protection of livestock coincides with lambing and calving, which is normally in the spring. During this time, aerial shooting is normally the method of choice because many of the grazing areas have poor access and driving conditions are usually limited by wet grounds. Recreationists, as well as WS-Nevada employees, have limited access to these public lands because of these limitations. In addition, WS-Nevada currently averages only 0.14 and 0.61 minutes of flight time per square mile, on BLM and USFS lands, respectively (Management Information System 2018b). Recreationists are generally unaware of the PDM actions occurring and the quality of the outdoor experience is not disrupted. Thus, WS-Nevada avoids significant effects on recreational users.

Some groups or individuals have expressed concerns regarding the effects of WS-Nevada's low level aerial shooting flights on non-target wildlife and on public land recreational users (Section 3.10.1.3). WS-Nevada conducts IPDM activities on a fraction of all potential land that is authorized under agreement or WID. WS-Nevada conducts flying efforts mainly during the times of year specific to lambing and calving so the annual amount of time spent flying over properties is relatively small. The average flight time for WS-Nevada for all land classes for FY12-16 averages 0.20 minutes per mi^2. Thus, the average amount of time during any given year that WS-Nevada spends on a given property is minimal. Additionally, as the majority of low level flying in Nevada is typically conducted in remote spring lambing and calving grounds, it is unlikely that recreationists would find themselves in a situation to be disturbed. With an average of 3.2 permits issued by NDOW (Julie Meadows, NDOW, Pers Comm. 12/03/18 email) each year from FY12-16 for aerial shooting by private individuals for take of coyotes, some disruption associated with aircraft use may be attributable to non-WS entities.

In some instances, use of aircraft may have less of an impact on recreation and aesthetic values than some other methods despite any potential noise and visual effects. As noted above, the actual time spent flying in a specific area, especially on public land, was very low. Wagner and Conover (1999) determined that winter proactive aerial hunting resulted in less use of traps, snares and M-44s for corrective control during summer months. In situations where there are concerns regarding interactions with summer recreational activities, a brief period of aerial hunting (minutes) may have less impact than more prolonged use of methods such as traps and snares (days).

Nonlethal PDM methods approved for use on most USFS, BLM and other lands include: mechanical and non-mechanical scare devices; livestock guarding animals; husbandry practices; herding dogs; and chemical and visual repellents. APHIS-WS is working collaboratively with livestock producers and land managers on ways to reduce interactions between livestock and recreationists and on the production and dissemination of educational materials and informative signs on livestock protection dogs (Marlow 2016). Lethal control methods approved for use on most USFS and BLM lands includes: foothold, cage, culvert and humane-kill traps; neck and foot snares; calling/shooting; decoy dogs; aerial shooting (fixed-wing and helicopter); and, EPA and NDA registered predacides (gas cartridges for denning and M-44s) and an avicide (DRC-1339). Prior to application of predacides/avicide or chemical repellents, WS-Nevada will ensure compliance with the National Pollution Discharge Elimination System. Additionally, USFS and BLM AWP's spell out any control measure restrictions.

3.12.3.1.4 Impacts to Native American Cultural Uses and Concerns

WS-Nevada recognizes that some actions such as the disturbance associated with lethal removal and non-lethal hazing of wildlife, may cause temporary localized shifts in species presence and or distribution, which could impact tribal members. Some tribes not only object to the removal of predators due to the effects on their population, but on the manipulation of the natural ecosystem in general. Predicting impacts and establishing ways to meet agency objectives on tribal members and tribal spiritual practices is complicated by the private nature of some tribal religious practices. In general, based on analysis of impacts on target and non-target species populations, recreation and aesthetics, these impacts are expected to be low. This Alternative also only includes work in WAs or WSAs for emergency human health and safety events, which further reduces the effects of the proposed action on the Nevada ecosystems as a whole. Nonetheless, WS-Nevada recognizes that the agency has unique government to-government obligations to the tribes as established in treaties. Practices to help reduce risks of adverse impacts are listed in Section 2.4.

Depending on the activity, potential impacts from IPDM on cultural values could include increased or decreased quality of interactions with wildlife for future consumptive and non-consumptive uses. As described in Section 3.5 to 3.11, WS-Nevada has low or negligible impacts on predator species populations, T&E species populations, species taken unintentionally, trophic cascades, humaneness, the environment, humans, or domestic animals, and WAs and WSAs (for public safety responses only) from its IPDM activities. Due to the low or negligible impacts described, and the protective measures described in Section 2.4, WS-Nevada would have minimal effects on Cultural uses of wildlife resources.

3.12.3.2 *Alternative 2. Proposed Action/Modified Current Program. A Continuance of the Current Program as modified to include IPDM in WAs and WSAs*

Under this Alternative, WS-Nevada would include IPDM in WAs and WSAs. Other commercial, governmental, and private entities and landowners will continue to conduct IPDM activities as described in Section 3.4. Therefore, under Alternative 2, there are likely to be slightly more impacts to consumptive, non-consumptive uses, aesthetics, and Native American cultural uses/values when compared to Alternative 1. Impacts to solitude and recreation in WAs were analyzed in Section 3.11.1.2.4. Impacts to wilderness characteristics of WSAs, including a discussion of impacts to recreation, was discussed in Section 3.11.1.2.6. As described in those sections, impacts to the qualities of wilderness character are expected to be minimal, short-term, not significant, and would not impair the suitability of a WSA for designation as a WA in the future.

The inclusion of WAs and WSAs in this alternative is of particular concern to the Summit Lake Paiute Tribe. While their reservation is surrounded by WAs and WSAs, the tribe's area of concern extends beyond tribal lands. Their cultural value system is opposed to human manipulation of ecosystems. Therefore the tribe would be most opposed to this alternative because it expands WS-Nevada's activities to include additional land classes.

3.12.3.3 *Alternative 3. WS-Nevada Provides Non-lethal IPDM Assistance before Recommending or Applying Lethal Assistance*

Under Alternative 3, WS-Nevada would provide technical assistance for both lethal and non-lethal activities, but the cooperator would need to apply reasonable non-lethal methods before WS-Nevada would provide lethal assistance. WS-Nevada would continue to implement IPDM actions while minimizing impacts to cultural values as described under Alternative 1. The APHIS-WS Decision Model may not be fully effective because even if they are deemed necessary, lethal actions could not be used by WS-Nevada during the time that non-lethal methods are attempted to address the immediate problems. Other commercial, governmental, and private entities and landowners would be likely to continue to conduct IPDM activities as described in Section 3.4.

Other entities would likely increase lethal IPDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada. During (or instead of) WS-Nevada's non-lethal assistance, landowners could still choose to address the problem themselves. If landowners determined that lethal IPDM is immediately necessary, they may implement lethal methods before applying all reasonable non-lethal methods. Landowners could use trained and experienced

WCOs or may implement lethal methods themselves. Entities requesting lethal assistance would have to determine if a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Relatively few WCOs are available for large predator damage management, but landowners can request someone to work as their agent. Private individuals are not likely to have the consistent training with lethal methods, the experience to confirm the cause of damage, or the level of selectivity possessed by WS-Nevada's employees. WCOs may not have the experience or response capability with some of the species and methods if they are not already conducting IDPM activities for those particular species (Section 3.4.2).

Other entities would likely increase lethal IPDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada. Depending on the skillset of others, it is possible that more animals could be taken unintentionally, without coordination of land management agencies and tribes, or more accessible to the public. Therefore, other private entities may have more impacts to cultural resources. While WS-Nevada would still be available for lethal technical assistance and could advise private entities on measures to reduce cultural impacts, these efforts would not compensate an individual's lack of experience and proficiency.

Therefore, under Alternative 3, there are likely to be more impacts to consumptive, non-consumptive uses, aesthetics, and Native American cultural uses as compared to Alternatives 1 and 2.

3.12.3.4 *Alternative 4. WS-Nevada Provides IPDM Lethal Assistance Only for Cases of Human/Pet Health or Safety*

Under Alternative 4, WS-Nevada would provide full IPDM technical and operational assistance (Appendix A), but lethal control could only be included as an option when responding to requests to protect human/pet health or safety, or federally-listed T&E species. WS-Nevada could not use lethal methods as part of IPDM to respond to other types of requests (e.g., agriculture, property, and game species). For threats to human and pet health or safety, the primary predator species of concern would be mountain lions, coyotes or black bears in residential areas, or disease vector species. Any predator species can pose a threat to T&E species. WS-Nevada would continue to implement IPDM actions while minimizing impacts to cultural values as described under Alternatives 1 and/or 2. Other commercial, governmental, and private entities and landowners would continue to conduct IPDM activities as described in Section 3.4. Other entities would likely increase IPDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada.

However, in the absence of lethal assistance from WS-Nevada for non-T&E species protection requests, some people choose to take lethal action to protect domestic animals from predation, if necessary. Entities requesting lethal assistance would have to determine if a commercial WCO or other private individual with the capabilities, approvals, and interest is available, or attempt to address their IPDM needs themselves (as discussed in Section 3.4). Relatively few WCOs are available for large predator damage management, but landowners can request someone to work as their agent. Private individuals are not likely to have the consistent training with lethal methods, the experience to confirm the cause of damage, or the level of selectivity possessed by WS-Nevada employees. WCOs may not have the experience or response capability with some of the species and methods if they are not already conducting IDPM activities for those particular species (Section 3.4.2).

There is a potential for other entities (as discussed in Section 3.4) to attempt to fill the need for lethal IPDM activities in the absence of lethal operational assistance from WS-Nevada. Other entities would likely increase lethal IPDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada. Depending on the skillset of others, it is possible that more animals could be taken unintentionally by other entities, as a result of less selective and less proficient removal efforts. Additionally, activities by private individuals are not required to and may not be coordinated with other land management agencies, tribes, and with NDOW to reduce exposure to the public viewing or recreational activities aside from restriction defined in Nevada State laws. Therefore, other private entities may have more potential effects to cultural resources. While WS-Nevada would still be available for lethal technical assistance and could advise private entities on applicable BMPs, these efforts would not compensate an individual's lack of experience and proficiency.

Therefore, under Alternative 4, there are likely to be more impacts to consumptive, non-consumptive uses, aesthetics, and Native American cultural uses as compared to Alternatives 1, 2 and 3.

3.12.3.5 *Alternative 5. No WS-Nevada IPDM Activities*

Under this alternative, WS-Nevada would not be available to provide any IPDM activities. Landowners experiencing damage or threats could only depend on advice and responses from NDA-Wildlife Services, commercial WCOs, NDOW, or other entities. Entities requesting lethal assistance would have to determine if a commercial WCO or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Other entities would likely increase IPDM actions in proportion to the reduction of services that would normally be provided by WS-Nevada.

Depending on the skillset of others, it is possible that more animals could be taken unintentionally by other entities, as a result of less selective and less proficient removal efforts. Additionally, activities by private individuals are not required to and may not be coordinated with other land management agencies, tribes, and with NDOW to reduce exposure to the public viewing or recreational activities aside from restrictions defined in Nevada State laws.

Under this Alternative, WS-Nevada will not conduct activities that are opposed by tribes. Certain aspects of PDM may still be carried out by other entities. Those entities do not have the same obligations to consult with tribes regarding impacts to cultural values as WS-Nevada. The extent to which activities opposed by tribes will be conducted will depend on the factors described above. Therefore, the impacts of this alternative on tribal values may by greater or less than Alternatives 1 and 2.

Therefore, under Alternative 5, there are likely to more impacts to consumptive, non-consumptive uses, aesthetics, and Native American cultural uses as compared to Alternative 1-4.

3.13 Summary of the Environmental Effects of Each Program Alternative by Issue

Table 3-23. Summary of the Environmental Effects of Each Program Alternative by Issue.

Issues	**Alternative 1** No Action-Continue WS-Nevada IPDM Assistance Outside of Wilderness and Wilderness Study Areas	**Alternative 2** Proposed Action/Modified Current Program. A Continuance of the Current Program as Modified to Include IPDM in Wilderness and Wilderness Study Areas	**Alternative 3** Non-lethal IPDM Assistance before Recommending or Applying Lethal IPDM Assistance	**Alternative 4** Lethal IPDM Assistance Only for Human/Pet Safety	**Alternative 5** No WS-Nevada IPDM Activities
Effects on predator species populations	Current and projected direct and cumulative take are well below maximum sustainable harvest levels as determined by a review of the available scientific literature. All predator species populations are stable as determined by	WS-Nevada would have slightly more effect on predator species populations compared to Alternative 1. Other entities would likely have slightly less take as compared to their take under Alternative 1 as WS-Nevada would be able to respond to damage in WAs and WSAs. Cumulative take would be expected to	WS-Nevada would have slightly less effects on predator species populations compared to Alternatives 1 and 2. Other entities would be expected to fill the need for lethal operational assistance to some degree, if they determine that lethal IPDM is immediately necessary. Cumulative levels of take would be expected to be similar to Alternatives 1 and 2	WS-Nevada would have less effects on predator species populations compared to Alternatives 1, 2 and 3. Other entities would be expected to fill the need for lethal IPDM to protect other resources to some degree and have a level of take less than the cumulative take under Alternatives 1, 2 and 3. Cumulative	WS-Nevada would have no effect on predator species populations. Other entities including NDA-WS would be expected to fill the need for lethal operational assistance to some degree. Without WS-Nevada technical or non-lethal operational assistance, other entities may be less efficient and effective,

	NDOW. WS-Nevada is not and would not adversely impact any native predator populations.	be similar to slightly higher than under Alternative 1, but would not be expected to near the maximum sustainable harvest levels. Predator populations are expected to be stable.	and would not be expected to near the maximum sustainable harvest levels. Predator populations are expected to be stable.	take would not be expected to near the maximum sustainable harvest levels. Predator populations are expected to be stable.	and operate without WS-Nevada oversight, and therefore effects on predator species populations would likely be higher than under Alternatives 1-4. Predator populations are expected to be stable.
Effects on threatened and endangered species	WS-Nevada has had no take of T&E species since FY 2005 and has completed appropriate ESA consultations with USFWS to avoid jeopardy to the desert tortoise. WS-Nevada is not likely to adversely affect any other T&E species or would have no effect. Effects are expected to continue to be minimal. WS-Nevada could conduct IPDM to protect T&E species if requested.	WS-Nevada would have similar effects on T&E species compared to Alternative 1. Other entities would be expected to have less need for lethal operational assistance as WS-Nevada would be able to respond to damage in WAs and WSAs, potentially resulting in similar to less risk to T&E species than under Alternative 1.	WS-Nevada would have slightly less effects on T&E species compared to Alternatives 1 and 2. Other entities would be expected to fill the need for lethal operational assistance to some degree if lethal IPDM is deemed immediately necessary, potentially resulting in higher risks to T&E species than under Alternatives 1 and 2.	WS-Nevada would have less effects on T&E species compared to Alternatives 1, 2 and 3. Other entities would be expected to fill the need for lethal operational assistance to some degree, potentially resulting in higher risks to T&E species, than under Alternatives 1, 2 and 3. WS-Nevada would not conduct IPDM to protect T&E species.	WS-Nevada would have no effect on T&E species. T&E species would not benefit from IPDM conducted by WS-Nevada for T&E species protection. Other entities including NDA-WS would be expected to fill the need for lethal operational assistance to some degree, potentially resulting in higher risks to T&E species. Without WS-Nevada technical or non-lethal operational assistance, other entities may be less efficient and effective, operate without WS-Nevada oversight and therefore adverse effects on T&E species

					would be expected to be higher than under Alternatives 1-4.
Effects on species taken unintentionally	WS-Nevada's IPDM activities lethally take very few individual animals unintentionally and activities are highly selective for specific predator species. WS-Nevada's unintentional take is expected to remain negligible.	WS-Nevada's effects on species taken unintentionally would likely be similar to Alternative 1. Although WS-Nevada could be working in WAs and WSAs, potentially conducting IPDM in more areas than under Alternative 1, the work would be less common and less frequent. As activities are highly selective for specific predator species, unintentional take is expected to be negligible.	WS-Nevada would likely take slightly fewer individual animals unintentionally compared to Alternatives 1 and 2. Other entities would be expected to fill the need for lethal operational assistance to some degree, if they determine that lethal IPDM is immediately necessary, potentially resulting in higher unintentional take compared to Alternatives 1 and 2.	WS-Nevada would likely take fewer individual animals unintentionally compared to Alternatives 1, 2 and 3. Other entities would be expected to fill the need for lethal operational assistance to some degree and potentially have a higher level of take compared to Alternatives 1, 2 and 3.	WS-Nevada would have no unintentional take of individual animals. Other entities including NDA-WS would be expected to fill the need for lethal operational assistance to some degree, potentially resulting in higher unintentional take. Without WS-Nevada technical or non-lethal operational assistance, other entities may be less efficient and effective, operate without WS-Nevada oversight and therefore effects on species taken unintentionally would be expected to be higher than under Alternatives 1-4.
Effects on ecological trophic cascades	The effects of WS-Nevada IPDM activities on predator species populations are	WS-Nevada would have similar to slightly more take than under alternative 1. Other	WS-Nevada would have less take compared to Alternatives 1 and 2. Other entities would be expected to fill the need	WS-Nevada would have less take compared to Alternatives 1, 2 and 3. Other entities	WS-Nevada would have no take. Other entities including NDA-WS would be expected to fill the

	temporary, localized, and of low magnitude. It is highly unlikely that WS-Nevada's current and projected direct and cumulative take will contribute to any trophic cascades.	entities would be expected to fill the need for lethal operational assistance to some degree and potentially have a higher level of take compared to Alternative 1. However, it is highly unlikely that take by other entities will contribute to any trophic cascades.	for lethal operational assistance to some degree, if they determine that lethal IPDM is immediately necessary. Cumulative levels of take would be expected to be similar or less than Alternatives 1 and 2. It is highly unlikely that cumulative take will contribute to any trophic cascades.	would be expected to fill the need for lethal operational assistance to some degree but would likely have a lower level of take compared to Alternatives 1, 2 and 3. It is highly unlikely that cumulative take will contribute to any trophic cascades.	need for lethal operational assistance to some degree, potentially resulting in a higher level of take. Without WS-Nevada technical or non-lethal operational assistance, other entities may be less efficient and effective, operate without WS-Nevada oversight and therefore take would be expected to be higher than under Alternatives 1-4. However, it is highly unlikely that take by other entities will contribute to any trophic cascades.
Effects on humaneness and ethics	WS-Nevada follows APHIS-WS training, Directives, and ethics policies. WS-Nevada also follows applicable state laws and regulations and use BMPs, expertise, and highly selective methods to	WS-Nevada would continue to uphold the same standards under Alternative 1.	WS-Nevada would continue to uphold standards under Alternatives 1 and 2. However, in cases where lethal IPDM is deemed immediately necessary, it may be less humane and ethical to delay immediate lethal action. Other entities would be expected to fill the need for lethal operational	WS-Nevada would continue to uphold standards under Alternative 1. In addition, some people may feel it is unethical and inhumane not to take lethal measures to protect domestic livestock from predation, if necessary. Other entities would be	WS-Nevada would have no effect on humaneness and ethics. Other entities including NDA-WS would be expected to fill the need for lethal operational assistance to some degree, potentially resulting in less humane and ethical practices. Without WS-Nevada technical or non-

	uphold high standards of humaneness and ethics.		assistance to some degree, if they determine that lethal IPDM is immediately necessary, potentially resulting in less humane and ethical practices as compared to Alternatives 1 and 2.	expected to fill the need for lethal operational IPDM to some degree. However, technical assistance would not compensate for private entities lack of experience in lethal IPDM, likely resulting in less humane and ethical practices compared to Alternatives 1, 2 and 3.	lethal operational assistance or oversight, other entities may be less humane and ethical compared to Alternatives 1-4.
Effects on the environment, humans, and domestic animal health and safety from the use of mechanical/ physical methods	The analysis of impacts on soil, water, and terrestrial and aquatic species indicates there would be little to no effect on the environment from WS-Nevada's use of mechanical/physical methods. Risks to humans and domestic animals from WS-Nevada's use of mechanical/physical methods are very low on private lands and	WS-Nevada's effects on the environment, humans, and domestic animals would be similar to Alternative 1. WS-Nevada's use of mechanical/physical methods and risks to humans and domestic animals from the use of mechanical/physical methods are very low and highly unlikely on WAs and WSAs due to short duration, protective measures and remoteness.	WS-Nevada's effects on the environment, humans, and domestic animals would be similar to slightly less than Alternatives 1 and 2. Other entities would be expected to fill the need for lethal operational assistance to some degree, if they determine that lethal IPDM is immediately necessary, potentially resulting in greater risks to the environment, humans, and domestic animals compared to Alternatives 1 and 2.	WS-Nevada's effects on the environment, humans, and domestic animals would be less than Alternatives 1, 2 and 3. Other entities would be expected to fill the need for lethal operational IPDM to some degree, potentially resulting in greater risks to the environment, humans, and domestic animals compared to Alternatives 1, 2 and 3.	WS-Nevada would have no effect on the environment, humans, and domestic animals. Other entities including NDA-WS would be expected to fill the need for lethal operational assistance to some degree, potentially resulting in greater risks to the environment, humans, and domestic animals. Without WS-Nevada technical or non-lethal operational assistance or oversight, effects on the environment, humans, and domestic

	highly unlikely on public lands due to short duration and protective measures.				animals would be expected to be higher than under Alternatives 1-4.
Effects on the environment, humans, and domestic animal health and safety from the use of lead ammunition	Impacts of lead on soils, water, plants, aquatic species, and invertebrates from WS-Nevada's sources of lead is negligible. Impacts of lead on birds and terrestrial mammals from WS-Nevada sources are low. Risks to humans and domestic animals from WS-Nevada sources of lead are very low.	Impacts of lead on soils, water, plants, aquatic species, and invertebrates from WS-Nevada's sources of lead is negligible. Impacts of lead on birds and terrestrial mammals from WS-Nevada sources would be low, similar to Alternative 1. Risks to humans and domestic animals from WS-Nevada sources of lead would also be very low, similar to Alternative 1.	WS-Nevada's effects on the environment, humans, and domestic animals would be slightly less than Alternatives 1 and 2. Other entities would be expected to fill the need for lethal operational assistance to some degree, if they determine that lethal IPDM is immediately necessary, potentially resulting in greater risks to the environment, humans, and domestic animals compared to Alternative 1.	WS-Nevada's effects on the environment, humans, and domestic animals would be less than Alternatives 1, 2 and 3. Other entities would be expected to fill the need for lethal operational IPDM to some degree, potentially resulting in greater risks to the environment, humans, and domestic animals compared to Alternative 1.	WS-Nevada's use of lead would have no effect on the environment, humans, and domestic animals. Other entities including NDA-WS would be expected to fill the need for lethal operational assistance to some degree, potentially resulting in greater risks to the environment, humans, and domestic animals. Without WS-Nevada technical or non-lethal operational assistance or oversight, effects on the environment, humans, and domestic animals would be expected to be higher than under Alternatives 1-4.
Effects on the environment, humans, and	The analysis of impacts on soil, water, and terrestrial and	The analysis of impacts on soil, water, and terrestrial and aquatic species	WS-Nevada's effects on the environment, humans, and domestic animals would be	WS-Nevada's effects on the environment, humans, and domestic animals	WS-Nevada would have no effect on the environment, humans, and domestic animals.

domestic animal health and safety from the use of chemical methods	aquatic species indicates there would be little to no effect on the environment from WS-Nevada's use of chemical methods. Risks to humans and domestic animals from WS-Nevada's use of chemical methods are very low to negligible due to protective measures.	indicates there would be little to no effect on the environment from WS-Nevada's use of chemical methods. Risks to humans and domestic animals from WS-Nevada's use of chemical methods are very low to negligible due to protective measures.	slightly less than Alternatives 1 and 2. Other entities would be expected to fill the need for lethal operational IPDM to some degree, however since chemical methods are limited for other entities, the risks to the environment, humans, and domestic animals would be less than under Alternative 1.	would be less than Alternatives 1, 2 and 3. Other entities would be expected to fill the need for lethal operational IPDM to some degree, however since chemical methods are limited for other entities, the risks to the environment, humans, and domestic animals would be less than under Alternatives 1, 2 and 3.	Other entities including NDA-WS would be expected to fill the need for lethal operational assistance to some degree, such as using DRC-1339 for common raven work, however since chemical methods are limited for other entities, the risks to the environment, humans, and domestic animals would be less than under Alternative 1.
Effects on WAs and WSAs	WS-Nevada would only respond to IPDM requests in WAs and WSAs if in response to public safety as requested by land management agencies, law enforcement or state agencies. Such an occurrence would be exceedingly rare (once in the last	WS-Nevada would respond to IPDM requests by land management agencies, state agencies, or livestock permittees on WAs and WSAs. WS-Nevada's response would be according to close coordination with the land management agency, MOUs, and applicable laws, agency policies, work plans, and, as applicable, minimum requirements	WS-Nevada effects on WAs and WSAs would be more than Alternative 1 and slightly less than Alternative 2. Other entities would be expected to fill the need for lethal operational assistance to some degree, as authorized by state agencies in coordination with land management agencies, if they determine that lethal IPDM is immediately necessary. Effects on WAs and	WS-Nevada effects on WAs and WSAs would be more than alternative 1 and less than Alternatives 2 and 3. Other entities are expected to fill the need for lethal IPDM to some degree through other legal methods, as authorized by state agencies in coordination with land management agencies. Effects on WAs and WSAs from state and other	WS-Nevada would have no effect on WAs and WSAs. Other entities such as NDA-WS are expected to fill the need for lethal IPDM to some degree through other legal methods, as authorized by state agencies in coordination with land management agencies. Effects on WAs and WSAs from state and other federal agency IPDM activities would be

	10 years) Other entities would be expected to fill the need for lethal operational assistance to some degree, as authorized by state agencies in coordination with land management agencies, if they determine that lethal IPDM is necessary.	analyses. Current activities are infrequently requested and short duration in SMAs. WS-Nevada has negligible effects to WAs and WSAs.	WSAs from state and other federal agency IPDM activities would be similar to Alternative 2. Effects on WAs and WSAs from other private entities would be expected to be higher than under Alternative 1.	federal agency IPDM activities would be similar to Alternative 1. Effects on WAs and WSAs from other private entities would be expected to be higher than under Alternative 1.	greater than Alternative 1. Without WS-Nevada technical or non-lethal operational assistance or oversight, effects on WAs and WSAs from other private entities would be expected to be higher than under Alternatives 1, 3 and 4.
Effects on Cultural Uses	WS-Nevada follows APHIS-WS training, Directives, and ethics policies. WS-Nevada also follows state laws and regulations and coordinates with land and wildlife management agencies, and tribes, to coordinate IPDM activities in ways to reduce impacts to recreation, aesthetics, and other cultural	WS-Nevada would again work in wilderness areas and wilderness study areas (areas not worked under Alternative 1), presenting a potential for slightly more effects than under alternative 1, but would continue to uphold the same standards under Alternative 1.	WS-Nevada would continue to uphold standards under Alternative 1. However, in cases where lethal IPDM is deemed immediately necessary, it may be less ethical to delay immediate lethal action. Other entities would be expected to fill the need for lethal operational assistance to some degree, if they determine that lethal IPDM is immediately necessary, potentially resulting in less coordination with tribal and other public	WS-Nevada would continue to uphold standards under Alternative 1. In addition, some people may feel it is unethical not to take lethal measures to protect domestic livestock from predation, if necessary. Other entities would be expected to fill the need for lethal operational IPDM to some degree. However, technical assistance would not compensate for	WS-Nevada would have no effect on cultural uses. Other entities, such as NDA-WS would be expected to fill the need for lethal operational assistance to some degree, potentially resulting in less coordination with tribal and other public entities. Without WS-Nevada's technical or direct assistance, others actions would likely result in more cultural impacts as compared to Alternative 1-4.

	uses of wildlife resources.		entities, likely resulting in more cultural impacts as compared to Alternative 1.	private entities lack of experience in lethal IPDM, and coordination with tribal and other public entities, likely resulting in more cultural impacts as compared to Alternative 1.	

3.14 How does this EA Address WS-Nevada's Stated Goal and Objectives?

Section 1.5.2.1 states the goals and objectives of WS-Nevada IPDM activities. This section identifies where the details in meeting the goals and objectives are addressed in the EA and how the alternatives compare in meeting the objectives. This section is not an environmental impact analysis. The vast majority of issues analyzed had little difference in impact among the alternatives because the Proposed Action, Alternative 2, had very low impacts, however there was more variation among alternatives in meeting the objectives. Based on the information and analysis in each section, WS-Nevada IPDM activities meet the goal and objectives.

Goal: Meet the APHIS-WS mission of professionally supporting the coexistence of humans and wildlife

The following components of this goal are addressed throughout this EA. WS-Nevada staff consistently responds to all requests for assistance to meet the following components of the goal:

- Respond in a timely and appropriate way to all requests for assistance.
- Responses, whether over the phone, remotely, or in the field, follow a formal decision process (WS Decision Model WS Directive 2.201, Section 2.3.1.1) to evaluate, formulate, and implement or recommend the most effective strategy.
- The recommended strategy for each response intends to effectively reduce or eliminate damage and risks caused by the offending animal(s) to resolve conflicts with humans and their valued resources, health, and safety.
- These strategies may be both short-term and/or long-term and are often a combination of lethal and/or non-lethal methodologies to ensure effectiveness.

Objectives:

Each objective listed below (Section 1.5.2) is addressed in the following sections of the EA:

> 1. Professionally and proficiently respond to all reported and verified losses or threats due to predators, using the IPDM approach using the APHIS-WS Decision Model. IPDM must be consistent with all applicable federal, state and local laws, APHIS-WS policies and directives, cooperative agreements, MOUs and other requirements as provided in any decision resulting from this EA.
>
> - **Section 1.8:** Description of how WS-Nevada works with Federal/State agencies and Grazing Boards including cooperative agreements
> - **Section 1.8.2:** MOUs between APHIS-WS and USFS, USFWS, and BLM
> - **Section 1.11.2-1.11.5:** NDOW and USFWS wildlife management plans

- **Section 2.3.1.1:** Description of APHIS-WS Decision Model
- **Section 2.4:** APHIS-WS relevant Directives and policies and, USFWS and NDOW relevant laws and regulations for integrated predator damage management
- **Section 2.4:** Use of APHIS-WS relevant Directives and USFWS and NDOW relevant laws and regulations in integrated predator damage management

2. Implement IPDM so that cumulative effects do not negatively affect the viability of any native predator populations.

- **Section 3.5:** Cumulative effects analysis for native predator populations for predators taken intentionally
- **Section 3.7:** Cumulative effects analysis for native predator populations for predators taken unintentionally
- **Section 3.8:** Cumulative impact analysis for native predator populations related to the potential to cause trophic cascades

3. Ensure that actions conducted within the IPDM strategy fall within the management goals and objectives of applicable wildlife damage management plans or guidance as determined by the jurisdictional state, tribal, or federal wildlife management agency.

- **Section 1.11.2-1.11.5:** USFWS and NDOW management goals and plans for wildlife management in Nevada
- **Section 3.11:** NDOW, USFS, and BLM objectives and management of predator damage in special management areas, including wilderness areas and wilderness study areas
- **Section 3.5:** Intentional take of predators either under USFWS or NDOW authorization or reported to USFWS or NDOW per CFR or state law and regulations

4. Reduce impacts on target and non-target species populations by using the APHIS-WS Decision Model to select the most effective, target-specific, and humane remedies available, given legal, environmental, and other constraints.

- **Section 1.12:** Effectiveness of predator damage management
- **Section 2.3.1.1:** Description of APHIS-WS Decision Model
- **Section 2.4:** APHIS-WS relevant Directives and policies and NDOW relevant laws and regulations for predator damage management
- **Section 3.5:** Impacts of IPDM involving all known intentional and reported lethal takes of native predators

- **Section 3.6 and 3.7:** Impacts of IPDM involving all known unintentional WS-Nevada take of native predators
- **Section 3.6 and 3.7:** Impacts of IPDM involving all known unintentional WS-Nevada takes of non-predator species during IPDM activities
- **Section 3.6:** Impacts of IPDM involving all known unintentional WS-Nevada takes of ESA-listed species
- **Section 3.9:** Analysis of the humaneness of IPDM methods used by WS-Nevada
- **Section 3.10:** Analysis of the impacts of IPDM on the environment and risks to human health and safety

5. Incorporate the use of effective new and existing lethal and non-lethal technologies, where appropriate, into technical and direct assistance strategies.

- **Section 1.12:** Analysis of effectiveness of IPDM activities
- **Section 2.3 and Appendix A:** Description of WS-Nevada IPDM activities, including methods
- **Section 3.9:** Analysis of the humaneness of methods used by WS-Nevada for IPDM

Table 3-24. Comparison of Alternatives in Meeting the Objectives to Support WS-Nevada's Goal to Meet the APHIS-WS Mission of Professionally Supporting the Coexistence of Humans and Wildlife.

Alternative 1 **No Action-Continue WS-Nevada IPDM Assistance Outside of Wilderness and Wilderness Study Areas**	**Alternative 2** **Proposed Action/Modified Current Program.**	**Alternative 3** **Non-lethal IPDM Assistance before Recommending or Applying Lethal IPDM Assistance**	**Alternative 4** **Lethal IPDM Assistance Only for Human/Pet Safety**	**Alternative 5** **No WS-Nevada IPDM Activities**
Objective 1. Professionally and proficiently respond to all reported and verified losses or threats due to predators, using the IPDM approach using the APHIS-WS Decision Model. IPDM must be consistent with all applicable federal, state and local laws, APHIS-WS policies and directives, cooperative agreements, MOUs and other requirements as provided in any decision resulting from this EA.				
Does not meet objective, due to exclusion of WAs or WSAs.	Meets objective	Does not meet all components, as a comprehensive IPDM approach cannot be implemented with predetermined restrictions on lethal methods.	Does not meet objective for non-human or pet health and safety damage requests.	Does not meet objective
Objective 2. Implement IPDM so that cumulative effects do not negatively affect the viability of any native predator populations.				
Meets objective	Meets objective	Meets objective	Meets objective	Does not meet objective
Objective 3. Ensure that actions conducted within the IPDM strategy fall within the management goals and objectives of applicable wildlife damage management plans or guidance as determined by the jurisdictional state, tribal, or federal wildlife management agency.				
Meets objective under constraints of the alternative (e.g., does not meet objectives where protection of livestock, natural resources and property is included in	Meets objective	Meets objective except where non-lethal methods are inappropriate according to partner agency management objectives, plans or guidance. (E.g., administrative removal of mountain lions).	Meets objective for Human/Pet Health and Safety and T&E species protection. Meets objectives for needs to protect agriculture, property and natural resource except where lethal IPDM is indicated	Not applicable.

partner agency management objectives, plans or guidance).			in partner agency management objectives, plans or guidance.	
Objective 4. Reduce impacts on target and non-target species populations by using the APHIS-WS Decision Model to select the most effective, target-specific, and humane remedies available, given legal, environmental, and other constraints.				
Meets objective.	Meets objective	Does not meet objective.	Does not meet objective.	Not applicable
Objective 5. Incorporate the use of effective new and existing lethal and non-lethal technologies, where appropriate, into technical and direct assistance strategies.				
Meets objective.	Meets objective	Meets objective	Meets objective.	Does not meet objective
Total Objectives Met				
4	5	3	3	0

4 Literature Cited

Ables, E.D. 1969. Activity studies of red foxes in southern Wisconsin. Journal of Wildlife Management 33:145-153.

Ackerman, B.B., F.G. Lindzey, and T.P. Hemker. 1984. Cougar food habits in southern Utah. Journal of Wildlife Management 48:147-155.

Adler, B., and A. de la Peña Moctezuma. 2010. Leptospira and leptospirosis. Veterinary Microbiology 140:287-296.

Agency for Toxic Substances and Disease Registry. 2006. Toxicological profile for cyanide. United States Department of Health and Human Services - Public Health Service - Agency for Toxic Substance and Disease Registry.

_____. 2012. Toxicological profile for carbon monoxide. United States Department of Health and Human Services - Public Health Service - Agency for Toxic Substance and Disease Registry.

_____. 2016. Toxicological profile for lead. U.S. Department of Health and Human Services, Public Health Service. https://www.atsdr.cdc.gov/csem/csem.asp?csem=7&po=8

Allen, B. L., A. Fawcett, A. Anker, R. M. Engeman, S. Lisle, and L. K. P. Leung. 2018. Environmental effects are stronger than human effects on mammalian predator-prey relationships in arid Australian ecosystems. Science of the Total Environment 610-611451-461.

Allen, B. L., G. Lundie-Jenkins, N. D. Burrows, R. M. Engeman, and P. Fleming. 2014. Does lethal control of top-predators release mesopredators? A re-evaluation of three Australian case studies. Ecological Management & Restoration 15(3):191-195.

Allen, B. L., L. R. Allen, H. Andrén, G. Ballard, L. Boitani, R. M. Engeman, P. J. S. Fleming, A. T. Ford, P. M. Haswell, R. Kowalczyk, J. D. C. Linnell, D. L. Mech, and D. M. Parker. 2017. Can we save large carnivores without losing large carnivore science? Food Webs 1264-75.

Allen, S. H., and A. B. Sargeant. 1993. Dispersal patterns of red foxes relative to population density. Journal of Wildlife Management 57(3):526-533.

Allen, S.H., J.O. Hastings, and S.C. Kohn. 1987. Composition and stability of coyote families and territories in North Dakota. Prairie Naturalist 19:107-114.

Alonso, A., and J. A. Camargo. 2006. Toxicity of nitrite to three species of freshwater invertebrates. Environmental Toxicology 21(1):90-94.

Alstatt, A.L. 1995. The Potential impact of raven predation on sage-grouse production in Nevada. M.S. Thesis. University of Nevada, Reno, Nevada, USA.

American Society of Mammalogy - Animal Care and Use Committee. 1998. Guidelines for the capture, handling, and care of mammals as approved by the American Society of Mammalogists. Journal of Mammalogy 79(4):1416-1431.

American Veterinary Medical Association. 2004. Animal welfare forum: management of abandoned and feral cats. Journal of the American Veterinary Medical Association 225(9):1349-1383.

_____. 2012. U.S. pet ownership & demographics sourcebook. American Veterinary Medical Association, Schaumburg, Illinois, USA.

_____. 2020. AVMA Guidelines for the Euthanasia of Animals: 2020 Edition. https://www.avma.org/KB/Policies/Documents/euthanasia.pdf

_____. 2019. AVMA Guidelines for the Depopulation of Animals: 2019 Edition. https://www.avma.org/sites/default/files/resources/AVMA-Guidelines-for-the-Depopulation-of-Animals.pdf

Andelt, W. F., R. L. Phillips, R. H. Schmidt, and R. B. Gill. 1999. Trapping furbearers: An overview of the biological and social issues surrounding a public controversy. Wildlife Society Bulletin 27(1):53-64.

Anderson, A. E. 1983. A critical review of literature on puma (Felis concolor). Colorado Division of Wildlife. Special Report 54. Denver, Colorado, USA.

Andersen, D. E., O. J. Rongstad, and W. R. Mytton. 1989. Response of nesting red-tailed hawks to helicopter overflights. Condor 91:296-299.

Anderson, C.R., and F.G. Lindzey. 2003. Estimating cougar predation rates from GPS location clusters. Journal of Wildlife Management 67:307-316.

Andreason, A.M., K.M. Stewart, W.S. Longland, J.P. Beckmann, and M.L. Forister. 2012. Identification of source-sink dynamics in mountain lions of the Great Basin. Molecular Ecology 21:5689-5701.

Andrews, R. D., G. L. Storm, R. L. Phillips, and R. A. Bishops. 1973. Survival and movements of transplanted and adopted red fox pups. Journal of Wildlife Management 37(1):69-72.

APHIS-WS. 2015. Feral Swine Damage Management: A National Approach. http://www.regulations.gov/#!docketDetail;D=APHIS-2013-0031.

APHIS-WS. 2016. Plague and Tularemia Procedures Manual. United States Department of Agriculture, Animal and Plant Health Inspection Service, Fort Collins, Colorado, USA.

APHIS-WS. 2019. Wildlife Services Strategic Plan (2020-2024). U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, Washington, D.C., USA. https://usdagcc.sharepoint.com/sites/aphis-ws/StrategicPlanDevelopment/Shared%20Documents/WS%20Strategic%20Plan%20FY2020-2024%20FINAL%209%2010%202019.pdf

Arim, M. and P.A. Marquet. 2004. Intraguild predation: A widespread interaction related to species biology. Ecology Letters 7:557-564.

Arjo, W. M., D. H. Pletscher, and R. R. Ream. 2002. Dietary overlap between wolves and coyotes in northwestern Montana. Journal of Mammalogy 83:754–766.

Arrington, O.N., and A.E. Edwards. 1951. Predator control as a factor in antelope management. Transactions of the North American Wildlife Conference 16:179-193.

Ashman, D., G.C. Christensen, M.L. Hess, G.K. Tsukamoto, and M.S. Wickersham. 1983. The mountain lion in Nevada. Nevada Department of Wildlife, Reno, Nevada, USA.

Association of Fish and Wildlife Agencies. 2006. Policies and guidelines for Fish and Wildlife Management in National Forest and Bureau of Land Management Wilderness. June 2006.

Atamian, M., J. Sedinger, and C. Frey. 2007. Dynamics of Greater Sage-grouse (Centrocercus urophasianus) Populations in Response to Transmission Lines in Central Nevada. Progress Report: Year 5. Department of Natural Resources and Environmental Sciences, University of Nevada, Reno, NV 89512.

Atwood, T. C., B. G. Marcot, D. C. Douglas, S. C. Amstrup, K. D. Rode, G. M. Durner, and J. F. Bromaghin. 2016. Forecasting the relative influence of environmental and anthropogenic stressors on polar bears. Ecosphere 7:1-22.

Atwood, T.C. and E. M. Gese. 2008. Coyotes and recolonizing wolves: Social rank mediates risk-conditional behavior at ungulate carcasses. Animal Behavior 75:75762.

Atwood, T. C., E. M. Gese, and K. E. Kunkel. 2007. Comparative patterns of predation by cougars and recolonizing wolves in Montana's Madison Range. Journal of Wildlife Management 71:1098-1106.

Atwood, T. C., E. Peacock, M. A. McKinney, K. Lillie, R. Wilson, D. C. Douglas, S. Miller, and P. Terletzky. 2016. Rapid environmental change drives increased land use by an Arctic marine predator. PLoS ONE 11:1–18.

Australian Bureau of Statistics. 2013. Statistical language- Correlation and causation. http://www.abs.gov.au/websitedbs/a3121120.nsf/home/statistical+language+-+correlation+and+causation.

Bailey, T.N. 1974. Social organization in a bobcat population. Journal of Wildlife Management 38:435- 446.

Baker, R.H., and M.W. Baker. 1975. Montane habitat used by the spotted skunk (Spilogale putorius) in Mexico. Journal of Mammalogy 56:671-673.

Ballard, W. B., L. A. Ayres, P. R. Krausman, D. J. Reed, and S. G. Fancy. 1997. Ecology of wolves in relation to a migratory caribou herd in northwest Alaska. Wildlife Monographs 135. 47 pp.

Ballard, W.B., D.L. 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.

Balvanera, P., A. B. Pfisterer, N. Buchmann, J.-S. He, T. Nakashizuka, D. Raffaelli, and B. Schmid. 2006. Quantifying the evidence for biodiversity effects on ecosystem functioning and services. Ecology Letters 9:1146-1156.

Bartmann, R. M., G. C. White, and L. H. Carpenter. 1992. Compensatory Mortality in a Colorado Mule Deer Population. Wildlife Monographs 1213-39.

Bartush, W.S. 1978. Mortality of white-tailed deer fawns in the Wichita Mountains, Comanche County, Oklahoma, Part II. Thesis, Oklahoma State University, Stillwater, USA.

Batcheller, G. R., T. A. Decker, D. A. Hamilton, and J. F. Organ. 2000. A vision for the future of furbearer management in the United States. Wildlife Society Bulletin 28(4):833-840.

Batterson, W. M., and W. B. Morse. 1948. Oregon sage grouse. Oregon State Game Commission. Oregon Fauna 1. Portland, Oregon, USA.

Beasley, J.C., and O.E. Rhodes. 2012. Are raccoons limited by the availability of breeding resources? Evidence of variability in fecundity at fine spatial scales. Journal of Wildlife Management 76:1718-1724.

Beasom, S.L. 1974. Relationships between predator removal and white-tailed deer net productivity. Journal Wildlife Management 38:854-859.

Beck, J. L., and D. L. Mitchell. 2000. Influences of livestock grazing on sage grouse habitat. Wildlife Society Bulletin 28(4):993-1002.

Bedrosian, B. 2005. Nesting and post-fledging ecology of the common raven in Grand Teton National Park. M.S. Thesis. Arkansas State University, Jonesboro, Arkansas, USA.

Beier, P. 1991. Cougar attacks on humans in the United States and Canada. Wildlife Society Bulletin 19:403-412. In: ODFW (Oregon Department of Fish and Wildlife). 2006. Oregon Cougar Management Plan. http://www.dfw.state.or.us/wildlife/cougar/docs/cougarPLAN-Final.pdf.

_____. 1992. Cougar attacks on humans: an update and some further reflections. Proc. 15th Vertebrate Pest Conf. (J. E. Borrecco & R. E. Marsh, Editors) Published at University of Calif., Davis. 1992.

Beier, P., and R.H. Barrett. 1993. The cougar in the Santa Ana Mountain Range, California. Orange County Cooperative Mountain Lion Study, Final Report. University of California, Berkeley, USA.

Bekoff, M. 2002. The importance of ethics in conservation biology: Let's be ethicists not ostriches. Endangered Species Update 19:23-26.

Bekoff, M., and M.C. Wells. 1980. The social ecology of coyotes. Scientific American 242:130-148.

_____. 1982. Behavioral ecology of coyotes: Social organization, rearing patterns, space use, and resource defense. Zietschrift für Tierpsychologie 60281-305.

Benson, J.F., K.M. Loveless, L.Y. Rutledge, and B.R. Patterson. 2017. Ungulate predation and ecological roles of wolves and coyotes in eastern North America. Ecological Applications 27:718-733.

Bentz, T., S. Lapidge, D. Dall, and R. G. Sinclair. 2007. Managing starlings in Australia – Can DRC- 1339 be the answer? Pages 361 to 364 *in* G. W. Witmer, W. C. Pitt, and K. A. Fagerstone, editors. Proceedings from an International Symposium – Managing Vertebrate Invasive Species. USDA/APHIS/WS, National Wildlife Research Center, Fort Collins, Colorado, USA.

Berger, K.M. 2006. Carnivore-livestock conflicts: Effects of subsidized predator control and economic correlates on the sheep industry. Conservation Biology 20:751-761.

Berger, K.M., and E.M. Gese. 2007. Does interference competition with wolves limit the distribution and abundance of coyotes? Journal of Animal Ecology, 76:1075-1085.

Berger, K.M. E.M. Gese, and J. Berger. 2008. Indirect effects and traditional trophic cascades: A test involving wolves, coyotes, and pronghorn. Ecology 89:818-828.

Berger-Tal, O., T. Polak, Oron A., Y. Lubin, B. P. Kotler, and D. Saltz. 2011. Integrating animal behavior and conservation biology: A conceptual framework. Behavioral Ecology 22:236-239.

Bergerud, A. T. 1988. Increasing the numbers of grouse. Pages 686-731 in A. T. B. a. M. W. Gratson. Adaptive Strategies and Population Ecology of Northern Grouse. University of Minnesota Press. Minneapolis, Minnesota, USA.

Bergman, D., S. Breck, and S. Bender. 2009. Dogs gone wild: Feral dog damage in the United States. In: Boulanger, J.R., Ed. Proc. 13th Wildlife Damage Management Conference, Pp. 177-183.

Bergstrom, B.J., L.C. Arias, A.D. Davidson, A.W. Ferguson, L.A. Randa, and S.R. Sheffield. 2014. License to kill: Reforming federal wildlife control to restore biodiversity and ecosystem function. Conservation Letters 7:131-142.

Bergstrom, D.M., A. Lucieer, K. Kiefer, J. Wasley, L. Belbin, T.K. Pedersen, and S.L. Chown. 2009. Indirect effects of invasive species removal devastate World Heritage Island. 2009. Journal of Applied Ecology 46:73-81.

Beschta, R.L. and W.J. Ripple. 2012. The role of large predators in maintaining riparian plant communities and river morphology. Geomorphology 157-158:88-98.

Bino, G., A. Dolev, D. Yosha, A. Guter, R. King, D. Saltz, and S. Kark. 2010. Abrupt spatial and numerical responses of overabundant foxes to a reduction in anthropogenic resources. Journal of Applied Ecology 47:1262-1271.

Birhane, M.G., J.M. Cleaton, B.P. Monroe, A. Wadhwa, L.A. Orciari, P. Yager, J. Blanton, A. Velasco-Villa, B.W. Petersen, and R.M. Wallace. 2017. Ravies surveillance in the United States during 2015. Journal of the American Veterinary Medical Association 250(10):1117-1130.

Bishop, C. J., G. C. White, D. J. Freddy, and B. E. Watkins. 2009. Effect of enhanced nutrition on mule deer population rate of change. Wildlife Monographs 1721-28.

Bishop, R. C. 1987. Economic values defined. Pages 24-33 in D. J. Decker, and G. R. Goff| Book Title. |Publisher|, Place Published|.

Bixler, A., and J. L. Gittleman. 2000. Variation in home range and use of habitat in the striped skunk (Mephitis mephitis). Journal of Zoology 251:525-533.

Bjorge, R.R., J.R. Gunson, and W.M. Samuel. 1981. Population characteristics and movements of striped skunks (Mephitis mephitis) in central Alberta. Canadian Field Naturalist 95:149-155.

Blejwas, K.M., B.N. Sacks, M.M. Jaeger, and D.R. McCullogh. 2002. The effectiveness of selective removal of breeding coyotes in reducing sheep predation. Journal of Wildlife Management 66:451-462.

Boarman, W.I. 1993. When a native predator becomes a pest: a case study. Pages 191-206 in Majumdar, S. K., E. W. Miller, D. E. Baker, E. K. Brown, J. R. Pratt, and R. F. Schmalz.

Boarman, W. I. and B. Heinrich. 1999. Common raven. in Birds of North America, No. 476, Cornell Lab. Ornithology and the Academy of Natural Science, A. Poole and F. Gill eds. 31 pp.

Boddicker, M. L. 1980. Managing Rocky Mountain furbearers. Colorado Trapper's Association, LaPorte, Colorado, USA.

Bodenchuk, M.J., and D.J. Hayes. 2007. Predation impacts and management strategies for wildlife protection. Pages 221-263 In:. Elewa, A.M.T, Ed. Predation in organisms: A distinct phenomenon. Springer and Verlag, Heidelberg, Germany.

Bodenchuk, M J., J.R. Mason, and W.C. Pitt. 2002. Economics of predation management in relation to agriculture, wildlife, and human health and safety. Pages 80-90 in Clark, L., J. Hone, J. A. Shivik, R. A. Watkins, K. C. Vercauteren, and J. K. Yoder, editors. Human conflicts with wildlife: economic considerations. Proc. 3rd NWRC Special Symposium. National Wildlife Research Center, Fort Collins, Colorado, USA.

Boertje, R.D. and R.O. Stephenson. 1992. Effects of ungulate availability on wolf reproduction potential in Alaska. Canadian Journal of Zoology 70:2441-2443.

Bonnell, M.A. and S.W. Breck. 2017. Using resident-based hazing programs to reduce human-coyote conflicts in urban environments. Human-Wildlife Interactions 11(2): 146-155, Fall 2017.

Borer, E.T. E.W. Seabloom, J.B. Shurin, K.E. Anderson, C.A. Blanchette, B. Broitman, S.D. Cooper, and B.S. Halpern. 2005. What determines the strength of a trophic cascade? Ecology 86:528-537.

Born Free USA. 2017. State bounty laws by state. www.bornfreeusa.org/b4a2_bounty.php. 11-13-2017.

Botsford, L. W. 2016. Maximum sustainable yield. http://www.oxfordbibliographies.com/view/document/obo-9780199830060/obo-9780199830060-0071.xml. 11-11-2017.

Boyd, D.K., P.C. Paquet, S. Donelson, R.R. Ream, D.H. Pletscher, and C.C. White. 1995. Transboundary movements of a colonizing wolf population in the Rocky Mountains. Eds. L.N. Carbyn, S.H.Fritts and D.R. Seip. Ecology and conservation of wolves in a changing world. Edmonton, Alberta, Canada.

Bradley, E. H., H. S. Robinson, E. E. Bangs, K. Kunkel, M. D. Jimenez, J. A. Gude, and T. Grimm. 2015. Effects of wolf removal on livestock depredation recurrence and wolf recovery in Montana, Idaho, and Wyoming. Journal of Wildlife Management 79(8):1337-1346.

Brashares, J.S., L.R. Prugh, C.J. Stoner, and C.W. Epps. 2010. Ecological and Conservation Implications of mesopredator release. In: Terborgh, J., and J.A. Estes, Eds. Trophic Cascades: Predators, Prey, and the Changing Dynamics of Nature. Island Press. P. 221-240.

Breck, S.W., S.A. Breck, and M.A. Bonnell. 2017. Evaluating lethal and nonlethal management options for urban coyotes. Human-Wildlife Interactions 11(2): 133-145, Fall 2017.

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). Journal of Wildlife Diseases 39(3): 638-648.

Briggs, C.J. and E.T. Borer. 2005. Why short-term experiments may not allow long-term predictions about intraguild predation. 15:1111-1117. DOI: 10.1111/j.1365-2664.2012.02207.x

Broadfoot, J.D., R.C. Rosatte, and D T. O'Leary. 2001. Raccoon and skunk population models for urban disease control planning in Ontario, Canada. Ecological Applications 11:295-303.

Brodie, J., H. Johnson, M. M. Mitchell, P. Zager, K. M. Proffitt, M. Hebblewhite, M. Kauffman, B. Johnson, J. Bissonette, C. Bishop, J. Gude, J. Herbert, K. Hersey, M. Hurley, P. M. Lukacs, S. McCorquodale, E. McIntire, J. Nowak, H. Sawyer, D. Smith, and P. J. White. 2013. Relative influence of human harvest, carnivores, and weather on adult female elk survival across western North America. Journal of Applied Ecology 50(2):295-305.

Bromley, C and E.M. Gese. 2001a. Surgical sterilization as a method of reducing coyote predation on domestic sheep. Journal of Wildlife Management 65:510-519.

_____. 2001b. Effects of sterilization on territory fidelity and maintenance, pair bonds, and survival rates of free-ranging coyotes. Canadian Journal of Zoology 79:386-392.

Brook, L.A., C.N. Johnson, and E.G. Ritchie. 2012. Effects of predator control on behavior of an apex predator and indirect consequences of mesopredator suppression. Journal of Applied Ecology 49:1278-1286.

Brown, D.E. and M.R. Conover. 2011. Effects of large-scale removal of coyotes on pronghorn and mule deer productivity and abundance. Journal of Wildlife Management 75:876-882.

Bruscino, M.T. and T.L. Cleveland. 2004. Compensation programs in Wyoming for livestock depredation by large carnivores. Sheep & Goat Research Journal 19:47-49.

Bui, T.D. 2009. The effects of nest and brood predation by common ravens (*Corvus corax*) on greater sage-grouse (Centrocercus urophasianus) in relation to land use in western Wyoming. M.S. Thesis. University of Washington, Seattle, Washington, USA.

Bull, E.L., and T.W. Heater. 2001. Survival, causes of mortality, and reproduction in the American marten in northeastern Oregon. Northwestern Naturalist 82:1-6.

Bulte, E.H. and D. Rondeau. 2005. Research and management viewpoint: Why compensating wildlife damages may be bad for conservation. Journal of Wildlife Manaagement 75:14-19.

Bunnell, K.D., and J.T. Flinders. 1999. Restoration of sage grouse in Strawberry Valley, Utah 1998. Utah State Forest Service-Utah Division of Wildlife Resources, Provo, Utah, USA.

Bureau of Land Management. 1988. Manual 6830 - Animal Damage Control. Bureau of Land Management.

_____. 2012a. Manual 6330-Management of Wilderness Study Areas (public). United States Department of the Interior-Bureau of Land Management.

_____. 2012b. Manual 6340 – Management of designated wilderness areas (public). United States Department of the Interior - Bureau of Land Management.

_____. 2018a. Nevada National Conservation Lands - National Monuments. United States Department of Interior - Bureau of Land Management. https://www.blm.gov/programs/national-conservation-lands/nevada (accessed 8/29/2018).

_____. 2018b. Nevada National Conservation Lands - Wilderness areas. United States Department of Interior - Bureau of Land Management.

https://www.blm.gov/programs/national-conservation-lands/nevada (accessed 08/29/2018).

_____. 2018c. Nevada National Conservation Lands - Wilderness study areas. United States Department of Interior - Bureau of Land Management. https://www.blm.gov/programs/national-conservation-lands/nevada (accessed 08/29/2018).

_____. 2018d. Programs - Planning and NEPA – Areas of Critical Environmental Concern. https://www.blm.gov/programs/planning-and-nepa/planning-101/special-planning-designations/acec (accessed 08/29/2018).

Burkepile, N.A., K.P. Reese, and J.W. Connelly. 2001. Mortality patterns of sage grouse in chicks in Southeast Idaho. Annual Meeting of the Idaho Chapter of Wildlife Society. Boise, Idaho, USA.

Burns, R.J. 1980. Evaluation of conditioned predation aversion for controlling coyote predation. Journal of Wildlife Management 44:938-942.

_____. 1983. Coyote predation aversion with lithium chloride: management implications and comments. Wildlife Society Bulletin 11:128-133.

Burns, R.J. and G.E. Connolly. 1980. Lithium chloride aversion did not influence prey killing in coyotes. Proceeding of the Vertebrate Pest Conference 9:200-204.

_____. 1985. A comment on "coyote control and taste aversion." Appetite 6:276-281.

Burt, W.H., and R.P. Grossenheider. 1980. Peterson Field Guides: Mammals. 4th edition. Houghton Mifflin Company, NY, NY.

Cade, T. J. 2007. Exposure of California Condors to lead from spent ammunition. J. Wildl. Manage.71: 2125–2133.

California Department of Fish and Game. 1995. Furbearing and nongame mammal hunting and trapping. Final Environmental Impact Report. 164 p.

California Department of Fish and Wildlife. 2014. Verified mountain lion attacks on humans in California (1986 through 2014). <https://www.wildlife.ca.gov/Conservation/Mammals/Mountain-Lion/Attacks>. Accessed 2 April 2019.

_____. 2015a. Coyote incidents in southern California prompt precautionary reminders. <https://cdfgnews.wordpress.com/2015/07/08/coyote-incidents-in-southern-california-prompt-precautionary-reminders/>. Accessed 2 April 2019.

_____. 2015b. Number of depredation permits issued and black bears taken 2006-2014. California Department of Fish and Wildlife.

_____. 2016. Lion depredation totals in California: 2001-2016. California Department of Fish and Wildlife.

Callan, R, N.P. Nibbelink, T.P. Rooney, J.E. Weidenhoeft, and A.P, Wydeven. 2013. Recolonizing wolves trigger a trophic cascade in Wisconsin (USA). Journal of Ecology 101:837-845.

Camenzind, F. J. 1978. Behavioral ecology of coyotes on the National Elk Refuge, Jackson, Wyoming. In: M. Bekoff, Ed. Coyotes: Biology, behavior and management. Academic Press, New York. Pp. 267-294.

Camus, A.C., M.M. Mitchell, J.E. Williams and P.L.H. Jowett. 1998. Elevated lead levels in farmed American Alligators, Alligator mississippiensis, consuming nutria, Myocastor coypus, meat contaminated by lead bullets. Journal of World Aquatic Society 29: 370-376.

Canadian Broadcasting Company. 2009. "Coyotes kill Tortonto singer in Cape Breton". https://www.cbc.ca/news/canada/nova-scotia/coyotes-kill-toronto-singer-in-cape-breton-1.779304. Accessed April 02, 2019.

Cashman, J.L., M. Pierce, and P.R. Krausman. 1992. Diets of mountain lions in southwestern Arizona. Southwest Naturalist 37: 324-326.

Cassirer, E.F. 2004. The Hells Canyon Initiative. Hells Canyon Bighorn Sheep Restoration Plan. Lewiston, Idaho, USA.

Casula, P., A. Wilby, and M.B. Thomas. 2006. Understanding biodiversity effects on prey in multi-enemy systems. Ecology Letters 9:995-1004. doi: 10.1111/j.1461-0248.2006.00945.x

Caudell, J. N., S.R. Stopak, and P.C. Wolf. 2012. Lead-free, high-powered rifle bullets and their applicability in wildlife management. Human–Wildlife Interactions 6:105–111.

Center for Disease Control and Prevention. 2011. Rabies. <https://www.cdc.gov/rabies/transmission/index.html>. Accessed 2 April 2019.

_____. 2014. Update on Blood Lead Levels in Children (http://www.cdc.gov/nceh/lead/ACCLPP/blood_lead_levels.htm), last accessed 2/5/14.

_____. 2016. Healthy pets, Healthy People, Dogs, Diseases. https://www.cdc.gov/healthypets/pets/dogs.html. Accessed 4 April 2019.

Chen, T.H., J.A. Gross and W.H. Karasov. 2006. Sublethal effects of lead on northern leopard frog (Rana pipiens) tadpoles. Environmental Toxicology Chemistry 25:1383-1389.

Chinitz, A.E. 2002. Laying the groundwork for public participation in cougar management: a case study of southwestern Oregon (Puma concolor). Thesis, University of Oregon, Eugene, USA. In: ODFW (Oregon Department of Fish and Wildlife). 2006. Oregon Cougar Management Plan. http://www.dfw.state.or.us/wildlife/cougar/docs/cougarPLAN-Final.pdf.

Clark, F.W. 1972. Influence of jackrabbit density on coyote population change. Journal of Wildlife Management 36:343-356.

Clark, J. P. 1986. Vertebrate pest control handbook. Division of Plant Industry, California Department of Food and Agriculture, Sacramento, California, USA.

Clark, W.R., and R.D. Andrews. 1982. Review of population indices applied in furbearer management. Proc. Symposium of the Midwest Fish and Wildlife Conference, Wichita, Kansas, 43:11-22.

Cleland, E. 2011. Biodiversity and ecosystem stability. Nature Education Knowledge 3:14. http://www.nature.com/scitable/knowledge/library/biodiversity-and-ecosystem-stability-17059965.

Coates, P. S. 2006. DRC-1339 egg baits: preliminary evaluation of their effectiveness in removing ravens. Proceedings of the Vertebrate Pest Conference 22: 250-255.

Coates, P. S. 2007. Greater Sage-Grouse (Centrocercus Urophasianus) Nest Predation and Incubation Behavior. A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Biology. Idaho State University May 2007.

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 7(2):1-20.

Coates, P.S., J.W. Connelly, and D.J. Delehanty. 2008. Predators of greater sage-grouse nests identified by video monitoring. Journal of Field Ornithology. 79(4):421-428.

Coates, P.S., and D.J. Delehanty. 2001. Progress report: Columbian sharp-tailed grouse reintroduction in northeastern Nevada. Nevada Division of Wildlife. Reno, Nevada, USA

_____. 2010. Nest predation of greater sage-grouse in relation to microhabitat factors and predators. Journal of Wildlife Management. 74(2):240-248.

Coates, P.S., K.B. Howe, M.L. Casazza, and D.J. Delehanty. 2014. Common raven occurrence in relation to energy transmission line corridors transiting human-altered sagebrush steppe. Journal of Arid Environments. 111:68-78.

Coates, P.S., J.O. Spencer Jr. and D.J. Delehanty. 2007. Efficacy of CPTH-treated egg baits for removing ravens. Human-Wildlife Conflicts 1(2):224-234.

Connelly, J.W., and C.E. Braun. 1997. Long-term changes in sage-grouse *Centrocercus urophasianus* population in western North America. Wildlife Biology. 3:229-234.

Connelly, J.W., S.T. Knick, M.A. Schroeder, and S.J. Stiver. 2004. Conservation assessment of greater sage-grouse and sagebrush habitats. 2004. Western Association of Fish and Wildlife Agencies, Cheyenne, Wyoming, USA.

Connelly, J.W., M.A. Schroeder, A.R. Sands, and C.E. Braun. 2000. Guidelines to manage sage grouse populations and their habitats. Wildlife Society Bulletin. 28:967-985.

Connolly, G.E. 1978. Predators and predator control. Pages 369-394 In: Schmidt J. L. and D. L. Gilbert, Eds. Big Game of North America: Ecology and Management. Wildlife Management Institute.

_____. 1981. U.S. Fish and Wildlife Service coyote control research. Pages 132-149 in Great Plains Wildlife Damage Control Workshop Proceedings, Paper 115.

_____. 1988. M-44 sodium cyanide ejectors in the animal damage control program, 1976-1986. Proceedings of the Vertebrate Pest Conference 13:220-225.

_____. 1992. Coyote damage to livestock and other resources. Pages 161-169 In: Boer, A.H., Ed. Ecology and Management of the Eastern Coyote. University of New Brunswick, Fredericton, Canada.

_____. 1995. The effects of control on coyote populations another look. Pages 23-29 In: Rollins, D., C. Richardson, T. Blankenship, K. Canon, S. Henke, Eds. Proc. Symposium on Coyotes in the Southwest: A Compendium of our Knowledge. Texas Parks and Recreation Department.

Connolly, G.E., and W.M. Longhurst. 1975. The effects of control on coyote populations. University of California, Division of Agricultural Science, Davis, California, USA.

Conomy, J. T., J. A. Collazo, J. A. Dubovsky, W. J. Fleming. 1998. Dabbling duck behavior and aircraft activity in coastal North Carolina. Journal of Wildlife Management 62(3):1127-1134.

Conover, M.R., J.G. Francik, and D.E. Miller. 1977. An experimental evaluation of aversive conditioning for controlling coyote predation. Journal of Wildlife Management 41:775-779.

Conover, M.R., W.C. Pitt, K.K. Kessler, T.J. DuBow, and W.A. Sanborn. 1995. Review of human injuries, illnesses, and economic losses caused by wildlife in the United States. Wildlife Society Bulletin 23:407-414.

Conover, M.R., and A.J. Roberts. 2016. Declining populations of greater sage-grouse: where and why. Human-Wildlife Interactions 10(2):217-229.

Copeland, J., K. McGowan, F. Mellissa, and L. Niell. 2014. Nevada greater sage-grouse conservation plan. State of Nevada-Sagebrush Ecosystem Program. Nevada, USA.

Cornicelli, L. and M. Grund. 2009. Examining Variability Associated With Bullet Fragmentation and Deposition in White-Tailed Deer and Domestic Sheep: Preliminary Results. Minnesota Department of Natural Resources (FSEIS ammunition.docxhttp://www.dnr.state.mn.us/hunting/lead/short-summary.html) last accessed 2/5/14.

Cougar Management Guidelines Working Group. 2005. Cougar Management Guidelines. WildFutures, Washington, USA.

Council on Environmental Quality. 2005. Guidance on the consideration of the consideration of past actions in cumulative effects analysis. Council on Environmental Quality. Washington, D.C., USA.

Courchamp F., J-L. Chapuis, and M. Pascal. 2003. Mammal invaders on islands: Impact, control, and control impact. Biological Review 78:347-383.

Courchamp, M.F., M. Langlais, and G. Sugihara, G. 1999. Cats protecting birds: modeling the mesopredator release effect. Journal of Animal Ecology. 68:282–292.

Crabb, W.D. 1948. The ecology and management of the prairie spotted skunk in Iowa. Ecological Monographs 18:201-232.

Crabtree, R.L., and M L. Wolfe. 1988. Effects of alternate prey on skunk predation of waterfowl nests. Wildlife Society Bulletin 16:163-169.

Crabtree, R.L., L.S. Broome, and M.L. Wolfe. 1989. Effects of habitat characteristics on gadwall nest predation and nest-site selection. Journal of Wildlife Management 53:129–137.

Craighead, D. and B. Bedrosian. 2008. Blood lead levels of common ravens with access to big game offal. Journal of Wildlife Management 72:240-245.

Creed, R.F.S. 1960. Gonad changes in the wild red fox (Vulpes vulpes crucigera). Journal of Physiology (London) 151:19-20.

Creel, S., and J. A. Winnie. 2005. Responses of elk herd size to fine-scale spatial and temporal variation in the risk of predation by wolves. Animal Behavior 69:1181-1189.

Crooks, K.R. 1994. Demography and status of the island fox and the island spotted skunk on Santa Cruz Island, California. Southwestern Naturalist, 39:257-262.

_____. 2002. Relative sensitivities of mammalian carnivores to habitat fragmentation. Conservation Biology 16:488-502.

Crooks, K.R., and D.Van Vuren. 1995. Resource utilization by two insular endemic mammalian carnivores, the island fox and island spotted skunk. Oecologia 104:301-307.

Crooks, K.R., and M.E. Soulé. 1999. Mesopredator release and avifaunal extinctions in a fragmented system. Nature 400:563-566.

Crowe, D.M. 1975. A model for exploited bobcat populations in Wyoming. Journal of Wildlife Management 39:408-415.

Cruz-Martinez, L. P. T. Redig and J. Deen. 2012. Lead from spent ammunition: a source of exposure and poisoning in bald eagles. Human-wildlife Interactions 6:94-104.

Cullen, G., A. Dines, and S. Kolev. 1996. Lead. National Poisons Information Service, United Kingdom Departments of Health. London, UK.

Cunningham, C. J., E.W. Schafer, and K. McConnell. 1979. DRC-1339 and DRC-2698 residues in starlings: preliminary evaluation of their effects on secondary hazard potential. Wildlife Damage Management, Internet Center for Bird Control Seminars Proceedings, University of Nebraska, Lincoln, Nebraska, USA.

Cypher, B.L. 2003. Foxes. In: Feldhamer, G.A., B.C. Thompson, and J.A. Chapman, Eds. Wild Mammals of North America: Biology, Management, and Conservation. John Hopkins University Press, Baltimore, Maryland, USA. Pp. 511–546.

Danner, D.A. and N.S. Smith. 1980. Coyote home range, movements, and relative abundance near cattle feedyard. Journal of Wildlife Management 44:484-487.

Danvir, R.E. 2002. Sage Grouse Ecology and Management in Northern Utah Sagebrush-Steppe. Deseret Land and Livestock Wildlife Research Report. 40 pp.

Darrow, P.A., R.T. Skirpstunas, S.W. Carlson, and J.A. Shivik. 2009. Comparison of injuries to coyotes from 3 types of cable foot-restraints. Journal of Wildlife Management 73:1441-1444.

Daugherty, M.P., J.P. Harmon, and C.P. Briggs. 2007. Trophic supplements to intraguild predation. Ecological Applications 15:1111-1117.

Davidson, G.A., D.A. Clark, B.K. Johnson, L.P. Waits, and J.R. Adams. 2014. Estimating cougar densities in northeast Oregon using conservation detection dogs. Journal of Wildlife Management 78:1104-1114.

Davidson, G.A., D.A. Clark, B.K. Johnson, L.P. Waits, and J R. Adams. 2015. A second trial of using conservation detection dogs to estimate cougar populations in northeastern Oregon. Technical Report. Oregon Department of Fish and Wildlife, Salem, OR.

Davis, W.B. 1945. Texas skunks. Texas Game and Fish 3:25-26.

Dawes, J. 2006. Is the use of DRC-1339 humane? Unpublished Pestat Ltd report. March 2006. 5pp.

DeCalesta, D.S. 1978. Documentation of livestock losses to predators in Oregon. Oregon State University Extension Service, Special Report 501, Corvallis, USA.

DeCino, T. J., D. J. Cunningham, and E. W. Shafer. 1966. Toxicity of DRC-1339 to starlings. Journal of Wildlife Management 30:249-253.

Decker, D.J., and G.F. Goff. 1987. Valuing Wildlife: Economic and social perspectives. Westview Press. Westview Press 424 pages, Boulder, Colorado, USA.

Delaney, D. K., T. G. Grubb, P. Beier, l. L. Pater, and M. H. Reiser. 1999. Effects of helicopter noise on Mexican spotted owls. Journal of Wildlife Management 63:60-76.

Derocher, A. E. 2004. Polar Bears in a Warming Climate. Integrative and Comparative Biology 44:163–176. <https://academic.oup.com/icb/article-lookup/doi/10.1093/icb/44.2.163>.

Diamond, P.A., and J.A. Hausman. 1994. Contingent valuation: is some number better than no number? Journal of Economic Perspectives 8(4):45-64.

Dillingham, P. W. and D. Fletcher. 2008. Estimating the ability of birds to sustain additional human-caused mortalities using a simple decision rule and allometric relationships. Biol. Cons. 141:1783-1792.

Dinkins, J.B., M.R. Conover, C.P. Kirol, J.L. Beck, and S.N. Frey. 2016a. Effects of common raven and coyote removal and temporal variation in climate on greater sage-grouse nesting success. Biol. Cons. 202:50-58.

Dinkins, J.B., K.T. Smith, J.L. Beck, C.P. Kirol, A.C. Pratt, and M.R. Conover. 2016b. Microhabitat conditions in Wyoming's sage-grouse core areas: effects on nest site selection and success. PLoS ONE. 11(3):1-17.

Dobson, A., Lodge, D., Alder, J., Cumming, G.S., Keymer, J., McGlade, J. 2006. Habitat loss, trophic collapse, and the decline of ecosystem services. Ecology, 87, 1915–1924.

Dolbeer, R.A. 2000. Birds and aircraft: Fighting for airspace in crowded skies. Proceedings of the Vertebrate Pest Conference 19:37-43.

_____. 2009. Birds and aircraft: Fighting for airspace in ever more crowded skies. Human-Wildlife Conflicts 3:165-166.

Dolbeer, R.A., J.R. Weller, A.L. Anderson and M J. Begier. 2016. Wildlife strikes to civil aircraft in the United States 1990-2015. U.S. Department of Transportation, Federal Aviation Administration, Report of the Associate Administrator of Airports, Serial Report Number 22. Washington, D.C., USA.

Dolbeer, R.A., S.E. Wright, J.R. Weller, and M.J. Begier. 2014. Wildlife strikes to civil aircraft in the United States 1990-2013. U.S. Department of Transportation, Federal Aviation Administration, Report of the Associate Administrator of Airports, Serial Report Number 20, Washington, D.C., USA.

Donaldson, C.W. 2003. Paintball toxicosis in dogs. Veterinary Medicine 98:995-997.

Donovan, S., C. Goldfuss and J. Holden. 2015. M-16-01. Memorandum for Executive Departments and Agencies. Dated October 7, 2015. Incorporating Ecosystem Services into Federal Decision Making.

Donovan, T. M., M. Freeman, H. Abouelezz, K. Royar, A. Howard, and R. Mickey. 2011. Quantifying home range habitat requirements for bobcats (Lynx rufus) in Vermont, USA. Biological Conservation 1442799-2809.

Duda, M.D., P.E. DeMichele, M. Jones, W. Testerman, C. Zurawski, J. Dehoff, A. Lanier, S.J. Bissell, P. Wang, and J.B. Herrick. 2002. Washington residents' opinions on and attitudes toward hunting and game species management. Responsive Management, Harrisonburg, Virginia, USA. In: ODFW (Oregon Department of Fish and Wildlife). 2006. Oregon Cougar Management Plan. http://www.dfw.state.or.us/wildlife/cougar/docs/cougarPLAN-Final.pdf.

Duffy, J.E. 2003. Biodiversity loss, trophic skew, and ecosystem functioning. Ecology Letters 6:680-687.

Duffy, J.E., B.J. Cardinale, K.E. France, P.B. McIntyre, E. Thébault, and M. Loreau. 2007. The functional role of biodiversity in ecosystems: Incorporating trophic complexity. Ecology Letters 10:522-538.

Dunbar, M.R., and M.R. Giordano. 2003. Abundance and condition indices of coyotes on Hart Mountain National Antelope Refuge, Oregon. Western North American Naturalist 62:341-347.

Dunk, J.R. 1995. White-tailed kite (Elanus leucurus). The Birds of North America Verison 2 (A.F. Pool and F.B. Gill Eds). Cornell Lab of Ornithology. Ithac, New York, USA.

Dzombak, D.A., R.S. Ghosh, and T.C. Young. 2006. Physical-chemical properties and reactivity of cyanide in water and soil. In: Dzombak, D.A., R.S. Ghosh, and G.M. Wong-Chong. Cyanide in Water and Soil: Chemistry, Risk and Management. CRC Press.

Eddleman, W. R. 1989, Biology of the Yuma clapper rail in the southwestern U.S. and northwestern Mexico, 4-AA-30-02060, U.S. Bureau Of Reclamation, Yuma Project Office, Yuma, AZ

Edelmann, F.B. 2003. Wintering mule deer ecology in the reservoir reach of the Hells Canyon Hydroelectric Complex. Technical Report E 3.2-32, Idaho Power Company, Boise, Idaho, USA. In: ODFW (Oregon Department of Fish and Wildlife). 2006. Oregon Cougar Management Plan. http://www.dfw.state.or.us/wildlife/cougar/docs/cougarPLAN-Final.pdf.

Egoscue, H.J., 1975. Population Dynamics of the kit fox in western Utah. Bulletin of the Southern California Academy of Sciences 74(3):122-127.

Eiler, J.H., W.G. Wathen, and M.R. Pelton. 1989. Reproduction in black bears in the southern Appalachian Mountains. Journal of Wildlife Management 53:353-360.

Eisemann, J.D., Pipas, P.A., and J.L. Cummings. 2003. Acute and chronic toxicity of compound DRC-1339 (3-chloro-4-methylaniline hydrochloride) to birds. Pp. 49-63. In G.M. Linz, ed. Management of North American Blackbirds. USDA-APHIS-WS National Wildlife Research Center, Ft. Collins, CO, USA. Accessed 4/11/2019 @ https://www.aphis.usda.gov/wildlife_damage/nwrc/symposia/blackbirds_symposium/eisemann.pdf

Eisler, R. 1988. Lead hazards to fish, wildlife, and invertebrates: a synoptic review. USGS Contaminant Hazard Reviews Report No. 14. 94 pp.

Elbroch, L.M., P.E. Lendrum, J. Newby, H. Quigley, D.J. Thompson. 2015. Recolonizing wolves influence the realized niche of resident cougars. Zoological Studies 54:41-52.

Elbroch, M.L., B.D. Jansen, M.M. Grigione, R.J. Sarno, and H.U. Wittmer. 2013. Trailing hounds v. foot snares: Comparing injuries to pumas Puma concolor captured in Chilean Patagonia. Wildlife Biology 19:210-216.

Ellins, S.R., and G.C. Martin. 1981. Olfactory discrimination of lithium chloride by the coyote (Canis latrans). Behavioral and Neural Biology 31:214-224.

Ellis, D. H. 1981. Responses of raptorial birds to low-level jet aircraft and sonic booms. Results of the 1980-81 joint U.S. Air Force-U.S. Fish and Wildl. Serv. Study. Institute for Raptor Studies, Oracle, AZ. 59 pp.

Elmhagen, B., G. Ludwig, S.P. Rushton, P. Helle, and H. Linden. 2010. Top predators, mesopredators and their prey: Interference ecosystems along bioclimatic productivity gradients. Journal of Animal Ecology 79:785-794.

Elowe, K.D., and W.E. Dodge. 1989. Factors affecting black bear reproductive success and cub survival. Journal of Wildlife Management 53:962-968.

Engeman, R. M. L. R. Allen, and B. L. Allen. 2017. Study design concepts for inferring functional roles of mammalian top predators. Food Webs 12 (2017): 56-63.

Engeman, R.M., H.W. Krupa, and J. Kern. 1997. On the use of injury scores for judging the acceptability of restraining traps. Journal of Wildlife Research 2:124-127.

Estes, J. A., M. T. Tinker, and D. F. Doak. 1998. Killer whale predation on sea otters linking oceanic and nearshore ecosystems. Science 282:473-475.

Estes, J.A., J. Terborgh, J.S. Brashares, M.E. Power, J. Berger, W.J. Bond, S.R. Carpenter, T.E. Essington, R.D. Holt, J.B.C. Jackson, R.J. Marquis, L. Oksanen, T. Oksanen, R.T Paine, E.K. Pikitch, W.J. Ripple, S.A. Sandin, M. Scheffer, T.W. Schoener, HB. Shurin, A.R.E. Sinclair, ME, Soulé, R. Virtanen, and D.A. Wardle. 2011. Trophic downgrading of planet earth. Science 3333:301-306.

Ewer, R.F. 1973. The Carnivores. Cornell University Press, Ithaca, New York, USA.

Fall, M.W. 2002. The search for acceptable animal traps. Proc. 20th Vertebrate Pest Conference, R.M. Timm and R.H. Schmidt, Eds. Pp. 371-377.

Fancy, S.G. 1982. Reaction of bison to aerial surveys in interior Alaska. Canadian Field-Naturalist 96 (1):91.

Federal Register. 2001. Vol. 66, No. 143/Wednesday, July 25, 2001 / Proposed Rules. Endangered and Threatened Wildlife and Plants; 12-Month Finding for a Petition To List the Yellow-billed Cuckoo (Coccyzus americanus) in the Western Continental United States 66 (143):325-331.

_____. 2013. Vol. 78, No. 2 / Thursday, January 3, 2013 / Rules and Regulations. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for Southwestern Willow Flycatcher 78 (2):344-534.

Ferris, D.H. and R.D. Andrews. 1967. Parameters of a natural focus of Leptospira pomona in skunks and opossums. Bulletin of the Wildlife Disease Association 3:2-10.

Finch, D.M., J.F. Kelly, and J-L.E. Cartron. 2000. Migration and winter ecology. Chapter 7 in Status, Ecology, and Conservation of the Southwestern Willow Flycatcher. (D.M. Finch and S.H. Stoleson, eds). USDA Forest Service Gen Tech. Rep. RMRS-GTR-60. 131 pp.

Finke, D.L. and R.F. Denno. 2005. Predator diversity and the functioning of ecosystems: The role of intraguild predation in dampening trophic cascades. 2005. Ecology Letters 8:1299-1306.

Fischer, J.D., S.H. Cleetin, T.P. Lyons, and J.R. Miller. 2012. Urbanization and the predation paradox: The role of trophic dynamics in structuring vertebrate communities. BioScience 62:809-818.

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.

Fitzhugh, E.L., S. Schmid-Holmes, M.W. Kenyon, and K. Etling. 2003. Lessoning the impact of a puma attack on a human. Pages 89-103 In: S.A. Becker, D.D. Bjornlie, F.G. Lindzey, and D.S. Moody, editors. Proc. 7th Mountain Lion Workshop, Wyoming Game and Fish Department, Lander, USA. In: ODFW (Oregon Department of Fish and Wildlife). 2006. Oregon Cougar Management Plan. http://www.dfw.state.or.us/wildlife/cougar/docs/cougarPLAN-Final.pdf.

Foresman, K.R., and J.C. Daniel, Jr. 1983. Plasma progesterone concentrations in pregnant and non-pregnant black bears (Ursus americanus). Journal of Reproduction and Fertility 68:235-239.

Forrester, T. D. and H.U. Wittmer. 2013. Population dynamics of mule deer and black-tailed deer. Mammal Review ISSN 0305-1838: 1-17.

Forthman-Quick, D.L., C.R. Gustavson, and K.W. Rusiniak. 1985. Coyotes and taste aversion: the authors' reply. Appetite 6:284-290.

Fowler, M.E. and R.E. Miller. 1999. Zoo and Wild Animal Medicine. W.B. Saunders, Co., Philadelphia, PA.

Fox, C.H. 2001. Taxpayers say no to killing predators. Animal Issues 31:27. In: Larson, S. 2006. The Marin County predator management program: Will it save the sheep industry? Proc. 22nd Vertebrate Pest Conference, Timm, R.M. and J.M. O'Brien, Eds. Pp. 294-297.

_____. 2006. Coyotes and humans: Can we coexist? Proc. Vertebrate Pest Conference 22:287-293. In: Larson, S. 2006. The Marin County predator management program: Will it save the sheep industry? Proc. 22nd Vertebrate Pest Conference, Timm, R.M. and J.M. O'Brien, Eds. Pp. 294-297.

France, K.E. & Duffy, J.E. 2006. Diversity and dispersal interactively affect predictability of ecosystem function. Nature 441:1139–1143.

Frank, M. 2011. Colorado hikers and bikers under attack from sheep dogs. Adventure. 4 Pps.

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. Wildlife Society Bulletin 10:53-57.

Freeman, A.M. 1993. The measurement of environmental and resource values. Measurement of Environmental and Resource Values, Theory and Methods, Resources for the Future, Washington D.C., USA. In: ODFW (Oregon Department of Fish and Wildlife). 2006. Oregon Cougar Management Plan. http://www.dfw.state.or.us/wildlife/cougar/docs/cougarPLAN-Final.pdf.

Frey, S.N., M.R. Conover, and G. Cook. 2007. Successful use of neck snares to live-capture red foxes. Human-Wildlife Conflicts 1:21-23.

Fritts, S.H., W.J. Paul, L.D. Mech, and D.P. Scott. 1992. Trends and management of wolf livestock conflicts in Minnesota. United States Fish and Wildlife Service Resource Publication 181, Washington, D.C., USA.

Fritzell. E.K. 1987. Gray fox and Island Gray Fox. In: Novak, M., J. Baker, M. Obbard, and B. Malloch, Eds. Wild Furbearer Management and Conservation in North America. Ontario Trappers Association, Ontario Ministry of Natural Resources, Toronto, Ontario, Canada. Pp. 408-420.

Fritzell, E.K., and K J. Haroldson. 1982. Urocyon cinereoargenteus. Mammalian Species 189:1-8.

Fryxell, J. M., A. R. E. Sinclaire, and G. Caughley. 2014. Wildlife ecology, conservation, and management. 3 edition. Wiley Blackwell, West Sussex, United Kingdom.

Fuller, T.K., D.L. Mech, and J.F. Cochrane. 2003. Wolf population dynamics. In: Mech, D.L., and L. Boitaini, Eds. Wolves: Behavior, Ecology, and Conservation. University of Chicago Free Press. Pp. 161-191.

Gantz, G.F. and F.F. Knowlton. 2005. Seasonal activity areas of coyotes in the Bear River Mountains of Utah and Idaho. Journal of Wildlife Management 69:1652-1659.

Garner, G.W. 1976. Mortality of white-tailed deer fawns in the Wichita Mountains, Comanche County, Oklahoma. Dissertation, Oklahoma State University, Stillwater, USA.

Garner, G.W., J.A. Morrison, and J.C. Lewis. 1976. Mortality of white-tailed deer fawns in the Wichita Mountains, Oklahoma. Proc. Annual Conference of the Southeast Association of Fish and Wildlife Agencies 13:493-506.

Garvey, M.E. and B.R. Patterson. 2014. Evaluation of cable restraints to live-capture coyotes (Canis latrans) in southern Ontario, Canada. Canadian Wildlife Biology and Management 3:22-29.

Gehrt, S.D. 2003. Raccoons (Procyon lotor and Allies). In: Feldhamer, G.A., B.C. Thompson, and J.A Chapman Eds. Wild mammals of North America: biology, management, and economics. John Hopkins University Press, Baltimore, Maryland, USA. Pp. 611-634.

_____. 2004. Ecology and management of striped skunks, raccoons, and coyotes in urban landscapes. In: People and Predators: From Conflict to Coexistence, Fascione, N., A. Delach, and M. Smith, Eds. Island Press, Washington DC, USA.

_____. 2005. Seasonal survival and cause-specific mortality of urban and rural striped skunks in the absence of rabies. Journal of Mammalogy 86:1164-1170.

Gehrt, S.D. and S. Prange. 2006. Interference competition between coyotes and raccoons: A test of the mesopredator release hypothesis. Behavioral Ecology 18:204-214.

Gehrt, S.D., C. Anchor, and L.A. White. 2009. Home range and landscape use of coyotes in a metropolitan landscape: conflict or coexistence. Journal of Mammalogy 90:1045-1057.

George, K.A., K.M. Slagle, R.S. Wilson, S.J. Moeller, and J.T. Bruskotter. 2016. Changes in attitudes toward animals in the United States from 1978 to 2014. Biological Conservation 201:237-242.

Gese, E. M. 1998. Response of neighboring coyotes (Canis latrans) to social disruption in an adjacent pack. Canadian Journal of Zoology 76:1960-1963.

_____. 1999. Threat of predation: Do ungulates behave aggressively towards different members of a coyote pack? Canadian Journal of Zoology 77:499-503.

_____. 2001. Territorial defense by coyotes (Canis latrans) in Yellowstone National Park, Wyoming: Who, how, where, when, and why. Canadian Journal of Zoology 79:980-987.

_____. 2005. Demographic and spatial responses of coyotes to changes in food and exploitation. Proc. Wildlife Damage Conference 11:271-285.

Gese, E.M., and R.L. Ruff. 1998. Howling by coyotes (Canis latrans): Variation among social classes, seasons, and pack sizes. Canadian Journal of Zoology 76:1037-1043.

Gese, E. M., R. L. Ruff, and R. L. Crabtree. 1996a. Social and nutritional factors influencing the dispersal of resident coyotes. Animal Behaviour 52:1025-1043.

_____. 1996b. Foraging ecology of coyotes (Canis latrans): The influence of extrinsic factors and a dominance hierarchy. Canadian Journal of Zoology 74:769-783.

Gese, E.M., O.J. Rongstad, and W.R. Mytton. 1988. Home range and habitat use of coyotes in southeastern Colorado. Journal of Wildlife Management 52:640-646.

_____. 1989. Population dynamics of coyotes in southeastern Colorado. Journal of Wildlife Management 53:174-181.

Gese, E.M., and P.A. Terletzky. 2009. Estimating coyote numbers across Wyoming: A geospatial and demographic approach. Report prepared for Wyoming Department of Agriculture Animal Damage Management Board. USDA, Animal and Plant Health Inspection Service, Wildlife Services, National Wildlife Research Center, Logan, Utah.

Gese, E.M., R.L. Ruff, and R.L. Crabtree. 1996. Social and nutritional factors influencing the dispersal of resident coyotes. Animal Behaviour 52:1025-1043.

Golden, N.H., S.E Warner, and M.J. Coffey. 2016. A review and assessment of spent lead ammunition and its exposure and effects to scavenging birds in the United States. Reviews of Environmental Contamination and Toxicology. 237:123-191.

Goldfuss, C. 2016. Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews.

Goodrich, J.M. and S.W. Buskirk. 1995. Control of abundant native vertebrates for conservation of endangered species. Conservation Biology 9:1357-1364.

Goodwin, D. 1986. Crows of the world. British Museum of Natural History. Cornell University Press, Ithaca, New York, USA.

Graber, D.M. 1981. Ecology and management of black bears in Yosemite National Park. Ph.D. Thesis, University of California, Berkeley, California, USA.

Greg, M.A. 1991. Use and selection of nesting habitat by sage-grouse in Oregon. M.S. Thesis. Oregon State University, Corvallis, Oregon, USA.

Grubb, T. G., Delaney, D. K., Bowerman, W. W. and M. R. Wierda. 2010. Golden Eagle indifference to heli-skiing and military helicopters in northern Utah. J. Wildl. Manage. 74:1275–1285.

Gunnison Sage-Grouse Rangewide Steering Committee. 2005. Gunnison sage-grouse rangewide conservation plan. 544 pages. Colorado Division of Wildlife, Denver, Colorado, USA.

Gustavson, C.R., J. Garcia, W.G. Hankins, and K.W. Rusiniak. 1974. Coyote predation control by aversive conditioning. Science 184:581-583.

Gustavson, C.R., J.R. Jowsey, and D.N. Milligan. 1982. A 3-year evaluation of taste aversion coyote control in Saskatchewan. Journal of Range Management 35:57-59.

Guthrey, F.S. 1996. Upland gamebirds. Rangeland Wildlife. The Society for Range Management:56-69. Denver, Colorado, USA.

Guthrey, F.S., and S.L. Beasom. 1977. Responses of game and nongame wildlife to predator control in south Texas. Journal of Range Management 30:404-409.

Hagen, C.A. 2011. Predation on greater sage-grouse: facts, process, and effects. Pp. 95-100 in S.T. Knick and J.W. Connelly (editors). Greater Sage-grouse: ecology and conservation of a landscape species and its habitats. Studies in Avian Biology. 38:95-100. University of California Press, Berkely, CA, USA.

Haider, S., and K. Jax. 2007. The application of environmental ethics in biological conservation: a case study from the southernmost tip of the Americas. Biodiversity Conservation 16: 2559-2573.

Halaj, J., and D. H. Wise. 2001. Terrestrial trophic cascades: how much do they trickle? American Naturalist 157:262– 281.

Hall, E.R., and K.R. Kelson. 1959. The Mammals of North America. Ronald, New York, New York, USA.

Halterman, M. D. 1991. Distribution and Habitat Use of the Yellow-Billed Cuckoo (Coccyzus americanus occidentalis) on the Sacramento River, California, 1987-90, MS Thesis: California State University: Chico, CA.

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. Journal of Wildlife Management 48:489-499.

Hammerton, K.M., N. Jayasinghe, R.A. Jeffree and R.P. Lim. 2003. Experimental study of blood lead kinetics in estuarine crocodiles (Crocodylus porosus) exposed to ingested lead shot. Arch. Environ. Contamination Toxicology 45:390–398.

Hanneman, M. 1994. Valuing the environment through contingent valuation. Journal of Economic Perspectives 8(4):19-43. In: ODFW (Oregon Department of Fish and Wildlife). 2006. Oregon Cougar Management Plan. http://www.dfw.state.or.us/wildlife/cougar/docs/cougarPLAN-Final.pdf.

Hansen, L.A., N.E. Mathews, B.A. Vander Lee, and R.S. Lutz. 2004. Population characteristics, survival rates, and causes of mortality of striped skunks (Mephitis mephitis) on the southern high plains, Texas. Southwestern Naturalist 49:54-60.

Harper, E., W.J., Paul, L.D. Mech, and S. Weisberg. 2008. Effectiveness of lethal, directed wolf-depredation control. Journal of Wildlife Management 72:778-784.

Harris, S. 1977. Distribution, habitat utilization and age structure of a suburban fox (Vulpes vulpes) population. Mammal Review 7:25-39.

Harris, S. and J. Rayner. 1986. Urban fox (Vulpes vulpes) population estimates and habitat requirements in several British cities. Journal of Animal Ecology 55:575-591.

Harrison, A. 1989. Predators and prey: A case of imbalance. Forestry Research West, U.S. Department of Agriculture, Forest Service, Washington, D.C., USA. In: ODFW (Oregon Department of Fish and Wildlife). 2006. Oregon Cougar Management Plan. http://www.dfw.state.or.us/wildlife/cougar/docs/cougarPLAN-Final.pdf.

Hass, C.C., and J.W. Dragoo. 2006. Rabies in hooded and striped skunks in Arizona. Journal of Wildlife Diseases 42:825-829.

Hawkins, C.C., W.E. Grant, and M.T. Longnecker. 1999. Effect of subsidized house cats on California birds and rodents. Trans. Western Section of the Wildlife Society 35:29-33.

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. Journal of Wildlife Management 64:954-959.

Hebblewhite, M., C. A. White, C. G. Nietvelt, J. A. McKenzie, T. E. Hurd, J. M. Fryxell, S. E. Bayley, and P. C. Paquet. 2005. Human activity mediates a trophic cascade caused by wolves. Ecology 86:2135–2144.

Heck, K. 2015. California town on high alert after coyotes attack children. ABCNews. 10 July 2015. <http://abcnews.go.com/US/california-town-high-alert-coyotes-attack-children/story?id=32355667>. Accessed 2 April 2019.

Hein, E.W., and W.F. Andelt. 1995. Evaluation of indices of abundance for an unexploited badger population. Southwestern Association of Naturalists 40:288-292.

Hellgren, E.C., M.R. Vaughan, F.C. Gwazdauskas, B. Williams, P.F. Scanlon, and R.L. Kirkpatrick. 1990. Endocrine and electrophoretic profiles during pregnancy and nonpregnancy on captive female black bears. Canadian Journal of Zoology 69:892-898.

Hemker, T.P., F.G. Lindzey, and B.B. Ackerman. 1984. Population characteristics and movement patterns of cougars in southern Utah. Journal of Wildlife Management 48:1275-1284.

Henke, S.E. and F.C. Bryant. 1999. Effects of coyote removal on the faunal community in western Texas. Journal of Wildlife Management 63:1066-1081.

Henne, D.R. 1975. Domestic sheep mortality on a western Montana ranch. Thesis, University of Montana, Bozeman, USA.

Herrero, S. and S. Fleck. 1990. Injury to people inflicted by black, grizzly, or polar bears: recent trends and new insights. International Conference on Bear Research and Management 8: 25-32.

Herrero, S., A. Higgins, J.E. Cardoza, L.I. Hajduk, and T.S. Smith. 2011. Fatal attacks by American black bear on people: 1900-2009. Journal of Wildlife Management 75:596-603.

Holloran, M.J. 2005. Greater sage-grouse (*Centrocercus urophasianus*) population response to natural gas field development in western Wyoming. Ph.D. Thesis. University of Wyoming, Laramie, Wyoming, USA.

Holt, R.D., R.M. Holdo, F.J. van Veen. 2010. Theoretical perspectives on trophic cascades: current trends and future directions. In: Terborgh, J., and J.A. Estes, Eds. Trophic cascades: Predators, prey, and the changing dynamics of nature. Island Press, Washington, pp 301–318

Holt, R.S. and G.R. Huxel. 2007. Alternative prey and the dynamics of intraguild predation: Theoretical perspectives. Ecology 88:2706-2712.

Holt, R.D. and G.A. Polis. 1997. A theoretical framework for intraguild predation. The American Naturalist 149:745-764.

Hooper, D.U., F.S. Chapin III, J.J. Ewel, A. Hector, P. Inchausti, S. Lavorel, J.H. Lawton, D.M. Lodge, M. Loreau, S. Naeem, B. Schmid, H. Setala, A.J. Symstad, J. Vandermeer, and D.A. Wardle. 2005. Effects of biodiversity on ecosystem functioning: A consensus of current knowledge and needs for future research. Ecological Monographs 75:3-35. http://onlinelibrary.wiley.com/doi/10.1890/04-0922/full.

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 25119-128.

Houben, J.M., W.R. Bonwell, and T. R. McConnell. 2004. Development of the West Virginia integrated predation management program to protect livestock. Pages 70-74 in Proceedings of the 21st Vertebrate Pest Conference. Timm, R.M. and W. P. Gorenzel, Eds. University of California, Davis, USA.

Horn, S. W. 1983. An evaluation of predatory suppression in coyotes using lithium chloride-induced illness. Journal of Wildlife Management 47:999-1009.

Houlihan, J., and R. Wiles. 2001. Lead Pollution at Outdoor Firing Ranges. Environmental Working Group. 6 pages. 1718 Connecticut Ave, NW, Ste. 600, Washington, DC, 20009.

Houseknecht, C.R. 1971. Movements, activity patterns and denning habits of striped skunks (Mephitis mephitis) and exposure potential for disease. Dissertation, University of Minnesota, Minneapolis, Minnesota, USA.

Howard, V.W. Jr., and R.E. Shaw. 1978. Preliminary assessment of predator damage to the sheep industry in southeastern New Mexico. Agriculture Experiment Station resource Report 356, New Mexico State University, Las Cruces, USA.

Howard, W.E., and R.E. Marsh. 1982. Spotted and hog-nosed skunks Spilogale putorius and allies. 3 In: Chapman, J.A. and G. A. Feldhamer, Eds. Wild

Mammals of North America. The John Hopkins Press, Baltimore, Maryland, USA. Pp. 664-67.

Howe, K. B., P. S. Coates, and D. J. Delehanty. 2014. Selection of anthropogenic features and vegetation characteristics by nesting common ravens in the sagebrush ecosystem. Condor. 16(1):35-49.

Howell, R.G. 1982. The urban coyote problem in Los Angeles County. Proc. Vertebrate Pest Conference 10:21-23.

Hrbáček, J., and M. Straškraba. 1966. Horizontal and vertical distribution of temperature, oxygen, pH and water movements in Slapy Reservoir (1958-1960). Pages 7-40. Hydrobiological Studies 1. Academia Publishing House of the Czechoslovak Academy of Sciences. Prague, Czechoslovakia.

Hristienko, H., and J.E. McDonald, Jr. 2007. Going into the 21st century: A perspective on trends and controversies in the management of the American black bear. Ursus 18:72-88.

Hughes, J. M. (2015). Yellow-billed Cuckoo (*Coccyzus americanus*), version 2.0. In The Birds of North America (P. G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bna.418

Hui, C.A. 2002. Lead distribution throughout soil, flora, and an invertebrate at a wetland skeet range. Journal of Toxicology and Environmental Health 65 (15):1093-1107.

Humane Society of the United States. 2017. Pets by the numbers: U.S. pet ownership, community cat and shelter population estimates. www.humansociety.org/issues/pet_overpopulation/facts/pet_ownership_statistics.html?referrer=https://search.yahoo.com/. 11-14-2017.

Hunt, W.G., R.T. Watson, J.L. Oaks, C.N. Parish, K.K. Burnham, R.L. Tucker, J.B. Belthoff, and G. Hart. 2009. Lead bullet fragments in venison from rifle-killed deer: potential for human dietary exposure. PLoS ONE 4(4):6 Pps.

Hunter, J. and T. Caro. 2008. Interspecific competition and predation in American carnivore families. Ethology Ecology and Evolution 20:295–324.

Huot, A.A. and D.L. Bergman. 2007. Suitable and effective coyote control tools for the urban/suburban setting. Proc. 12th Wildlife Damage Management Conference, D.L. Nolte, W.M. Arjo, D.H. Stalman, Eds. Pp. 312-322.

Hurley, M.A., J.W. Unsworth, P. Zager, M. Hefflewhite, E.O. Garton, D.M. Montomery, J.R. Skalski, and C.L. Maycock. 2011. Demographic response to mule deer to experimental reduction of coyotes and mountain lions in Southeastern Idaho. Wildlife Monographs 178:1-33.

Intergovernmental Panel on Climate Change (IPCC). 2014. Climate Change 2014: Synthesis Report Summary for Policymakers. And IPCC. 2014. Climate Change 2014: Mitigation of climate change. Working Group III contribution to the fifth assessment report of the IPCC. Edenhofer, O. et al. Eds.

https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_full.pdf.

International Agency for Research on Cancer. 2006. Monographs on the Evaluation of Carcinogenic Risks to Humans, Volume 87, 2006. http://monographs.iarc.fr/ENG/Monographs/vol87/index.php

International Organization for Standardization (ISO). 1999. Animal (mammal) traps, Part 5: Methods for testing restraining traps. ISO/DIS 10990-5, Geneva, Switzerland.

Iossa G., C.D. Soulsbury, and S. Harris. 2007. Mammal trapping: A review of animal wefare standards of killing and restraining traps. Animal Welfare 16:335-352.

Iriarte, J.A., W. L. Franklin, W. E. Johnson and K. H Redford. 1990. Biogeographic variation of food habits and body size of the America puma. Oecologia 85: 185–190. In: ODFW (Oregon Department of Fish and Wildlife). 2006. Oregon Cougar Management Plan. http://www.dfw.state.or.us/wildlife/cougar/docs/cougarPLAN-Final.pdf.

Internal Revenue Service. 2016. Farmer's Tax Guide for Use in Preparing 2016 Returns. Department of the Treasury, Publication 225, Cat. No. 11049L. https://www.irs.gov/pub/irs-pdf/p225.pdf, viewed December 6, 2016.

Isom, G.E. 1993. Cyanide. Handbook of Hazardous Materials. M. Corn, Ed. Academic Press, Inc., pp. 161-172.

Ives, A.R., B.J. Cardinale, and W.E. Snyder. 2005. A synthesis of subdisciplines: Predator–prey interactions, and biodiversity and ecosystem functioning. Ecological Letters 8:102–116.

Jaeger, M.M. 2004. Selective targeting of alpha coyotes to stop sheep depredation. Sheep and goat Research Journal 19:80-84.

Jessup, D.A. 2004. The welfare of feral cats and wildlife. Journal of the American Veterinary Medical Association 225:1337-1383.

Johnson, C.L., and R.T. Reynolds. 2002. Responses of Mexican spotted owls to low-flying military jet aircraft. USDA-USFS-Rocky Mountain Research Station. RMRS-RN-12. Fort Collins, Colorado, USA.

Johnson, E.L. 1984. Applications to use sodium fluoroacetate (Compound 1080) to control predators; final decision. Fed. Reg. 49:4830-4836.

Johnson, G.D. and M.D. Strickland. 1992. Mountain lion compendium and an evaluation of mountain lion management in Wyoming. Western EcoSystems Technology, Inc., Cheyenne, Wyoming, USA.

Johnston, J.J., C.A. Furcolow, D.G. Griffin, R.S. Stahl, and J.D. Eisemann. 2001. Analysis of pesticide gas cartridges. Journal of Agricultural and Food Chemistry. 49:3753-3756.

Jørgensen, S. and M. Willems. 1987. The fate of lead in soils: the transformation of lead pellets in shooting-range soils. Ambio 16(1):11-15.

Julien, T.J., S.M. Vantassel, S.R. Groepper, and S.E. Hygstrom. 2010. Human-Wildlife Interactions 4:158-164.

Kamler, J.F., W.B. Ballard, R.R. Gilliland, P.R. Lemons, and K. Mote. 2003. Impacts of coyotes on swift foxes in northwestern Texas. Journal of Wildlife Management 67:317-323.

Kamler, J.F., R. M. Lee, J.C. deVOS, JR., W.B. Ballard and H.A. Whitlaw. 2002. Survival and cougar predation of translocated bighorn sheep in Arizona. Journal of Wildlife Management 66:1267-1272.

Kasworm, W.F., and T.J. Thier. 1994. Adult black bear reproduction, survival, and mortality sources in Northwest Montana. International Conference on Bear Research and Management 9:223–230.

Kauffman, M. J., J. F. Brodie, and E. S. Jules. 2010. Are wolves saving Yellowstone's aspen? A landscape-level test of a behaviorally mediated trophic cascade. Ecol. 91: 2742–2755.

Keay, J.A. 1995. Accuracy of cementum age assignments for black bears. California Fish and Game 81:113-121.

Keirn, G., J. Cepek, B. Blackwell, and T. DeVault. 2010. On a quest for safer skies: managing the growing threat of wildlife hazards to aviation. The Wildlife Professional Summer 2010:52-55.

Keister, G.P., and M.J. Willis. 1986. Habitat selection and success of sage-grouse hens while nesting and brooding. Progress Report W-87-R-2. Oregon Department of Fish and Wildlife, Portland, Oregon, USA.

Kellert, S. and C. Smith. 2000. Human values towards large mammals. Pages 38-63 In: Demarais, S. and P. Krausman, Eds. Ecology and Management of Large Mammals in North America. Prentice Hall, New Jersey, USA.

Kellert, S. R. 1994. Public attitudes towards bears and their conservation. International Conference on Bear Research and Management. Bears: Their Behavior, and Management. 9:43-50.

Ketcheson, K. and M. Fingas. 2000. Sodium cyanide: Properties, toxicity, uses, and environmental impacts. Proc. 17th Technical Seminar on Chemical Spills. Ottawa Environment Canada, Environmental Protection Service, pp. 51-81.

Kim, B. I., J. D. Blanton, A. Gilbert, L. Castrodale, K. Hueffer, D. Slate, and C. E. Rupprecht. 2014. A conceptual model for the impact of climate change on fox rabies in Alaska, 1980-2010. Zoonoses and Public Health 61:72–80. <http://www.ncbi.nlm.nih.gov/pubmed/23452510>. Accessed 7 Nov 2013.

Kinlaw, A. 1995. Spilogale putorius. Mammalian Species 511:1-7.

Kitchen, A.M., Gese, E.M. and Schauster, E.R. 2000. Changes in coyote activity patterns due to reduced exposure to human persecution. Canadian Journal of Zoology, 78, 853–857.

Knick, S. 1990. Ecology of bobcats relative to exploitation and prey base decline in southeast Idaho. Wildlife Monographs 108:3-42.

Knight, R. L. and M. W. Call. 1981. The common raven. BLM, Bureau of Land Management. Technical Note. No. 344. 62 pp.

Knittle, C.D, E.W. Schafer, JR., and K.A. Fagerstone. 1990. Status of compound DRC-1339 registrations. Vertebrate Pest Conference 14:311-313.

Knowlton, F.F. 1964. Aspects of coyote predation in south Texas with special reference to white-tailed deer. Dissertation, Purdue University, Lafayette, USA.

Knowlton, F.F. 1972. Preliminary interpretation of coyote population mechanics with some management implications. Journal of Wildlife Management 36:369-382.

Knowlton, F.F., and L.C. Stoddart. 1983. Coyote population mechanics: another look. In: Bunnell, F.L. ,D.S. Eastman, and J.M. Peek, Eds. Symp. Natural Regulation of Wildlife Populations. Forest, Wildlife, and Range Experiment Station, University of Idaho, Moscow, Idaho, USA. Pp. 83-111.

Knowlton, F.F., E.M. Gese, and M.M. Jaeger. 1999. Coyote depredation control: an interface between biology and management. Journal of Range Management 52:398-412.

Koehler, G. 1987. The Bobcat. In: Silvestro, R.L. Ed. Audubon Wildlife Report. The National Audubon Society, New York, New York, USA. Pp. 399-409.

Kohn, B.E. 1982. Status and management of black bears in Wisconsin. Wisconsin Department of Natural Resources Technical Bulletin, Volume 129. Wisconsin Department of Natural Resources, Madison, Wisconsin, USA.

Kolenosky, G.B., and S.M. Strathearn. 1987. Black bear. In: Nowak, M., J.A. Baker, M E. Obbard, and B. Malloch, Eds. Wild Furbearer Management and Conservation in North America. Ontario Ministry of Natural Resources, Toronto, Canada. Pp. 443–454.

Kozlowski, A.J. E.M. Gese, and W.M. Arjo. 2008. Niche overlap and resource partitioning between sympatric kit foxes and coyotes in the Great Basin Desert of Western Utah. American Midland Naturalist 160:191-208.

Krausman, P. R., and J. J. Hervert. 1983. Mountain sheep responses to aerial surveys. Wildl. Soc. Bull. 11:372-375.

Krausman, P. R., B. D. Leopold, and D. L. Scarbrough. 1986. Desert mule deer response to aircraft. Wildl. Soc. Bull. 14:68-70.

Krausman, P. R., M. C. Wallace, C. L. Hayes, and D. W. DeYoung. 1998. Effects of jet aircraft on mountain sheep. Journal of Wildlife Management 62:1246-1254.

Kreeger, T.J., P.J. White, U.S. Seal, and J.R Tester. 1990. Pathological responses of red foxes to foot hold traps. Journal of Wildlife Management 54:147-160.

Kremen, C. 2005. Managing ecosystem services: What do we need to know about their ecology? Ecological Letters, 8:468–479.

Kristin, W. B., and W. I. Boarman. 2003. Spatial patterns of risk of common raven predation on desert tortoises. Ecology 84:2432-2443.

Kushlan, J. A. 1979. Effects of helicopter censuses on wading bird colonies. J. Wildl. Manage. 43:756-760.

Lackey, C. W. 2012. Managing Bear-Human Conflicts. A Procedural Manual for Personnel of the Nevada Department of Wildlife.

Lackey, C. W., S. W. Breck, B. F. Wakeling, and B. White. 2018. Human-Black Bear Conflicts: A review of common management practices. Human-Wildlife Interactions Monograph 2:1-68.

Laidlaw, M. A., H. W. Mielke, G. M. Filippelli, D. L. Johnson, and C. R. Gonzales. 2005. Seasonality and children's blood lead levels: Developing a predictive model using climatic variables and blood lead data from Indianapolis, Indiana, Syracuse, New York, and New Orleans, Louisiana (USA). Environ. Health Perspectives 113:793-800.

Lance, V.A., T.R. Horn, R.M. Elsey and A. de Peyster. 2006. Chronic incidental lead ingestion in a group of captive-reared alligators (Alligator mississippiensis): Possible contribution to reproductive failure. Comparative Biochemistry and Physiology, Part C 142: 30-35.

Landres, Peter; Barns, Chris; Boutcher, Steve; Devine, Tim; Dratch, Peter; Lindholm, Adrienne; Merigliano, Linda; Roeper, Nancy; Simpson, Emily. 2015. Keeping it wild 2: an updated interagency strategy to monitor trends in wilderness character across the National Wilderness Preservation System. Gen. Tech. Rep. RMRS-GTR-340. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 114 p.

Lansford, K. C. and W. Woolstenhulme. 2008. Nevada mountain lion status report. Pages 52-61 in Toweill D. E., S. Nadeau and D. Smith, editors. Proceedings of the Ninth Mountain Lion Workshop May 5-8, 2008, Sun Valley, Idaho.

Larivière, S. 2001. Ursus americanus. Mammalian Species 647:1-11.

Larivière, S., and F. Messier. 1997a. Characteristics of waterfowl nest depredation by the striped skunk (Mephitis mephitis): Can predators be identified from nest remains? American Midland Naturalist 137:393-396.

Larivière, S., and F. Messier. 1997b. Seasonal and daily activity patterns of striped skunks (Mephitis mephitis) in the Canadian prairies. Journal of Zoology 243:255-262.

Larivière, S., and F. Messier. 1998. Denning ecology of the striped skunk in the Canadian prairies: Implications for waterfowl nest predation. Journal of Applied Ecology 35:207-213.

Larson, S. 2006. The Marin County predator management program: Will it save the sheep industry? Proc. 22nd Vertebrate Pest Conference, Timm, R.M. and J.M. O'Brien, Eds. Pp. 294-297.

Larson, S., D. A. McGranahan, and R. M. Timm. 2016. The Marin County livestock protection program: 15 Years in review. Proc. 27th Vertebrate Pest Conference, Timm, R.M. and R. A. Baldwin, Eds. Pp. 294-297.

Laundré, J.W., L. Hernández, and S.G. Clark. 2007. Numerical and demographic responses of pumas to changes in prey abundance: Testing current predictions. Journal of Wildlife Management 71:345-355.

Laymon, S.A. 1980. Feeding and nesting behavior of the Yellow-billed Cuckoo in the Sacramento Valley. Administrative Report 80-2, California Department of Fish and Game. Sacramento, CA.

Laymon, S.A., and M.D. Halterman. 1989. A proposed habitat management plan for yellow-billed cuckoos in California. USDA Forest Service Gen. Tech. Rep. PSW-110. 1989.

Lebbin, D.J., M.J. Parr, and G.H. Fenwick. 2010. The American Bird Conservancy Guide to Bird Conservation. University of Chicago, Illinois, USA.

Leblond, M., C. Dussault, J. P. Quallet, and M. H. St. Laurent. 2016. Caribou avoiding wolves face increased predation by bears - caught between Scylla and Charybdis. Journal of Applied Ecology 53(4):1078-1087.

LeCount, A.L. 1983. Evidence of wild black bears breeding while raising cubs. Journal of Wildlife Management 47:264-268.

LeCount, A.L. 1987. Causes of black bear cub mortality. International Conference of Bear Research and Management 7:75-82.

Lendrum, P.E., L.M. Elbroch, H. Quigley, M. Jimenez, and D. Craighead. 2014. Home range characteristics of a subordinate predator: Section for refugia or prey availability? Journal of Zoology 294:58-66.

Letnic, M., A. Greenville, E. Denny, C.R. Dickman, M. Tischler, C. Gordon, and F. Koch. 2011. Does a top predator suppress the abundance of an invasive mesopredator at a continental scale? Global Ecology and Biogeography 20:343-353.

Levi, T. and C.C. Wilmers, 2012. Wolves-coyote-foxes: A cascade among carnivores. Ecology 93:921-929.

Lindzey, F C. 1978. Movement patterns of badgers in northwestern Utah. Journal of Wildlife Management 42:418-422.

_____. 1971. Ecology of badgers in Curlew Valley, Utah and Idaho with emphasis on movements and activity patterns. Thesis, Utah State University, Logan, Utah, USA.

_____. 2003. Badger (Taxidea taxus). In: Feldhamer, G.A., B.C. Thompson, and J.A Chapman Eds. Wild Mammals of North America. The Johns Hopkins University Press, Baltimore, Maryland, USA. Pp. 683-691.

Lindzey, F., 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.

Lindzey, F.G. and E.C. Meslow. 1980. Harvest and population characteristics of black bears in Oregon (1971-74). Bears: Their Biology and Management 4:213-219.

Lindzey, F.G., W.D. Van Sickle, S.P. Liang, and C.S. Mecham. 1992. Cougar population response to manipulation in southern Utah. Wildlife Society Bulletin 20:224-227.

Link, W. A., and J. R. Sauer. 1994. Estimating equations estimates of trend. Bird Populations 2:23-32.

Linnell, J.D.C., J. Odden, M.E. Smith, R. Aanes, and J.E. Swenson. 1999. Large carnivores that kill livestock: Do "problem individuals" really exist? Wildlife Society Bulletin 27:698-705.

Linnell, M.A., M.R. Conover, and T.J. Ohashi. 1996. Analysis of bird strikes at a tropical airport. Journal of Wildlife Management 60:935-945.

Linz, G. M., C. E. Knittle, and R. E. Johnson. 1990. Ecology of Corvids in the vicinity of the Aliso Creek California Least Tern colony, Camp Pendleton, California. USDA, APHIS, Denver Wildl. Res. Cen., Bird Section Res. Rpt. No. 450. 29 pp

__________. 1992. Home range of breeding Common ravens in coastal southern California. Southwest Naturalist 37:199-202.

Littin, K. E. and D. J. Mellor. 2005. Strategic animal welfare issues: ethical and animal welfare issues arising from the killing of wildlife for disease control and environmental reasons. Scientific and Technical Review of the Office International des Epizooties 24(2): 767-782.

Littin, K. E., D. J. Mellor, B. Warburton and C. T. Eason. 2004. Animal welfare and ethical issues relevant to the humane control of vertebrate pests. New Zealand Veterinary Journal 52(1):1-10.

Litvaitis, J.A. and R. Villafuerte. 1996. Intraguild predation, mesopredator, and prey stability. Conservation Biology 10:676-677.

Logan, K.A., and L.L. Sweanor. 2000. Cougar. In: Demarais, S., and P.R. Krausman Eds. Ecology and Management of Large Mammals in North America. Prentice–Hall, Inc., Upper Saddle River, New Jersey, USA. Pp. 347–377.

_____. 2001. Desert puma: Evolutionary Ecology and Conservation of an Enduring Carnivore. Island Press, Washington, D.C., USA.

Logan, K.A., L.L. Sweanor, T K. Ruth, and M.G. Hornocker. 1996. Cougars of the San Andres Mountains, New Mexico. Final report. Federal aid in wildlife restoration, project W-128-R. New Mexico Department of Game and Fish, Santa Fe.

Loomis, J. 2012. Fuzzy math: Wildlife Services should improve its economic analysis of predator control. Natural Resources Defense Council Issue Paper. https://www.nrdc.org/sites/default/files/fuzzy-math-IP.pdf.

Loomis, J.B. 1993. An investigation into the reliability of intended visitation behavior. Environmental and Resource Economics 3:183-191.

Loomis, J.B., and R. Richardson. 2001. Economic values of the U.S. wilderness system: research evidence to date and questions for the future. International Journal of Wilderness 7(1):31-34.

Loreau, M., S. Naeem, P. Inchausti, J. Bengtson, J.P. Grime, and A. Hector. 2001. Ecology–biodiversity and ecosystem functioning: Current knowledge and future challenges. Science, 294:804–808.

Loss, S.R., T. Will, and P.P. Marra. 2013. The impact of free-ranging domestic cats on wildlife of the United States. Nature Communications 4:1-7.

Lowe, S., M. Browne, S. Boudjelas, and M. De Poorter. 2000. 100 of the world's worst invasive alien species: A selection from the global invasive species database. Invasive Species Specialist Group.

Lute, M.L. and S.Z. Attari. 2016. Public preferences for species conservation: Choosing between lethal control, habitat protection and no action. Environmental Conservation doi:10.10.17/S037689291600045X.

Lynch, G.M. 1972. Effect of strychnine control on nest predators of dabbling ducks. Journal of Wildlife Management 36:436-440.

MacDonald, D.W. and M.T. Newdick. 1982. The distribution and ecology of foxes. Vulpes vulpes (L.) in urban areas. In: Bornkamm, R., J.A. Lee, and M.R.D. Seaward, Eds. Urban Ecology. Blackwell Science Publication, Oxford, UK. Pp. 123-135.

Mace, R.D., and T. Chilton-Radandt. 2011. Black bear harvest research & management in Montana 2011 final report. Federal Aid in Wildlife Restoration Project W-154-R, Montana Fish, Wildlife and Parks, Wildlife Division, Helena, Montana, USA.

MacInnes, C. D., S. M. Smith, R. R. Tinline, N. R. Ayers, P. Bachmann, D. G. Ball, L. A. Calder, S. J. Crosgrey, C. Fielding, P. Hauschildt, J. M. Honig, D. H. Johnston, K. F. Lawson, C. P. Nunan, M. A. Pedde, B. Pond, R. B. Stewart, and D. R. Voigt. 2001. Elimination of rabies from red foxes in eastern Ontario. Journal of Wildlife Diseases 37:119–132.

Mack, J.A., W.G. Brewster, and S.H. Fritts. 1992. A review of wolf depredation on livestock and implications for the Yellowstone area. Pages 3-20 In: Varley, J. D., and W. G. Brewster, Eds. Wolves for Yellowstone? A report to the United States Congress: Volume IV Research and Analysis. National Park Service, Yellowstone National Park, Mammoth Hot Springs, Wyoming, USA.

MacKinnon, B., R. Sowden, and S. Dudley. 2001. Sharing the skies: an aviation guide to the management of wildlife hazards. Transport Canada, Aviation Publishing Division, Tower C, Ottawa, Ontario, Canada.

Maehr, D.S. 1997. The comparative ecology of bobcat, black bear, and Florida panther in South Florida. Florida Museum of Natural History, Bulletin 40, University of Florida, Gainesville, USA.

Manfredo, M.J., Sullivan, L., Don Carlos, A. W., Dietsch, A. M., Teel, T. L., Bright, A. D., and Bruskotter, J. (2018). America's Wildlife Values: The Social Context of Wildlife Management in the U.S. National report from the research project entitled "America's Wildlife Values". Fort Collins, CO: Colorado State University, Department of Human Dimensions of Natural Resources.

Manzer, D.L., and S.J. Hannon. 2005. Relating grouse nest success and corvid density to habitat: A multi-scale approach. Journal of Wildlife Management 69(1):110-123.

Marlow, M. 2016. No laughing matter: Livestock protection dogs conserve predators, too. Wildlife Professional 4:26-31.

Maron, J.L., and D.E. Pearson. 2011. Betrebrate predators have minimal cascading effects on plant production or seed predation in an intact grassland ecosystem. Ecology Letters 14:661-669.

Marshall, K.N., N. T. Hobbs, and D.J. Cooper. 2013. Stream hydrology limits recovery of riparian ecosystems after wolf reintroduction. Proc. The Royal Society B Vol. 280. DOI: 10.1098/rspb.2012.2977. http://rspb.royalsocietypublishing.org/content/280/1756/20122977.

Maser, C., and R. S. Rohweder. 1983. Winter food habits of cougars from northeastern Oregon. Great Basin Naturalist 43(3):425-428. In: ODFW (Oregon Department of Fish and Wildlife). 2006. Oregon Cougar Management Plan. http://www.dfw.state.or.us/wildlife/cougar/docs/cougarPLAN-Final.pdf.

Maser, C., B.R. Mate, J.F. Franklin, and C.T. Dyrness. 1981. Natural history of Oregon coast mammals. U.S. Department of Agriculture, Forest Service, General Technical Report PNW-133, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon, USA.

Mastro, L.L. 2011. Life history and ecology of coyotes in the Mid-Atlantic States: A summary of the scientific literature. Southeastern Naturalist 10:721-730.

Mathews, P.E. and V.L. Coggins. 1997. Movements and mortality of mule deer in the Wallowa Mountains. Pages 78-88 In: deVos, Jr., J. C . Ed. Proc. 1997 Deer/Elk

Workshop. Rio Rico, Arizona. Arizona Game and Fish Department, Phoenix, Arizona, USA. In: ODFW (Oregon Department of Fish and Wildlife). 2006. Oregon Cougar Management Plan. http://www.dfw.state.or.us/wildlife/cougar/docs/cougarPLAN-Final.pdf.

McAllister, M.M. 2014. Successful vaccines for naturally occurring protozoal diseases of animals should guide human vaccine research: a review of protozoal vaccines and their designs. Parasitology 141(5):624-640.

Mcalpine, D., J. D. Martin, and C. Libby. 2008. First occurrence of the Grey Fox, Urocyon cinereoargenteus, in New Brunswick: A climate-change mediated range expansion? Canadian Field-Naturalist 122:169–171.

McConnell, T.R. 1995. West Virginia's sheep predator situation: The findings of the 1995 WV shepherds survey. West Virginia University Cooperative Extension Service, Morgantown, USA. In: Houben, J. M., W. R. Bonwell, and T. R. McConnell, Eds. 2004. Development of the West Virginia integrated predation management program to protect livestock. Pages 70-74 in Proceedings of the 21st Vertebrate Pest Conference. R. M. Timm, and W. P. Gorenzel, Eds. University of California, Davis, USA.

McCord, C. M. 1974. Selection of winter habitat of bobcats (Lynx rufus) on the Quabbin Reservations, Massachusetts. Journal of Mammalogy 55(2):428-437.

McCord, C.M., and J.E. Cardoza. 1982. Bobcat and lynx. In: Chapman, J.A. and G.A. Feldhamer, Eds. Wild Mammals of North America: Biology, Management, and Economics. Johns Hopkins University Press, Baltimore, Maryland, USA. Pp. 728-766.

McKinney, T., T.W. Smith and J. C. deVOS Jr. 2006. Evaluation of Factors Potentially Influencing a Desert Bighorn Sheep Population. Wildlife Monographs 164: 1-36.

McShane, T.O., P.D. Hirsch, T.C. Trang, A.N. Songorwa, A. Kinzig, B. Monteferri, D. Mutekanga, H.V. Thang, J.L. Dammert, M. Pulgar-Vidal, M. Welch-Devine, J.P. Brosius, P. Coppolillo, and S. O'Connor. 2011. Hard choices: Making trade-offs between biodiversity conservation and human well-being. .Biological Conservation 144:966-972.

Mead, R.A. 1968. Reproduction in western forms of the spotted skunk (Genus Spilogale). Journal of Mammalogy 49:373-390.

Mech, L.D. 1970. The Wolf: The ecology and behavior of an endangered species. University of Minnesota Press. Minneapolis, Minnesota, USA.

_____. 2012. Is science in danger of sanctifying the wolf? Biological Conservation 150: 143-149.

Mech, L.D. and L. Boitani. 2003. Wolf Social Ecology. In: Mech, L.D. and L. Boitani, Eds. Wolves: Behavior, Ecology, and Conservation. University of Chicago Free Press.

Messmer, T.A., M.W. Brunson, D. Reiter, D.G. Hewitt. 1999. United States public attitudes regarding predators and their management to enhance avian recruitment. Wildlife Society Bulletin 27(1):75-85.

Messick, J.P., and M.G. Hornocker. 1981. Ecology of the badger in southwestern Idaho. Wildlife Monographs 76:3-53.

Messier, F. and C. Barrette. 1982. The social system of the coyote (Canis latrans) in a forested habitat. Canadian Journal of Zoology 60:1743-1753.

Mezquida, E.T., S.J. Slater, and C.W. Benkman. 2006. Sage-Grouse and indirect interactions: Potential implications of coyote control on sage-grouse populations. Condor 108:747- 759.

Middleton, A. D., M. J. Kauffman, D. E. McWhirter, J. G. Cook, R. C. Cook, A. A. Nelson, M. D. Jimenez, and R. W. Klaver. 2013. Animal migration amid shifting patterns of phenology and predation: lessons from a Yellowstone elk herd. Ecology 94(6):1245-1256.

Miller, B.J., H.J. Harlow, T.S. Harlow, D. Biggins and W.J. Ripple. 2012. Trophic cascades linking wolves (Canis lupus), coyotes (Canis latrans) and small mammals. Canadian Journal of Zoology 90:70-78.

Mitchell, B.R., M.M. Jaeger, and R.H. Barrett. 2004. Coyote depredation management: Current methods and research needs. Wildlife Society Bulletin 32:1209-1218.

Mitchell, J. and R.A. Beck. 1992. Free-ranging domestic cat predation on native vertebrates in rural and urban Virginia. Virginia Journal of Science 43:197-206.

Moehrenschlager, A., R. List, and D. W. Macdonald. 2007. Escaping intraguild predation: Mexican kit foxes survive while coyotes and golden eagles kill Canadian swift foxes. Journal of Mammalogy 88:1029–1039.

Montieth, 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. Wildlife Monographs 186 (1): 1-62.

Mosnier, A., D. Boisioly, R. Courtois, and J. Ouellet, 2008. Extensive predator space use can limit the efficacy of a control program. Journal of Wildlife Management 72:483-491.

Mugaas, J. N., J. Seidensticker, and K. P. Mahlke-Johnson. 1993. Metabolic adaptation to climate and distribution of the raccoon Procyon lotor and other Procyonidae. Smithsonian Contributions to Zoology 1:1–34.

Munoz, J.R. 1977. Cause of sheep mortality at the Cook Ranch, Florence, Montana. 1975-1976. Thesis, University of Montana, Missoula, USA.

Muñoz-Igualada, J.A. Shivik, F. G. Domínquez, J. Lara, and L.M. González. 2008. Evaluation of cage-traps and cable restraint devices to capture red foxes in Spain. Journal of Wildlife Management 72 (3):830-836.

Musiani, M., T. Muhly, C.C. Gates, C. Callaghan, M.E. Smith, and Elisabetta Tosoni. 2005. Seasonality and reoccurrence of depredation and wolf control in western North America. Wildlife Society Bulletin 33:876-887.

Myers, W.L., B. Lyndaker, P.E. Fowler, and W. Moore. 1999. Investigations of calf elk mortalities in southeast Washington: study completion report. Washington Department of Fish and Wildlife, Olympia, USA.

Nadeau, M.S., C. Mack, J. Holyan, J. Husseman, M. Lucid, D. Spicer, and B. Thomas. 2008. Wolf conservation and management in Idaho. Progress Report 2007. Idaho Department of Fish and Game, Nez Perce Tribe, Lapwai, Idaho.

_____. 2009. Wolf conservation and management in Idaho. Progress Report 2008. Idaho Department of Fish and Game, Nez Perce Tribe, Lapwai, Idaho.

Naiman, R.J., and K.H. Rogers. 1997. Large animals and system-level characteristics in river corridors BioScience 47(8):521-529.

Nass, R.D. 1977. Mortality associated with range sheep operations in Idaho. Journal of Range Management 30:253-258.

Nass, R.D. 1980. Efficacy of predator damage control programs. Proceedings of Vertebrate Pest Conference 9:205-208.

National Audubon Society. 2015. Audubon's Birds and Climate Change Report: A Primer for Practitioners. National Audubon Society, New York. Contributors: Gary Langham, Justin Schuetz, Candan Sykan, Chad Wilsey, Tom Auer, Geoff LeBaron, Connie Sanchez, Trish Distler. Version 1.3.

National Oceanic and Atmospheric Administration. 2017 *Sodium Cyanide*. Cameo Chemicals Datasheet. https://cameochemicals.noaa.gov/chemical/4477

National Park Service. 2017. Lead bullet risks for wildlife & humans. https://www.nps.gov/pinn/learn/nature/leadinfo.htm.

Niel, C. and J-D. Lebreton. 2005. Using demographic invariants to detect overharvested bird populations from incomplete data. Cons. Biol. 19:826-835.

Neal, D.L. 1990. The effect of predation on deer in the central Sierra Nevada. Predator Management in North Coastal California: Proceedings of a workshop held in Ukiah and Hopland, Calif., March 10-11, 1990. G.A. Giusti, R.M. Timm and R.H. Schmidt Eds. University of California, Hopland Field Station, USA.

Neal, D. L., G.N. Steger, and R.C. Bertram. 1987. Mountain lions: preliminary findings on home-range use and density in the central Sierra Nevada. U. S. Department of Agriculture Research Note PSW-392, PSW Forest and Range Experiment Station, Albany, California, USA. In: ODFW (Oregon Department of Fish and Wildlife). 2006. Oregon Cougar Management Plan. http://www.dfw.state.or.us/wildlife/cougar/docs/cougarPLAN-Final.pdf.

Neff, D.J., R.H. Smith, and N.G. Woolsey. 1985. Pronghorn antelope mortality study. Arizona Game and Fish Department, Resource Branch Final Report, Federal Aid Wildlife Restoration Project W-78-R, Phoenix, USA.

Nelson, M.P., J.A. Vucetich, P.C. Paquet, and J.K. Bump. 2011. An inadequate construct? North American model: What's flawed, what's missing, what's needed. The Wildlife Professional 2011 pp. 58-60.

Nelson, M.P., J.T. Bruskotter, J.A. Vucetich, and G. Chapron. 2016. Emotions and the ethics of consequence in conservation decisions: Lessons from Cecil the lion. Conservation Letters 9:302-306.

Nevada Department of Agriculture. 2017a. An Economic Analysis of the Food and Agriculture Sector in Nevada 2017. Nevada Department of Agriculture, Reno, NV, USA.

_____. 2017b. Nevada Department of Agriculture. 2016-2017 Biennial Report. Nevada Department of Agriculture, Reno, NV, USA.

Nevada Department of Wildlife. 1983. Nevada's Pronghorn Antelope Ecology, Management and Conservation. Biological Bulletin No. 13. May 2003. Nevada Department of Wildlife, Reno, NV, USA.

_____. 1995. Nevada Mountain Lion Species Management Plan: draft. Nevada Department of Wildlife, Reno, NV, USA.

_____. 1997. Nevada Elk Species Management Plan. Reno, NV, USA. Nevada Department of Wildlife, Reno, NV, USA.

_____. 2001. Nevada Division of Wildlife's Bighorn Sheep Management Plan. October 2001. Nevada Department of Wildlife, Reno, NV, USA.

_____. 2004a. Black Bear Ecology & Conservation of a Charismatic Omnivore. Biological Bulletin No. 15. December 2004. Nevada Department of Wildlife, Reno, NV, USA.

_____. 2004b. Greater Sage-Grouse Conservation Plan for Nevada and Eastern California. First Edition-June 30, 2004. Nevada Department of Wildlife, Reno, NV, USA.

_____. 2005. 2004-2005 Big Game Status report. Nevada Department of Wildlife, Reno, NV, USA.

_____. 2006. Management Plan for Mule Deer. Nevada Department of Wildlife, Reno, NV, USA.

_____. 2012a. Black Bear Management Plan 2012. Nevada Department of Wildlife, Reno, NV, USA.

_____. 2012b. 2011-2012 Big Game Status report. Nevada Department of Wildlife, Reno, NV, USA.

_____. 2013. Nevada Department of Wildlife Predation Management Plan. Fiscal Year 2013. Nevada Department of Wildlife, Reno, NV, USA.

_____. 2014a. 2013-2014 Big Game Status report. Nevada Department of Wildlife, Reno, NV, USA.

_____. 2014b. Nevada Department of Wildlife Predation Management Plan. Fiscal Year 2014. Nevada Department of Wildlife, Reno, NV, USA.

_____. 2015. Nevada Department of Wildlife Predation Management Plan. Fiscal Year 2015. Nevada Department of Wildlife, Reno, NV, USA.

_____. 2016a. 2015-2016 Big Game Status report. Nevada Department of Wildlife, Reno, NV, USA.

_____. 2016b. NDOW's Urban Wildlife Program. Urban Wildlife Update. Urban Wildlife Update. Prepared by Jessica Heitt & Joshua Cerda. July 29, 2016. Nevada Department of Wildlife, Las Vegas, NV, USA.

_____. 2016c. Commercial Collection Permitees. http://www.ndow.org/uploadedFiles/ndoworg/Content/Forms_and_Resources/Commercial-Collection-Permitees-List.pdf.

_____. 2017a. Aerial Depredation Permit Application. http://www.ndow.org/uploadedFiles/ndoworg/Content/Forms_and_Resources/Application-Aerial-Depredation.pdf.

_____. 2017b. 2016-2017 Big Game Status report. Nevada Department of Wildlife, Reno, NV, USA.

_____. 2017c. Nevada Department of Wildlife Predation Management Plan. Fiscal Year 2017. Nevada Department of Wildlife, Reno, NV, USA.

_____. 2017d. 2016-2017 Small Game Status Book. Nevada Department of Wildlife, Reno, Nevada, USA.

_____. 2018a. 2017-2018 Big Game Status report. Nevada Department of Wildlife, Reno, NV, USA.

_____. 2018b. Species/Furbearer/Coyote. Coyote fact sheet. http://www.ndow.org/Species/Furbearer/Coyote/. Accessed January 24, 2018.

_____. 2019. 2018-2019 Big Game Status report. Nevada Department of Wildlife, Reno, NV, USA.

Newsome, T.M., J.A. Dellinger, C.R. Pavey, W.J. Ripple, C.R. Shores, A.J. Wirsing, and C.R. Dickman. 2015. The ecological effects of providing resources subsidies to predators. Global Ecology and Biogeography 24:1-11. DOI: 10.1111/geb.12236 (http://wileyonlinelibrary.com/journal/geb)

Nowak, M.C. 1999. Predation rates and foraging ecology of adult female mountain lions in northeastern Oregon. Thesis, Washington State University, Pullman, USA. In: ODFW (Oregon Department of Fish and Wildlife). 2006. Oregon Cougar Management Plan. http://www.dfw.state.or.us/wildlife/cougar/docs/cougarPLAN-Final.pdf.

Nyhus, P., H Fischer, F Madden, and S. Osofsky. 2003. Taking the bite out of wildlife damage - The challenges of wildlife compensation schemes. Conservation in Practice 4:37-40.

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. Wildlife Society Bulletin 11:253-264.

ODFW (Oregon Department of Fish and Wildlife). 2006. 2006 Oregon Cougar Management Plan. Oregon Department of Fish and Wildlife. Salem, Oregon. USA.

_____. 2010. Evaluation of Cougar Removal on Human Safety Concerns, Livestock Damage Complaints, and Elk Cow:Calf Ratios in Oregon. Unpubl. report.

OIG (USDA Office of Inspector General). 2015. APHIS-Wildlife Services – Wildlife Damage Management. Audit Report 33601-0002-41. https://www.usda.gov/oig/webdocs/33601-0002-41.pdf.

Okoniewski, J.C., and R.E. Chambers. 1984. Coyote vocal response to an electronic siren and human howling. Journal of Wildlife Management 48:217-222.

Olsen, G.H., S.B. Linhart, R.A. Holmes, G.J. Dasch, and C.B. Male. 1986. Injuries to coyotes caught in padded and unpadded steel foothold traps. Wildlife Society Bulletin 14:219-223.

Onderka, D.K., D.L. Skinner, and A.W. Todd. 1990. Injuries to coyotes and other species caused by four models of footholding devices. Wildlife Society Bulletin 18:175-182.

Organization for Economic Cooperation and Development (OECD). 2002. Screening Information Data Set (SIDS): Sodium carbonate. http://www.inchem.org/documents/sids/sids/Naco.pdf.

Organization for Economic Cooperation and Development (OECD). 2007. Screening Information Data Set (SIDS): Initial assessment report for nitrates category. http://webnet.oecd.org/hpv/ui/SIDS_Details.aspx?id=3d9eafad-49b1-42ff-96c9-f40f0ff36aa3.

Orrock, J.L., L.M. Dill, A. Sih, J.H. Grabowski, S.D. Peacor, B.L. Peckarsky, E.L. Preisser, J.R. Vonesh, and E.E. Werner. 2010. Predator effects in predator-free space: The remote effects of predators on prey. The Open Ecology Journal 3:22-30.

Pace, M.L., J.J. Cole, S.R. Carpenter, and J.F Kitchell. 1999. Trophic cascades revealed in diverse ecosystems. Trends in Ecology and Evolution 14, 483–488.

Pain, D.J., R.L. Cromie, J. Newth, M.J. Brown, E. Crutcher, P. Hardman, L. Hurst, R. Mateo, A.A. Meharg, A.C. Moran, A. Raab, M.A. Taggart, R.E. Green. 2010. Potential Hazard to Human Health from Exposure to Fragments of Lead

Bullets and Shot in the Tissues of Game Animals. http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0010315 last accessed 11/26/13

Painter, L.E., R.L. Beschta, E.J. Larsen, and W.J. Ripple. 2015. Recovering aspen follow changing elk dynamics in Yellowstone: Evidence of a trophic cascade? Ecology 96:252-263.

Palmer, B.C., M.R. Conover, and S.N. Frey. 2010. Replication of a 1970s study on domestic sheep losses to predators on Utah's summer rangelands. Society for Range Management 63(6):689-695.

Palmore, W. P. 1978. Diagnosis of toxic acute renal failures in cats. Florida Veterinary Journal 14:14- 15, 36-37.

Palomares, F., P. Goana, P. Ferreras, and M. Delibes. 1995. Positive effects on game species of top predators by controlling smaller predator populations: An example with lynx, mongooses, and rabbits. Conservation Biology 9:295-305.

Palomeres, F., M. Delibes, P. Ferreras, and Pilar Gaona. 1996. Mesopredator release and prey abundance: Reply to Litvaitis and Villafuerte. Conservation Biology 10:678-679.

Paquet, P.C. 1992. Prey use strategies of sympatric wolves and coyotes in Riding Mountain National Park, Manitoba. Journal Mammalogy 73: 337-343.

Parks, M. and T. Messmer. 2016. Participant perceptions of range rider programs operating to mitigate wolf-livestock conflicts in the western United States. Wildlife Society Bulletin 40:512-524.

Partners in Flight Science Committee 2013. Population Estimates Database, version 2013. Available at http://pif.birdconservancy.org/PopEstimates. Accessed on 02/17/2018.

Patton, R. 1974. Ecological and behavioral relationships of the skunks of Trans Pecos Texas. Dissertation, Texas A&M University, College Station, USA.

Peckarsky, B.A. P.a. Abrams, D.I. Bolnick, L.M. Dill, J.H. Grabowski, B. Luttbeg, J.L. Orrock, S.D. Peacor, E.L. Preisser, O.J. Schmitz, and G.C. Turssell. 2008. Revisiting the classics: Considering nonconsumptive effects in textbook examples of predator-prey interactions. Ecology 89:2416-2425.

Pearce, R., D. Henderson, T. Harris, and T. Tetz. 1999. Impacts of federal land livestock reductions on Nevada's economy. Rangelands 21(4):22-24.

Peebles, L.W., M.R. Conover, J.B. Dinkins. 2017. Adult sage-grouse numbers rise following raven removal or an increase in precipitation. Wildlife Society Bulletin 41(3):471-478.

Peek, J. M. 1980. Natural regulation of ungulates (what constitutes a real wilderness?). Wildlife Society Bulletin 8217-227.

Perry, D., and G. Perry. 2008. Improving interactions between animal rights groups and conservation biologists. Conservation Biology 22(1):27-35.

Peterson, R.O., J.D. Woolington, and T.N. Bailey. 1984. Wolves of the Kenai Peninsula, Alaska. Wildlife Monographs 88.

Phillips, R.L., and L.D. Mech. 1970. Homing behavior of a red fox. Journal of Mammalogy 51:621.

Phillips, R.L., K.S. Griver, and E.S. Williams. 1996. Leg injuries to coyotes captured in three types of foothold traps. Wildlife Society Bulletin 24:260-263.

Pierce, B.M., V.C. Bleich, and R.T. Bowyer. 2000. Social organization of mountain lions: Does a land-tenure system regulate population size? Ecology 81:1533-1543.

Pierce, B.M., V. C. Bleich, and R.T. Bowyer. 2000a. Selection of mule deer by mountain lions and coyotes: Effects of hunting style, body size, and reproductive status. Journal of Mammalogy 81:462-472.

Pils, C.M. and M.A. Martin. 1978. Population dynamics, predator-prey relationships and management of the red fox in Wisconsin. Wisconsin Department of Natural Resources, Technical Bulletin 105.

Pimlott, D.H. 1970. Predation and productivity of game populations in North America. Transactions of the International Congress Game Biology 9:63-73.

Pitt, W.C., F.F. Knowlton, and C.P.W. Box. 2001. A new approach to understanding canid populations using an individual-based computer model. Endangered Species Update 18:103-106.

Pitt, W.C., P.W. Box, and F.F. Knowlton. 2003. An individual-based model of canid populations: Modeling territoriality and social structure. Ecological Modeling 166:109-121.

Poessel, S.A., E.M. Gese and J.K. Young. 2016. Environmental factors influencing the occurrence of coyotes and conflicts in urban areas. Landscape and Urban Planning 157 (2017) 259-269.

Pojar, T.M. and D.C. Bowden. 2004. Neonatal mule deer fawn survival in west-Central Colorado. Journal of Wildlife Management 68:550-560.

Polis, G. A., A. L. Sears, G. R. Huxel, D. R. Strong, and J. Maron. 2000. When is a trophic cascade a trophic cascade? Trends in Ecology and Evolution 15:473–475.

Polis, G.A., C.A. Myers, and R.D. Holt. 1989. The ecology and evolution of intraguild predation: Potential competitors that eat each other. Annual Review of Ecological Systematics, 20:297–330.

Poudyal, N., N. Baral, and S.T. Asah. 2016. Wolf lethal control and livestock depredations: Counter-evidence from specified models. PLoSOne 11:e0148743 doi:10.1371/journal.pone.0148743.

Powell, R.A. and G. Proulx. 2003. Trapping and marking terrestrial mammals for research: Integrating ethics, performance criteria, techniques, and common sense. Journal Institute for Laboratory Animal Research 44:259-276.

Prange, S., S.D. Gehrt, and E.P. Wiggers. 2003. Demographics factors contributing to high raccoon densities in urban landscapes. Journal of Wildlife Management 67:324-333.

Presnal, C.C., and A. Wood. 1953. Coyote predation on sage grouse. Journal of Mammalogy 34(1):127.

Proulx, G. and M.W. Barrett. 1989. Animal welfare concerns and wildlife trapping: Ethics, standards, and commitments. Trans. Western Section of the Wildlife Society 25:1-6.

Prugh, L.R., C.J. Stoner, C.W. Epps, W.T. Bean, W. J. Ripple, A.S. Laliberte, and J.S. Brashares. 2009. The rise of the mesopredator. Bioscience, 59:779-791.

Pruss, S.D., N.L. Cool, R.J. Hudson, and A.R. Gaboury. 2002. Evaluation of a modified neck snare to live-capture coyotes. Wildlife Society Bulletin 30:508-516.

Putman, R.J. 1995. Ethical considerations and animal welfare in ecological field studies. Biodiversity and Conservation 4:903-915.

Pyrah, D. 1984. Social distribution and population estimates of coyotes in north-central Montana. Journal of Wildlife Management 48:679-690.

Rashford, B.S. and J.M. Grant. 2010. Economic analysis of predator control: A literature review. http://www.wyomingextension.org/agpubs/pubs/B1208.pdf.

Rashford, B.S., T. Foulke, and D.T. Taylor. 2010. Ranch-level economic impacts of predation in a range livestock system. Society Range Management Rangelands 32:21-26.

Rattner, B.A., J.C. Franson, S.R. Sheffield, C.I. Goddard, N.J. Leonard, D. Stand, and P.J. White. 2008. Sources and Implications of Lead-based Ammunition and Fishing Tackle on Natural Resources. Wildlife Society Technical Review. The Wildlife Society, Bethesda, MD, USA.

Ray, J.C., K.H. Redford, J. Berger, and R. Steneck. 2005. Conclusion: Is large carnivore conservation equivalent to biodiversity conservation and how can we achieve both? In Ray, J.C., K.H. Redford, R.C. Steneck, and J. Berger, Ed. Large Carnivores and the Conservation of Biodiversity, Island Press, Washington. Pp. 400-427.

Regehr, E. V., N. J. Lunn, S. C. Amstrup, and I. Stirling. 2007. Effects of Earlier Sea Ice Breakup on Survival and Population Size of Polar Bears in Western Hudson Bay. Journal of Wildlife Management 71:2673–2683. <http://www.bioone.org/doi/abs/10.2193/2006-180>.

Reiter, D.K., M.W. Brunson, and R.H. Schmidt. 1999. Public attitudes towards wildlife damage management and policy. Wildlife Society Bulletin 24:746-

758. In: Darrow, P.A., R.T. Skirpstunas, S.W. Carlson, and J.A. Shivik. 2009. Comparison of injuries to coyotes from 3 types of cable foot-restraints. Journal of Wildlife Management 73:1441-1444.

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.

Ripple, W.J. and R.L. Beschta. 2006. Linking a cougar decline, trophic cascade and catastrophic regime shift in Zion National Park. Biological Conservation 133:297-408.

_____. 2007. Restoring Yellowstone's aspen with wolves. Biological Conservation 138:514-519.

_____. 2012. Trophic cascades in Yellowstone: The first 15 years after wolf reintroduction. Biological Conservation 145:205-213.

Ripple, W.J., A.J. Wirsing, C.C. Wilmers, and M. Letnic. 2013. Widespread mesopredator effects after wolf extirpation. Biological Conservation 160:70-79.

Ripple, W.J., A.J. Wirsing, R.L. Beschta, and S.W. Buskirk. 2011. Can restoring wolves aid in lynx recovery? Wildlife Society Bulletin 35:514-518.

Ripple, W.J., J.A. Estes, O.J. Schmitz, V. Constant, M.J. Kaylor, A. Lenz, J.L. Motley, K.E. Self, D.S. Taylor, and C. Wolf. 2016. What is a trophic cascade? Trends in Ecology and Evolution 31:842-849.

Ripple, W.J., L.A. Estes, R.L. Beschta, C.C. Wilmers, E.G. Ritchie, M. Hebblewhite, J. Berger, B. Elmhagen, M. Letnic, M.P. Nelson, O.J. Schmitz, D.W. Smith, A.D. Wallach, and A.I. Wirsing. 2014. Status and ecological effects of the world's largest carnivores. Science, 343:151–163.

Ripple, W.J., R.L. Beschta, I.K. Fortin, and C.T. Robbins. 2013. Trophic cascades from wolves to grizzly bears in Yellowstone. Journal of Animal Ecology 83:223-233. Doi: 10.1111/1365-2656.12123

_____. 2015. Wolves trigger a trophic cascade to berries as alternative food for grizzly bears. Journal of Animal Ecology 84:652-654.

Ritchie, E.G. and C.N. Johnson. 2009. Predator interactions, mesopredator release, and biodiversity conservation. Ecology Letters 12 982-998.

Ritchie, E.G., B. Elmhagen, A.S. Glen, M. Letnic, G. Ludwig, and R.A. McDonald. 2012. Ecosystem restoration with teeth: What role for predators? Trends in Ecology and Evolution 27:265-271.

Rivera-Milan, F. G. S. Boomer, and A. J. Martinez. 2016. Sustainability assessment of Plain Pigeons and White-crowned Pigeons illegally hunted in Puerto Rico. The Condor, 118:300-308.

Robert, C. P. and G. Casella. 2010. Introducing Monte Carlo Methods with R. Springer, New York, 284 pp

Roberts, N.M., and S.M. Crimmins. 2010. Bobcat population status and management in North America: evidence of large-scale population increase. Journal of Fish and Wildlife Management 1:169-174.

Robinette, W.L., J. S. Gashwiler, and O.W. Morris. 1959. Food habits of the cougar in Utah and Nevada. Journal of Wildlife Management 23:261–273.

Robinette, W.L., N.V. Hancock, and D.A. Jones. 1977. The Oak Creek mule deer herd in Utah. Utah Division of Wildlife Resource Publication 77-15, Salt Lake City, USA.

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.

Robinson, M. 1996. The potential for significant financial loss resulting from bird strikes in or around an airport. Proceedings of the Bird Strike Committee Europe 23:353-367.

Roemer, G.W., M.E. Gompper, and B. Van Valkenburgh. 2009. The ecological role of the mammalian mesocarnivore. BioScience 59:165-173.

Rogers, T.A., B. Bedrosian, J. Graham, and K.R. Foresman. 2012. Lead exposure in large carnivorers in the greater Yellowstone ecosystem. Journal of Wildlife Management 76:575-582.

Rolley, R.E. 1985. Dynamics of a harvested bobcat population in Oklahoma. Journal of Wildlife Management 49:283-292.

Rominger, E.M. 2007. Culling mountain lions to protect ungulate populations-Some lives are more sacred than others. Transactions of the North American Wildlife and Natural Resources Conference. 72:186-193.

Rominger, E.M., H.A. Whitlaw, D L. Weybright, W.C. Dunn, and W.E. Ballard. 2004. The influence of mountain lion predation on bighorn sheep translocations. Journal of Wildlife Management 68(4):993-999.

Rosatte, R. C., M. J. Power, D. Donovan, J. C. Davies, M. Allan, P. Bachmann, B. Stevenson, A. Wandeler, and F. Muldoon. 2007. Elimination of arctic variant rabies in red foxes, metropolitan Toronto. Emerging Infectious Diseases 13:25–27.

Rosatte, R.C. 1987. Striped, spotted, hooded and hog-nosed skunks. In: Novak, M., J.A. Baker, M.E. Obbard and B. Malloch, Eds. Wild Furbearer Management and Conservation in North America. Ministry of Natural Resources, Ontario, Canada. Pp. 599-613.

Rowlands, I.W., and A. Parkes. 1935. The reproductive processes of certain mammals VIII. Reproduction in foxes (Vulpes spp.). Proc. Zoological Society of London: 823-841.

Roy, L.D., and M.J. Dorrance. 1985. Coyote movements, habitat use, and vulnerability in central Alberta. Journal of Wildlife Management 49:307-313.

Royall, W.C., T.J. DeCino, and J.F. Besser. 1967. Reduction of a starling population at a turkey farm. Poultry Sci. 46(6):1494-1495. Runge, M. C., J. R. Sauer, M. L. Avery, B. F. Blackwell, M. D. Koneff. 2009. Assessing allowable take of migratory birds. J. Wildl. Mgmt. 73(4):556-565.Rivera-Milán et al., 2016, The Condor: Ornithological Applications 118:300-308)

Russell, J.C., V. Lecomte, Y. Dumont, and M. Le Corre. 2009. Intraguild predation and mesopredator release effect on long-lived prey. Ecological Modeling 220: 1098-1104.

Sacks, B.N., K.M. Blejwas, and M.M. Jaeger. 1999a. Relative vulnerability of coyotes to removal methods on a northern California sheep ranch. Journal of Wildlife Management. 63:939-949.

Sacks, B.N., M.M. Jaeger, C.C. Neale, and D.R. McCullough. 1999b. Territoriality and breeding status of coyotes relative to sheep predation. Journal of Wildlife Management 63:593-605.

Sanderson, G C. 1987. Raccoon. In: Novak, M., J.A. Baker, M.E. Obbard, and B. Mallock, Eds. Wild Furbearer Management and Conservation in North America. Ministry of Natural Resources, Ontario, Canada. Pp. 486-499.

Sargeant, A.B. 1972. Red fox spatial characteristics in relation to waterfowl predation. Journal of Wildlife Management 36:225-236.

Sargeant, A.B. 1978. Red fox prey demands and implications to prairie duck production. Journal of Wildlife Management 42:520-527.

Sauer, J.R., D.K. Niven, J.E. Hines, D.J. Ziolkowski, Jr, K. L. Pardieck, J.E. Fallon, and W.A. Link. 2017. The North American Breeding Bird Survey, Results and Analysis 1966-2015. Version 2.07.2017 USGS Patuxent Wildlife Research Center, Laurel, MD.

Scheetz and Rimstidt. 2009. Dissolution, transport, and fate of lead on a shooting range in the Jefferson National Forest near Blacksburg, VA, USA. http://www.deepdyve.com/lp/springer-journals/dissolution-transport-and-fate-of-lead-on-a-shooting-range-in-the-7olE1eHECM.

Scheuhammer, A. M., and S. L. Norris. 1995. A review of the environmental impacts of lead shotshell ammunition and lead fishing weights in Canada. Canadian Wildlife Service Occasional Paper 88. Environment Canada, Canadian Wildlife Service, National Wildlife Research Center, Hull, Quebec. 56pp

Schmidly, D.J. and R.D. Bradley. 2016. The Mammals of Texas. 7th ed. University of Texas Press, Austin, TX, USA.

Schmidt, R. 1989. Wildlife management and animal welfare. Transactions of the North America Wildlife and Natural Resource Conference 54:468-475.

Schmitz, O.J., V. Krivan, and O. Ovadia. 2004. Trophic cascades: The primary of trait-mediated indirect interactions. Ecology Letters 7:153-163.

Schroeder, M.A., and R.K. Baydack. 2001. Predation and the management of prairie grouse. Wildlife Society Bulletin 29:24-32.

Schuhmann, P.W. and K.A. Schwabe. 2000. Fundamentals of economic principles and wildlife management. Human Conflicts with wildlife: Economic considerations. <https://digitalcommons.unl.edu/nwrchumanconflicts/1>. Accessed 29 Sept 2016.

Schwartz, C.C., J.E. Swenson, and S.D. Miller. 2003. Large carnivores, moose and humans: A changing paradigm of predator management in the 21st century. Alces 39:41-63.

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.D., IV, M.G. Hornocker, W.V. Wiles, and J.P. Messick. 1973. Mountain lion social organization in the Idaho primitive area. W ildlife Monographs 35:1-60.

Sergio, F., C.J. Krebs, R.D. Holt, M.R. Heithaus, A.J. Wirsing, W.J. Ripple, E. Ritchie, D. Ainley, D.Oro, Y. Jhala, F. Hiraldo, and E Korpimaki. 2014. Towards a cohesive, holistic view of top predation: a definition, synthesis and perspective. Oikos Journal 123: 1234-1243. doi: 10.1111/oik.01468.

Servin, J. and C. Huxley. 1995. Coyote home range size in Durango, Mexico. Zeitschrift fuer Säugetierkunde 60:119-120.

Shaw, H.G. 1977. Impact of mountain lion on mule deer and cattle in nortwestern Arizona. Symposium of Montana Forest Conservation. Eds R.L. Phillips and C. Jonkel. Montana Forest Conservation Experimental Station.

_____. 1981. Comparison of mountain lion predation on cattle on two study areas in Arizona. University of Idaho, Symp. Wildlife Range Science 306-318.

_____. 1987. A mountain lion field guide. Arizona Game and Fish Department. Phoenix, Arizona, USA.

Sheldon, W.G. 1950. Denning habits and home range of red foxes in New York State. Journal of Wildlife Management 14:33-42.

Shelton, M. 2004. Predation and livestock production perspective and overview. Sheep & Goat Research Journal 19:2-5.

Shelton, M., and D. Wade. 1979. Predatory losses: a serious livestock problem. Animal Industry Today 2:4-9.

Shivik, J. A. 2006. Tools for the edge: What's new for conserving carnivores. BioScience 56:253-259.

Shivik, J.A., D.J. Martin, M.J. Pipas, J. Turnan, and T.J. DeLiberto. 2005. Initial comparison: Jaws, cables, and cage traps to capture coyotes. Wildlife Society Bulletin 33:1375-1383.

Shivik, J.A., L. Mastro, and J.K. Young. 2014. Animal attendance at M-44 sodium cyanide ejector sites for coyotes. Wildlife Society Bulletin 38:217-220.

Shurin, J.B., W.T. Borer, E.W. Seabloom, K. Anderson, C.A. Blanchette, B. Broitman, S.D. Cooper, and S. Halpern. 2002. A cross-ecosystem comparison of the strength of trophic cascades. Ecological Letters 5:785–791.

Shwiff, S.A. and M.J. Bodenchuk. 2004. Direct, spillover, and intangible benefits of predation management. Sheep & Goat Research Journal 19:50-52.

Shwiff, S.A., A. Anderson, R. Cullen, P.C.L. White, and S.S. Shwiff. 2012. Assignment of measurable costs and benefits to wildlife conservation projects. Wildlife Research 40:134-141.

Shwiff, S.A. and R.H. Merrill. 2004. Coyote predation management: an economic analysis of increased antelope recruitment and cattle production in south central Wyoming. Sheep & Goat Research Journal 19:29-33.

Shwiff, S.A., R.T. Sterner, K.N. Kirkpatrick, R.M. Engeman, and C.C. Coolahan. 2005. Wildlife Services in California: Economic assessments of select benefits and costs. Economics Research Project, Product Development Program National Wildlife Research Center, Fort Collins, Colorado, USA.

Shwiff, S.A., R.T. Sterner, K.N. Kirkpatrick, R.M. Engeman, and C.C. Coolahan. 2006. Benefits and costs associated with Wildlife Services activities in California. In: Tibbs, R.M., and J.M. O'Brien, editors. Proc. Twenty-Second Vertebrate Pest Management Conference. Pp. 356-360.

Sidwa, T. J., P. J. Wilson, G. M. Moore, E. H. Oertli, B. N. Hicks, R. E. Rohde, and D. H. Johnston. 2005. Evaluation of oral rabies vaccination programs for control of rabies epizootics in coyotes and gray foxes: 1995-2003. Journal of the American Veterinary Medical Association 227:785–792.

Sikes, R. 2016. 2016 Guidelines of the American Society of Mammalogists for the use of wild mammals in research and education:. Journal of Mammalogy. 97. gyw078. 10.1093/jmammal/gyw078.

Silva-Rodrigues, E.A. and K.E. Sieving. 2012. Domestic dogs shape the landscape-scale distribution of a threatened forest ungulate. Biological Conservation 150:103-110.

Silvy, N.J. 2012. The wildlife techniques manual. John Hopkins University Press 2:71,196,282. Baltimore, Maryland, USA.

Sinclair, A. R. E., and C. J. Krebs. 2002. Complex numerical responses to top-down and bottom-up processes in vertebrate populations. Philosophical Transcations of the Royal Society of London B 357(1425):1221-1231.

Skinner, D.L. and A. W. Todd. 1990. Evaluating efficiency of footholding devices for coyote capture. Wildlife Society Bulletin 18:166-175.

Slate, D. A., R. Owens, G. Connolly, and G. Simmons. 1992. Decision making for wildlife damage management. Trans. North American Wildlife Natural Resource Conference 57:51-62.

Slate, D., R. B. Chipman, T. P. Algeo, S. A. Mills, K. M. Nelson, C. K. Croson, E. J. Dubovi, K. Vercauteren, R. W. Renshaw, T. Atwood, S. Johnson, and C. E. Rupprecht. 2014. Safety and immunogenicity of Ontario rabies vaccine bait (ONRAB) in the first U.S. field trial in raccoons (Procyon lotor). Journal of Wildlife Diseases 50.

Smallwood, J.A., and D.M. Bird. 2002. American kestrel (Falco sparverius) (A.F. Poole and F.B. Gill Eds). The Birds of North America Version 2. Cornell Lab of Ornithology. Ithaca, New York, USA.

Smith, J. M. 1974. Models in ecology. Cambridge University Press. Cambridge, Great Britain.

Smith, R.H., D.J. Neff, and N.G. Woolsey. 1986. Pronghorn response to coyote control: a benefit:cost analysis. Wildlife Society Bulletin 14:226-231.

Sneddon, L.U., R.W. Elwood, S.A. Adamo, and M.C. Leach. 2014. Defining and assessing animal pain. Animal Behavior 97:201-212.

Sogge, M.K., R.M. Marshall, S.J. Sferra, and T.J. Tibbitts. 1997. *A Southwestern Willow Flycatcher Natural History Summary and Survey Protocol*. Technical Report NPS/NAUCPRS/NRTR-97/12 National Park Service. May.

Spencer, Jr., J.O. 2002. DRC-1339 Use and Control of Common Ravens. Proc. 20th Vertebr. Conf. Pp. 110-113.

Spickler, A.R., and K.R. Larson Leedom. 2013. Leptospirosis. August 2013. At http://www.sfsph.iastate.edu/DiseaseInfo/factsheets.php.

Squires, J.R., N.J. DeCesare, M. Hebblewhite, J. Berger. 2012. Missing lynx and trophic cascades in food webs: A reply to Ripple et al. Wildlife Society Bulletin 36:567-571.

Srivasta, D.S. and M. Vellend. 2005. Biodiversity-ecosystem function research: Is it relevant to conservation? Annual Review Ecological Evolution Systems 36:267-294.

Stahl, R. S., S J. Werner, J. L. Cummings, and J. J. Johnston. 2008. Computer Simulations of Baiting Efficacy for Raven Management Using DRC-1339 Egg Baits. Proc. 23rd Vertebr. Pest Conf. (R. M. Timm and M. B. Madon, Eds.). Univ. of Calif., Davis. 2008. Pp. 94-97.

Steele, J. R., B. S. Rashford, T. K. Foulke, J. A. Tanaka, and D. T. Taylor. 2013. Wolf (Canis lupus) predation impacts on livestock production: direct effects, indirect effects, and implications for compensation ratios. Rangeland Ecology and Management 66:539-544.

Stenseth, N.C., W. Falck, O.N. Bjornstad, and C.J. Krebs. 1997. Population regulation in snowshoe hare and Canadian lynx: Asymmetric food web configurations between hare and lynx. 94:5147-5152.

Sterner, R.T. 1995. Cue enhancement of lithium-chloride-inducted mutton/sheep aversions in coyotes. In: Masters, R. E., and J. G. Huggins, editors. Proc. Twelfth Great Plains Wildlife Damage Control Workshop, Published by the Noble Foundation, Ardmore, Oklahoma, USA. Pp 92-95.

Sterner, R.T., and S.A. Shumake. 1978. Bait-induced prey aversion in predators: some methodological issues. Behavioral Biology 22:565-566.

Stone, S.A., S.W. Breck, J. Timberlake, P.M. Haswell, F. Najera, B.S. Bean, and D.J. Thornhill. 2017. Adaptive use of non-lethal strategies for minimizing wolf-sheep conflict in Idaho. Journal of Mammalogy 98:33-44.

Storm, G.L. 1972. Daytime retreats and movement of skunks on farmlands in Illinois. Journal of Wildlife Management 36:31-45.

Storm, G.L. and M.W. Tzilkowski. 1982. Furbearer population dynamics: A local and regional management perspective. In: Anderson, G.C. Ed. Midwest Furbearer Management Proc. Symposium 43rd Midwest Fish and Wildlife Conference, Wichita, Kansas, USA. Pp. 69-90.

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 Monographs 49:3-82.

Stout, G.G. 1982. Effects of coyote reduction on white-tailed deer productivity on Fort Sill, Oklahoma. Wildlife Society Bulletin 10:329-332.

Su, Y. and Yajima, M. (2015). R2jags (R package version 0.5-7, pp. 1–12). Vienna, Austria: The Comprehensive R Archive Network. , http://mcmc-jags.sourceforge.net

Tabel, H., A.H. Corner, W.A. Webster, and C.A. Casey. 1974. History and epizootiology of rabies in Canada. Canadian Veterinary Journal 15:271-281.

Tanskanen, H., I. Kukkonen, and J. Kaija. 1991. Heavy metal pollution in the environment of a shooting range. Geological Survey of Finland. Special Paper 12:187-193.

Teacher, A. G., J. A. Thomas, and I. Barnes. 2011. Modern and ancient red fox (Vulpes vulpes) in Europe show an unusual lack of geographical and temporal structuring, and differing responses within the carnivores to historical climatic change. BMC Evolutionary Biology 11:214. <http://bmcevolbiol.biomedcentral.com/articles/10.1186/1471-2148-11-214>.

Teel, T. L., Daer, A. A., Manfredo, M. J., and Bright, A. D. (2005). Regional results from the research project entitled “Wildlife Values in the West.” (Project Rep. No. 58). Project Report for the Western Association of Fish and Wildlife

Agencies. Fort Collins, CO: Colorado State University, Human Dimensions in Natural Resources Unit.

Teer, J.G., D.L. Drawe, T.L. Blankenship, W.F. Andelt, R.S. Cook, J. Kie, F.F. Knowlton, and M. White. 1991. Deer and coyotes: the Welder experiments. Transactions of the North American Wildlife Natural Resource Conference 56:550-560.

Teichman, K.J., B. Cristescu, and C.T. Darimont. 2016. Hunting as a management tool? Cougar-human conflict is positively related to trophy hunting. BioMed Central Ecology 16: doi: 10.1186/s12898-016-0098-4.

Terborgh, J., L. Lopez, P. Nuñez, M. Rao, G. Shahabuddin, G. Orihuela, M. Riveros, R. Ascanio, G. H. Adler, T. D. Lambert, and L. Balbas. 2001. Ecological meltdown in predator-free forest fragments. Science 294:1923–1926.

The Wildlife Society. n.d. Standing position: Traps, trapping, and furbearer management. Report. Bethesda, Maryland, USA

_____. 2017. Final position statement: Lead in ammunition and fishing tackle. Bethesda, Maryland, USA

Theberge, J. B., and D. A. Gauthier. 1985. Models of wolf-ungulate relationships: When is wolf control justified. Wildlife Society Bulletin 13449-458.

Theodore Roosevelt Conservation Partnership. 2019. Unlocking the West's Inaccessible Public Lands. http://www.trcp.org/unlocking-public-lands/. Accessed January 31, 2019.

Thompson, C. M., and E. M. Gese. 2007. Food webs and intraguild predation: Community interactions of a native mesocarnivore. Ecology 88:334-346.

Thorpe, J. 1996. Fatalities and destroyed civil aircraft due to bird strikes, 1912-1995. Proc. Bird Strike Committee Europe 23:17-32.

_____. 1997. The implications of recent serious bird strike accidents and multiple engine ingestions. Bird Strike Committee USA.

Tigner, J.R., and G.E. Larson. 1977. Sheep losses on selected ranches in southern Wyoming. Journal of Range Management 30:244-252.

Till, J.A. 1992. Behavioral effects of removal of coyote pups from dens. Proc. 15th Vertebrate Pest Conference Paper 80.

Till, J.A., and F.F. Knowlton. 1983. Efficacy of denning in alleviating coyote depredations upon domestic sheep. Journal of Wildlife Management. 4:1018-1025.

Timm R. M. 1994. Starlicide®. Pages G-52 to G-53 in Prevention and Control of Wildlife Damage, Great Plains Agricultural Council and Nebraska Cooperative Extension Service, University of Nebraska, Lincoln, Nebraska, USA.

Timm, R.M. and R.O. Baker. 2007. A history of urban coyote problems. Notle, D.L., W.M. Arjo, and D.H. Stalman, Eds. Proc. 12th Wildlife Damage Management Conference, Pp. 272-286.

Timm, R. M., R.O. Baker, J.R. Bennett, C.C. Coolahan. 2004. Coyote attacks: an increasing suburban problem. Pages 47-57 in Proceedings of the Twenty-First Vertebrate Pest Conference. R. M. Timm and W. P. Gorenzel, Eds. University of California, Davis, USA.

Timm, R. M., and R.H. Schmidtz. 1989. Management problems encountered with livestock guarding dogs on the University of California, Hopland Field Station. Great Plains Wildlife Damage Control Workshop. 9:54-58. Fort Collins, Colorado, USA.

Toweill, D.E., and C. Maser. 1985. Food of cougars in the Cascade Range of Oregon. Great Basin Naturalist 45:77-80.

Toweill, D.E., and E.C. Meslow. 1977. Food habits of cougars in Oregon. Journal of Wildlife Management 41:576-578.

Towill L.E., J.S, Drury, B.L. Whitefield, E.B. Lewis, E.L. Galyan, and A.S. Hammans. 1978. Reviews of the environmental effects of pollutants: V. Cyanide. ORNL/EIS-81. EPA-600/1-78-027, US Environmental Protection Agency and DOE Oak Ridge National Laboratory.

Trainer, C.E., and N.E. Golly. 1992. Age and reproductive status of selected mammals: black bear age structure. Pittman-Robertson Federal Aid Report W-87-R, Study No 1, Job 5. 33 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 Department of Fish and Wildlife, Resources Division Section Wildlife Research Report 10, Portland, USA.

Trainer, C.E., M.J. Willis, G. P. Keister, Jr., and D.P. Sheehy. 1983. Fawn mortality and habitat use among pronghorn during spring and summer in southeastern Oregon, 1981-82. Oregon Department of Fish and Wildlife, Research Report 12.

Tranel, M. A., and R. O. Kimmel. 2009. Impacts of lead ammunition on wildlife, the environment, and human health—A literature review and implications for Minnesota. In R. T. Watson, M. Fuller, M. Pokras, and W. G. Hunt (Eds.). Ingestion of Lead from Spent Ammunition: Implications for Wildlife and Humans. The Peregrine Fund, Boise, Idaho, USA. DOI 10.4080/ilsa.2009US Forest Service. 2013. US Forest Service FY 2013 Aviation Safety Summary. USFS and US Dept. of Interior Interagency Aviation Training. 33 pp.

Trapp, G.R., and D.L. Hallberg. 1975. Ecology of the gray fox (Urocyon cinereoargenteus): A review. In: Fox, M.W., Ed. The Wild Canids: Their Systematics, Behavioral and Evolution. Behavioral Science Series, Van Nostrand Reinhold Company, New York, New York, USA. Pp. 164-178.

Treves, A., G. Chapron, J.V. López-Bao, C. Shoemaker, A.R. Goekner, and J.T. Briskotter. 2015. Predators and the public trust. Biological Review 92:248-270.

Treves, A., M. Krofel, and J. McManus. 2016. Predator control should not be a shot in the dark. Frontiers in Ecology and the Environment. 4:380-388.

Treves, A., R. B. Wallace and S. White. 2009. Participatory planning of interventions to mitigate human-wildlife conflicts. Conservation Biology 23:1577-1587.

Tsubota, T. Y. Takahashi, and H. Kanagawa. 1987. Changes in serum progesterone levels and growth of fetuses in Hokkaido brown bears. In: Zager, P., Ed. Bears: Their Biology and Management. Proceedings of the Seventh International Conference on Bear Research and Management, Williamsburg, Virginia, USA. Pp. 355-358.

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. New York Fish and Game Journal 23:93-95.

Turnbull, T.T., J.W. Cain, and G.W. Roemer. 2011. Evaluating trapping techniques to reduce potential for injury to Mexican wolves. U.S. Geological Survey Open-File Report 2011-1190.

Underwood, A.J. 1992. Beyond BACI: The detection of environmental impacts on populations in the real, but variable, world. Journal of Experimental Marine Biology and Ecology 161:145-178.

U.S. Army Corp of Engineers. 2009. National economic development procedures manual: overview. IWR Report 09-R-2. U.S. Army Institute for Water Resources, Alexandria, VA, USA. http://www.iwr.usace.army.mil/Portals/70/docs/iwrreports/09-R-02.pdf

United States Department of Agriculture, Animal and Plant Health Inspection Service, Animal Damage Control. 1991. Economic assessment of the California cooperative Animal Damage Control Program 1980-1990. United States Department of Agriculture - Animal and Plant Health Inspection Service.

U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Veterinary Services, National Animal Health Monitoring System. 2015. Sheep and Lamb Predator and Nonpredator Death Loss in the United States, 2015. National Animal Health Monitoring System, Fort Collins, CO, USA.

_____. 2017a. Death Loss in U.S. Cattle and Calves Due to Predator and Nonpredator Causes, 2015. National Animal Health Monitoring System, Fort Collins, CO, USA.

_____.2017b. Goat and Kid Predator and Nonpredator Death Loss in the United States, 2015. National Animal Health Monitoring System, Fort Collins, CO, USA.

U.S. Department of Agriculture, Animal and Plant Health Inspection Service. 2019. 2018 Program Data Reports. https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/sa_reports/sa_pdrs/ct_pdr_home_2017. Last Modified April 9, 2019.

U.S. Department of Agriculture, Animal and Plant Health Inspection Service-Wildlife Services. 2011. Appendix E from the Nevada predator damage management environmental assessment: Summary of public comments and responses. United States Department of Agriculture - Animal and Plant Health Inspection Service - Wildlife Services.

_____. 2014. Appendix E: Responses to comments: Summary of public comments and responses on the July 2012 Pre-decision environmental assessment Wildlife Services' gray wolf damage management in Oregon. Wildlife Services.

_____. 2016. Chapter 5: Responses to comments from the Idaho predator management environmental assessment. United States Department of Agriculture - Animal and Plant Health Inspection Service - Wildlife Services.

_____. 2019. Human Health and Ecological Risk Assessment for the Use of Wildlife Damage Management Methods by USDA-APHIS-Wildlife Services. Online. https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/programs/nepa/ct-ws-risk_assessments.

U.S. Department of Agriculture, National Agricultural Statistics Service. 2005. Sheep and Goats Death Loss. May 2005. United States Department of Agriculture-National Agricultural Statistics Service, Washington, D.C., USA.

_____. 2006. Cattle Death Loss. May 2006. United States Department of Agriculture-National Agricultural Statistics Service, Washington, D.C., USA.

_____. 2010. Sheep and Goats Death Loss. May 2010. United States Department of Agriculture-National Agricultural Statistics Service, Washington, D.C., USA.

_____. 2011. Cattle Death Loss. May 2011. United States Department of Agriculture-National Agricultural Statistics Service, Washington, D.C., USA.

_____. 2017. Nevada Agricultural Statistics Annual Bulletin 2015 Crop Year. United States Department of Agriculture National Agricultural Statistics Service Pacific Regional Field Office, Nevada. USA.

U.S. Environmental Protection Agency. 2004. Integrated Risk Information System (IRIS) https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0277_summary.pdf reviewed 12/2016.

_____. 2005. Ecological soil screening levels for lead – Interim final. OSWER Directive 9285.7-70. USEPA Office of Solid Waste and Emergency Response. 242 pp. https://www.epa.gov/sites/production/files/2015-09/documents/eco-ssl_lead.pdf.

_____. 2008. Problem formulation for Ecological Risk Assessment for carbon dioxide and gas fumigant producing cartridges: Sawdust, sodium nitrate, potassium nitrate, and sulfur. Case No. 4019, 4052, 0031. US Environmental Protection Agency, Office of Pesticide Programs, Environmental Fate and Effects Division.http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPP-2007-1118-0005.

_____. 2010. Toxicological review of hydrogen cyanide and cyanide salts. EPA/635/R-08/016F.

_____. 2013. Integrated Science Assessment for lead, EPA/600/R-10/075F, Office of Research and Development, National Center for Environmental Assessment, Research Triangle Park, NC, June 2013.

_____. 2016. Compound DRC-1339 Concentrate-Livestock, Nest and Fodder Depredations. Registration No. 56228-19. Revised 02, October, 2019.

_____. 2018. Restricted Use Pesticide. M-44 Cyanide Capsules. EPA Reg. No. 56228-15. EPA revised 15/January/2020.

U.S. Forest Service. 1995. FSM 2600-Wildlife, Fish, and Sensitive Plant Habitat Management. Effective date: May 4, 1995.

_____. 2007. FSM 2300-Recreation, Wilderness, and Related Resource Management. Chapter 2320-Wilderness Management. Effective date: January 22, 2007.

_____. 2015. Rocky Mountain Research Station – Research Natural Areas in the Interior West Region (Region 4) – Interior West Region_RNA.xls. https://www.fs.fed.us/rmrs/documents-and-media/research-natural-areas-interior-west-region-region-4 (accessed 8/29/2018).

_____. 2018a. Wilderness & Wild and Scenic Rivers & Wilderness Study Areas. https://data.fs.usda.gov/geodata/other_fs/wilderness/stateMap.php?stateID=NV#Fandango Wilderness Study Area (accessed 8/30/2018).

U.S. Government Accountability Office. 2001. Wildlife services program: Information on activities to manage wildlife damage. Report to Congressional Committees. GAO-02-138. United States General Accounting Office, Washington, D.C., USA.

U.S. Fish and W ildlife Service. 2002. Southwestern Willow Flycatcher Recovery Plan. Albuquerque, New Mexico. i-ix 210 pp., Appendices A-O.

_____. 2008. Sierra Nevada bighorn sheep (Ovis canadensis sierrae) 5-year review: summary and evaluation. Ventura Fish and Wildlife Office, Ventura, California, USA. http://ecos.fws.gov/docs/five_year_review/doc2000.pdf

_____. 2017. Statistical Data Tables for Fish & Wildlife Service Lands (as of 9/30/2017). https://www.fws.gov/refuges/land/PDF/2017_Annual_Report_of_Lands_Data_Tables.pdf (accessed 08/30/2018).

_____. 2018. Refuges - Nevada. https://www.fws.gov/refuges/refugeLocatorMaps/Nevada.html (accessed 08/30/2018).

_____. 2018a. Fish and Wildlife Service Biological opinion and informal consultation for addressing effects on federally listed or proposed threatened and endangered species in Nevada as a result of the Animal and Plant Health and Inspection Service-Wildlife Services' implementation of proposed wildlife damage management activities under the Nevada Animal Damage Control Plan. Files 08ENVS00-2018-F-0236, 08ENVS00-2018-I-0237 and 08ENVS00-2018-F-0236.AMD1 and 08ENVS00-2018-I-0237.AMD1 APHIS Wildlife Services Amendment.

United States Fish and Wildlife Service, and National Oceanic and Atmospheric Administration. 1998. Endangered species consultation handbook: Procedures for conducting consultation and conference activities under Section 7 of the Endangered Species Act. United States Fish and Wildlife Service.

USFWS 2016. U.S. Fish and Wildlife Service, Idaho Department of Fish and Game, Montana Fish, Wildlife & Parks, Wyoming Game and Fish Department, Nez Perce Tribe, National Park Service, Blackfeet Nation, Confederated Salish and Kootenai Tribes, Wind River Tribes, Confederated Colville Tribes, Spokane Tribe of Indians, Washington Department of Fish and Wildlife, Oregon Department of Fish and Wildlife, Utah Department of Natural Resources, and USDA Wildlife Services. 2016. Northern Rocky Mountain Wolf Recovery Program 2015 Interagency Annual Report. M.D. Jimenez and S.A. Becker, eds. USFWS, Ecological Services, 585 Shepard Way, Helena, Montana, 59601.

U.S. Geological Survey. 2017. Longevity records of North American birds. Bird Banding Laboratory, Laurel, Maryland, USA. http://www.pwrc.usgs.gov/BBL/longevity/Longevity_main.cfm (accessed 02/17/2018).

U.S. House of Representatives. 2019. Office of the Law Revision Counsel. United States Code. Chapter 7-Protection of Migratory Game and Insectivirous Birds. http://uscode.house.gov/view.xhtml?path=/prelim@title16/chapter7&edition=prelim. Accessed April 4, 2019.

Utah Department of Natural Resources. 2018. Utah Division of Wildlife Resources. Utah hunting: Utah's predator control program. Utah Department of Natural Resources. https://wildlife.utah.gov/hunting-in-utah/hunting%20%20-information/762.

Vance-Chalcraft, H.D., J.A. Rosenheim, J.R, Vonesh, C.W. Osenberg, and A. Sih. 2007. The influence of intraguild predation on prey suppression and prey release: A meta-analysis. Ecology 88:2689-2696.

Varner, G. 2011. Environmental ethics, hunting, and the place of animals. Pages 855-876 in T. L. Beauchamp and R. G. Frey, editors. The Oxford handbook of animal ethics. Oxford University Press, New York, USA.

Verts, B.J. 1967. The biology of the striped skunk. University of Illinois Press, Urbana, Illinois, USA.

Vickery, P.D., M.L. Hunter, Jr., J.V. Wells. 1992. Evidence of incidental nest predation and its effects on nests of threatened grassland birds. Oikos 63:281-288.

Virbac. 2011. Euthasol-pentobarbital sodium and phenytoin sodium solution. Virbac AH, Inc. Euthasol® (Euthanasia Solution). Product Information. Revised: 4/2011.

Vitousek, P.M., H.A. Mooney, J. Lubchenco, and J.M. Melillo. 1997. Human domination of Earth's ecosystems. Science, 277:494–499.

Voigt, D.R. 1987. Red Fox. In: Novak, M., Baker, J.A., Aboard, M.E. and Ballock, B., Eds. Wild Furbearer Management and Conservation in North America. Ontario Ministry of Natural Resources, Toronto, Ontario, Canada. Pp. 378-392.

Voigt, D.R., and W.E. Berg. 1999. Coyote. In: Novak, M., Ed. Wild Furbearer Management and Conservation in North America. Ontario Ministry of Natural Resources, Ontario, Canada. Pp.344-357.

Vucetich, J. A., D. W. Smith, and D. R. Stahler. 2005. Influence of harvest, climate and wolf predation on Yellowstone elk, 1961-2004. Oikos 111259-270.Wagner, K.K., and M.R. Conover. 1999. Effect of preventive coyote hunting on sheep losses to coyote predation. Journal of Wildlife Management 63:606-612.

Vucetich, J.A. and M.P. Nelson. 2007. What are 60 warblers worth? Killing in the name of conservation. Oikos, 116:1267-1278.

Vucetich, J.A., J.T. Bruskotter, and M.P. Nelson. 2015. Evaluating whether nature's intrinsic value is an axiom of or anathema to conservation. Conservation Biology 29:321-332.

Wade-Smith, J., and B.J. Verts. 1982. Mephitis mephitis. Mammalian Species 173:1-7.

Wagner, K. K., and M. R. Conover. 1999. Effect of preventive winter aerial coyote hunting on sheep losses to coyote predation. Journal of Wildlife Management 63: 606-612.

Wakeling, B. F., R. L. Day and A.A. Munig. 2015. The efficacy and economics of limited lethal removal of coyotes to benefit pronghorn in Arizona. Proceedings of the Western States and Provinces Biennial Pronghorn Workshop 26: 26-38.

Walker, B.L., A.D. Apa, and K. Eichhoff. 2016. Mapping and prioritizing seasonal habitats for greater sage-grouse in northwestern Colorado. Journal of Wildlife Management 80(1):63-77.

Wallach, A.D., B.R. Murray, A.J. O'Neill. 2008. Can threatened species survive where the top predator is absent? Biological Conservation 142:43–52.

Wallach, A.D., E.G. Ritchie, J. Read, and A.J. O'Neill. 2009. More than mere numbers: the impact of lethal control on the social stability of a top-order predator. PLoS One 4:1–8.

Wapenaar, W., F. De Bie, D. Johnston, R.M. O'Handley, and H.W. Barkema. 2012. Population structure of harvested red foxes (Vulpes vulpes) and coyotes (Canis latrans) on Prince Edward Island, Canada. Canadian Field-Naturalist 126:288-294.

Waser, N.M., W.V. Price, D.T. Blumstein, S.R. Arozqueta, B.D.C. Escobar, R. Pickens, and A. Pistoia. 2014. Coyotes, deer and wildflowers: diverse evidence point to a trophic cascade. Naturwissenschaften 101: 427-436.

Way, J.G., I.M. Ortega, P.J. Auger, and E.G. Strauss. 2002. Box-trapping eastern coyotes in southeastern Massachusetts Wildlife Society Bulletin 30 (3):695-702.

Webb, W. C. 2001. Common raven (Corvus corax) juvenile survival and movements. Thesis. University of California, Riverside, California, USA.

Webb, W. C., W. I. Boarman, and J.T. Rotenberry. 2004. Common raven juvenile survivorship in a human augmented landscape. Condor 106:517-528.

Wehausen, J.D. 1996. Effects of mountain lion predation on bighorn sheep in the Sierra Nevada and Granite Mountains of California. Wildlife Society Bulletin 24:471-479.

Wielgus, R.B. and K.A. Peebles. 2014. Effects of wolf mortality on livestock depredations. PLoS ONE 9(12):e113505. Doi:10.1371/journal.pone. 0113505.

Wiemeyer, S.N., E.F. Hill, J.W. Carpenter, and A.J. Krynitsky. 1986. Acute oral toxicity of sodium cyanide in birds. Journal of Wildlife Diseases 22:538-546.

Weisenberger, M. E., P. R. Krausman, M. C. Wallace, and O. E. Maughan. 1996. Effects of simulated jet aircraft noise on heart rate and behavior of desert ungulates. J. Wildl. Manage. 60:52-61.

Weston-Glenn, J. L, D. J. Civitello and S. L. Lance. 2009. Multiple Paternity and kinship in the gray fox (Urocyon cinereoargenteus). Mammalian Biology 74: 394-402.

White, C. M. and T. L. Thurow. 1985. Reproduction of ferruginous hawks exposed to controlled disturbance. Condor 87:14-22.

White, H.B, T. Decker, M.J. O'Brien, J.F. Organ, and N.M. Roberts. 2015. Trapping and furbearer management in North American wildlife conservation. 72 (5): 756-769.

White, L.A., and S.D. Gehrt. 2009. Coyote attacks on humans in the United States and Canada. Human Dimensions of Wildlife 14:419-432.

White, M.   1967. Population ecology of some white-tailed deer in south Texas. Dissertation, Purdue University, Lafayette, Indiana, USA.

White, P. J., and R. A. Garrott. 2005. Northern Yellowstone elk after wolf restoration. Wildlife Society Bulletin 33(3):942-955.

Whitfield, M.J. 1990. Willow flycatcher reproductive response to brown-headed cowbird parasitism. Masters Thesis, California State University, Chico, California. 25 pp.

Wilderness Connect. 2018a. United States Forest Services wilderness areas in Nevada. www.wilderness.net/NWPS/stateView?state-=NV. 8/30/18.

_____. 2018b. General Information about the Forest Service – Wilderness Areas on the National forests - Nevada. https://www.wilderness.net/forestservice (accessed 08/30/2018).

Williams, C.L., K.M. Blejwas, J.J. Johnson, and M.M. Jaeger. 2003. Temporal genetic variation in a coyote (Canis latrans) population experiencing high turnover. Journal of Mammalogy 84:177-184.

Willis, M.J., G.P. Keister, Jr., D.A. Immell, D.M. Jones, R.M. Powell, and K.R. Durbin. 1993. Sage grouse in Oregon. Oregon Department of Fish and Wildlife Research Report 15. Portland, USA.

Wilmers, C.C., R.L. Crabtree, D.W. Smith, K.M. Murphy, and W.M. Getz. 2003. Trophic facilitation by introduced top predators: Grey wolf subsidies to scavengers in Yellowstone National Park. Journal of Animal Ecology, Vol. 72: 909.

Wilson, R.R., T.L. Blankenship, M.B. Hooten, and J. Shivik. 2010. Prey-mediated avoidance of an intraguild predator by its intraguild prey. Oecologia 153:921-929.

Winnie Jr, J. & S. Creel. 2016. The Many Effects of Carnivores on their Prey and Their Implications for Trophic Cascades, and Ecosystem Structure and Function. Food Webs. 10.1016/j.fooweb.2016.09.002.

Windberg, L.A., and F.F. 1988. Management implications of coyote spacing patterns in southern Texas. Journal of Wildlife Management 52:632-640.

Winter, L. 2004. Trap-neuter-release programs: The reality and impacts. Journal of the American Veterinary Medical Association 225:1369-1376.

Wisconsin Department of Natural Resources (WDNR). 2017. Gray wolf Monitoring Report 15 April 2016 Through 14 April 2017. Jane E. Wiedenhoeft, David M. MacFarland, Nathan S. Libal, and Jean Bruner. 15 pp.

Wood, Z.T., D.C Fryxell, E.R. Moffett, M.T. Kinnison, K.S. Simmon, and E.P. Palkovacs. 2020. Prey adaptation along a competition-defense tradeoff cryptically shifts trophic cascades from density- to trait-mediated. *Oecologia* 192, 767–778 (2020). https://doi.org/10.1007/s00442-020-04610-2

Wright, G. J., R. O. Peterson, D. W. Smith, and T. O. Lemke. 2006. Selection of Northern Yellowstone Elk by Gray Wolves and Hunters. Journal of Wildlife Management 70(4):1070-1078.

Yensen, E. 2019. Urocitellus mollis. The IUCN Red List of Threatened Species 2019: e. T116989381A116989399. http://dx.doi.org/10.2305/IUCN.UK.2019-3.RLTS.T116989381A116989399.en. Downloaded on 1 February 2020.

5 Public Comments and Responses

WS-Nevada initiated a public scoping period in November of 2016 and received 19 comments and several pieces of supplementary information, including news articles, literature, and opinion pieces. These comments and papers were considered in the preparation of the EA.

In November 2019, WS-Nevada published the Draft EA on Regulations.gov for 45 days to allow the public to review and comment on the draft. During that period we received 1,699 comment submissions from the public on the Draft EA. Many of these comments were identical or substantially similar. Below, we have summarized these comments. Whenever possible, we have combined similar comments together, and provided a single response which covers the breadth of those comments. All of the comments we received were adequately addressed in the Draft EA, outside the scope of the EA, or have been clarified in this Final EA. The vast majority of these comments were adequately addressed in the Draft EA. In the interest of transparency, we have responded to all comments, and we provide all of these comments and responses below.

Below, comments are provided in bold, and our response is provided below the comment in normal font (i.e., not bold).

5.1 Outside the Scope of the EA.

We received numerous comments which are categorically outside the scope of the EA. Comments on topics outside the scope of the EA include hunting, wild horse and burro management, lethal wolf management, ecological effects of lethal wolf removal, National Park staffing and funding, introducing wildlife species, providing habitat for wildlife, and other land management decisions.

This EA covers PDM conducted by WS-Nevada within the State of Nevada, as stated in Sections 1.2 and 1.5.2. All other wildlife management actions, especially those conducted by other agencies, are outside the scope of the EA. This includes the following list of comments, which are outside the scope of this EA:

- Opposition to human encroachment into wildlife habitat.
- Hunting should be banned.
- Opposes selling hunting licenses to raise money.
- Opposes bear hunting.
- Opposes the Trump family's hunting.
- Christianity and its effects on thoughts about wildlife.
- Eliminations of humans from the environment.
- Reduction of the earth's population by 4 billion people.
- Forced veganism would help society be more humane and protect land.
- Effects of livestock/ranching on the environment.
- More lands should be protected in the United States.
- Livestock are trespassing on public lands.
- Native Americans were better at wildlife management than "white men".
- Trump/Pence/Republicans are evil.
- Introduction of grizzly bear and wolves.

- Cattle are useless and toxic to the environment.
- The agriculture industry is the leading cause of environmental destruction.
- BLM should help develop a new way to raise cattle.
- Livestock are pushing out wild horses and burros.
- Funding for parks and rangers should be restored and increased.
- The 6th mass extinction has begun.
- Mustangs must be allowed to stay on the ranges.
- Reduction of the human population.
- Curbing growth of human population.
- Opposition to ranching and livestock industry.
- Opposition to grazing on public lands.
- Opposed to trophy hunting.
- Wolves are essential.
- Humans cause ecological damage.
- Starting a sterilization program for any one of religion who wants to procreate.
- Decisions on use of public lands for grazing.
- Wildlife taken outside of Nevada by other APHIS-WS programs.

5.2 Supportive Comments.

We received several supportive comments, or comments with which we agree.

The following comments are generally supportive of the content and analyses in the EA, or provide statements with which we categorically agree. We appreciate these comments. These include:

- Support for the preferred alternative (Alternative 2).
- Agreement that predators are a source of loss for livestock producers.
- Commenters affirming their use of non-lethal methods prior to contacting WS-Nevada for assistance.
- Commenter compliments the efforts of the agencies involved in the preparation of the analysis.
- Support for the “important work” proposed by WS-Nevada.
- Comment stating that livestock losses have increased since WS-Nevada ceased work in wilderness.
- Appreciation for past WS-Nevada assistance with livestock depredation events.
- Observation of ravens being especially damaging to young livestock.
- The sentiment that livestock producers should not have to bear the brunt of the public’s desire for increased predator populations.
- The sentiment that maintaining a balance between wildlife and agriculture is necessary to maintain food and production.
- The opinion that Alternative 2 is the best path forward because it allows foe healthy predator populations alongside licensed livestock operations.
- Agreement with the analysis and science in the EA.

5.3 Purpose, Objectives, and Need for Action

We received several comments regarding the purpose, goals, and objectives of Purpose and Need for Action in the EA, the Preferred Alternative (Alternative 2), APHIS-WS, WS-Nevada, or PDM in general. Comments include assertions that PDM is not necessary, that the livestock industry does not need government help, should not extirpate any species, and that humans should not interfere with nature.

WS-Nevada thoroughly discussed and disclosed the Need for Action in Chapter 1 of the EA. There was no additional information brought forward to indicate that addressing predator damage in some capacity is not necessary. Public attitudes and values regarding wildlife and predator damage management were discussed in the EA Section 1.4.2.

Claims that the proposed action included decimating or extirpating any wildlife species are unfounded. As discussed in Section 1.5.2.1.2, one of WS-Nevada's objectives is to "[i]mplement PDM so that cumulative effects do not negatively affect the viability of any native predator populations." The analyses in Sections 3.5, 3.6, and 3.7 indicate that WS-Nevada's actions under Alternative 2 would accomplish this objective without significant or cumulative impacts to native predator populations or any other native wildlife species' population.

Many commenters stated that the livestock industry does not need any government assistance, implying that there no need to protect livestock. The need for action, as defined in the EA, is to respond to requests for assistance from any entity requesting assistance. As a government entity, WS-Nevada does not refuse specific PDM services to anyone or any entity without cause, because that would not be consistent with the fairness standards of USDA, APHIS, or WS. WS-Nevada also does not receive requests for assistance from the "livestock industry", but from individual producers with operations varying in size from backyard farms to large cattle operations. Per the first objective outlined in Section 1.5.2, WS-Nevada strives to respond to ALL requests for assistance with some type of PDM assistance.

5.4 Environmental Baseline

We received several comments related to the accuracy and appropriateness of the environmental baseline in the EA. These comments included variations on the EA not containing a true "no action" alternative, the EA not containing appropriate baseline data for populations, the population data in the EA being inaccurate, and the data not being site-specific enough.

WS-Nevada disagrees with the assertion that the "no action" alternative presented, Alternative 1, does not meet the requirements of CEQ. The environmental baseline appropriate for the analyses in this EA is not a "pristine" or "non-human-influenced" environment, but one that is already heavily influenced by human actions including WS-Nevada PDM which has been conducted in Nevada for decades, and PDM conducted by other federal, state, and local agencies, as well as individuals and other entities. Thus, the baseline impacts are those for Alternative 1, the No Action alternative, as described in Section 2.3.1.

One commenter disagreed with NDOW's mountain lion population data, citing a study on mountain lions from 2014 and information from public meetings in 2014. The commenter used data that has been superseded. WS-Nevada relied on data supplied by NDOW that is more recent than the 2014 information referenced by the commenter. In 2019, NDOW developed a population model to consider all of the factors affecting the statewide population, composed of 5 genetically distinct sub-populations and the transient population. These are all considered in the analysis in section 3.5.8.2.

One comment claims that PDM is concentrated in certain areas, making statewide population estimates inappropriate for analysis. While PDM is not evenly distributed across the state, it is also not heavily concentrated on any area as to have a significant adverse effect on any wildlife population (EA Section 3.5, 3.6, and 3.7). PDM is only conducted where there is damage, and only for as long as the damage is occurring. Areas that have higher densities of livestock or other agricultural production are, of course, more likely to receive PDM (EA Section 2.3.1.6). Similarly, some PDM activities may occur more frequently in certain times of the year, such as times when lambs are susceptible to predation, however, locations, frequency, and varieties of PDM work are varied from year to year (EA Section 2.3.1.6). WS-Nevada coordinates with the wildlife management agencies which ensures that PDM does not conflict with goals and plans for population management.

The same commenter requested that WS-Nevada consider geographic differences in regions of the state where PDM may occur and conduct more site specific population analysis. Commenter did not indicate what "regions" or "geographic differences" there was a concern about. WS-Nevada feels the analysis in the EA is at the appropriate level, based on input from the natural resource management agencies responsible for species population management and the extensive literature review conducted for this EA.

One commenter objected to the discussion in Section 1.10.2.2 titled Unique or Unknown Risks, WS-Nevada acknowledged that many species' populations are not numerically tracked by management agencies, stating this invalidated the analysis. These species include badgers, fox, coyotes, skunks, and weasels. States may choose to monitor population health using factors such as sex ratios, age distribution of the population, indices of abundance, and/or trend data to evaluate the status of populations that do not have direct population data. This EA uses the best available information from wildlife management agencies, including NDOW when available, and peer-reviewed literature to assess potential impacts to predator and non-target wildlife species. Where population estimates are unavailable, then the analyses in Chapter 3 use the lowest density or number estimates for wildlife species populations to arrive at the most conservative impact analysis. With the review and approval of the agencies responsible for managing those populations, we are confident this constitutes the best available science and an accurate portrayal of the wildlife populations in the state of Nevada.

5.5 Cumulative Effects

General assertions were made that the proposed action would have cumulative environmental effects to local predator populations and ecosystems and that the EA failed to take the requisite "hard look" at these issues.

We disagree with the assertion that the EA does not take a hard look at the cumulative impacts of the proposed action. Cumulative effects analysis was addressed in detail in Sections 3.5.3-18 and Section 3.8. Cumulative effects on trophic cascades, lead, and other specific issues are addressed in subsequent sections.

5.6 Ecologically Sensitive Areas

We received numerous comments opposed to the proposed PDM in Wilderness Areas (WAs) and Wilderness Study Areas (WSAs), collectively referred to by commenters as "wilderness". Commenters generally felt that grazing activities and PDM in wilderness are a violation of the Wilderness Act and that PDM work in wilderness was a significance factor requiring an EIS. Comments also included that PDM should only occur in wilderness for 1 of 3 reasons, that aerial work would be an unacceptable disruption to wilderness, and that "serious loss of livestock" was not defined in the EA. There were also comments in favor of allowing PDM in wilderness to support livestock, as indicated in Section 5.2 Supportive Comments.

Grazing is explicitly allowed in designated Wilderness Areas by the Wilderness Act under Section 4(d), is administered through the policies of the land-management agencies, and is further supported by Congressional Grazing Guidelines (WA Section 1.10.3.13). PDM is allowed in wilderness when it is conducted within the constraints of the Wilderness Act, as defined by land-management agency policies. These constraints are diligently documented and incorporated into the analysis of wilderness at all points, but Section 1.10.3.12 details the laws, policies, and processes that allow and facilitate PDM activities.

The 3 reasons why PDM may be conducted in wilderness are outlined by the management agencies in guidance (EA Section 1.10.3.12), one of which is the prevention of serious losses of domestic livestock. WS-Nevada understands that the "seriousness" threshold of a livestock loss event cannot be pre-determined. It must be evaluated on-site at each depredation event and in consideration of all incident specific factors. However, WS-Nevada uses the Decision Model (EA Section 1.9.3 and 2.3.2.4) to ensure PDM is conducted within the analysis of the EA and only conducts PDM approved by the agency designated with management authority for the wilderness at issue.

Commenters stated that methods proposed violate wilderness character. This is inaccurate, and EA Section 3.11.1 details all qualities of wilderness character and the potential effects of the proposed methods. WS-Nevada outlined a restricted set of tools proposed for use in WAs in section 2.3.2.3 to meet the intent of the Wilderness Act and the requirements of the implementing regulations.

One commenter states that WS-Nevada did not specify other ecologically sensitive areas where PDM may occur. The commenter specifically noted National Recreation Areas and Wild and Scenic River Corridors. EA Section 1.9.4.B identifies federally-managed lands where WS-Nevada does not anticipate working. The ESA Section 7 consultation analyzed potential impacts on critical habitat and found the proposed action would not affect designated habitat. Appendix G lists all WAs and WSAs in the state and shows the likelihood of WS-Nevada being requested to conduct PDM in each. The only National Recreation Area in Nevada is Lake Mead NRA, which is managed by NPS. Section 1.9.4 of the EA explicitly states that National Park Service Lands are excluded from the scope of the EA. There are no Wild and Scenic Rivers in Nevada, therefor WS-Nevada does not need to exclude any from the scope of work. WS-Nevada is not aware of other ecologically sensitive areas to either include or eliminate from analysis, and the commenter did not provide any other specifics of concern. Therefore, our analysis of the potential impacts to ecologically sensitive areas remains unchanged.

One comment misrepresented WS-Nevada's proposal for work in wilderness, stating that the proposed work will be conducted across large areas of wilderness, throughout the year. WS-Nevada clarified the presentation of that data in Section 3.11, adding in several summary tables/figures. As presented in Table 3-22, of all WA acres in the state, only 3.5% have an "extremely high likelihood" of being worked "nearly year round" at any point in the next 10 years. That is only 0.3% of the acres in Nevada. The scale of work, when combined with other proposed limitations and when analyzed by the land management agencies in minimum requirements analyses will not result in a significant impact on ecologically sensitive areas.

5.7 Economic Issues

We received a few comments related to economic issues, including the purported NEPA requirement of a cost-benefit analysis, potential impacts of PDM on outdoor recreation and tourism industries in Nevada, and subsidies to public land ranchers.

We did not prepare a monetary cost-benefit analysis (CBA) for this EA, and we did not use a monetary CBA to choose between alternatives. We also do not use a monetary CBA to make decisions about whether or how to respond to a request for PDM assistance.
The costs and benefits associated with WS-Nevada's services are unique to each entity that requests assistance. WS responds to requests for assistance on a case-by-case basis, and its recommendations are based on WS Directive (IWDM directive). Implementation of some methods may have no monetary cost to the cooperator, such as technical assistance (advice). When WS-Nevada does charge a fee, cooperators determine on a case-by-case basis whether the benefit is worth the cost. For example, one producer may determine WS-Nevada's fencing recommendation is cost-effective under the circumstances; another producer may reach the opposite conclusion. Either way, WS-Nevada recommends all effective methods as solutions for predations.

Commenters point to sections of the EA that describe economic issues relevant to PDM and those economic issues raised in other NEPA processes. We included this information because we believed them likely of interest to the public (Sections 1.11.2.1-3, and Sections 1.13.3-6). These discussions provide background about the conflicts that result in requests for WS-Nevada's assistance. However, commenters are incorrect to the extent that they imply Wildlife Services uses a cost benefit analysis to choose between alternatives in this EA, or to make decisions on whether and how to respond to a request for PDM assistance.
Economics alone are not an environmental effect that necessitate the preparation of an EIS (CEQ Section 1508.14). Even when an EIS is prepared, a monetary cost-benefit analysis is still not required when there are other qualitative considerations that are relevant and important to a decision (CEQ 1502.23). This EA considers important qualitative factors such as humaneness, population impacts, target selectivity, and human and pet safety. We identify and analyze these factors in Chapter 3.

Regarding potential impacts to outdoor recreation and tourism industries, the EA analyzed effects on recreation and aesthetic values of the environment in Sections 3.12, 3.12.2, 3.12.3.1, and 3.12.3.2, and determined that WS-Nevada's activities were unlikely to have any significant adverse effect on recreation. We based this determination on several factors, including:

- WS-Nevada coordinates with land management agencies to de-conflict PDM with recreational uses and minimize impacts to recreation. Impacts to the solitude or primitive recreation quality of wilderness character are part of the analysis provided in Section 3.11.1.2 and will be considered in MRAs;
- Land allotments designated for grazing livestock are not used extensively by recreationists during peak times of PDM, further reducing the likelihood of a recreationist being limited by or encountering PDM activities; and
- WS-Nevada is proposing very low levels of lethal removal of target species, (Section 3.5) and we do not expect the public will experience a noticeable decrease in wildlife encounters (Section 3.12.3.1).

We do not anticipate any adverse effects to tourism or recreation opportunities from the proposed activities.

Section 1.13.7 addresses comments related to the livestock industry receiving federal subsidies in the form of WS-Nevada PDM services, including use of taxpayer funds for livestock industry support, livestock losses being tax write-offs, compensation replacing WS-Nevada PDM, livestock producers paying for all PDM, WS-Nevada subsidizing privately-implemented non-lethal PDM, and PDM being funded through at state head tax. WS-Nevada is a cooperatively funded "fee for service" agency with the majority of its funding comprised of non-federal, cooperative dollars (as opposed funds to congressionally appropriated to the agency), not a federal subsidy for livestock production.

5.8 Efficacy of PDM

We received numerous comments questioning the efficacy of lethal PDM. Many commenters felt that the individual methods were not effective while some felt that lethal control on the whole was not effective. Some questions about the efficacy suggests a misunderstanding of the intent of PDM by asking "if PDM was effective then why wasn't all wildlife dead by now?" The issue of compensatory reproduction was also raised, with one commenter stating that killing coyotes results in more coyotes so lethal PDM can't be effective.

Efficacy of PDM was discussed in Sections 1.12.3 and 1.12.4. We have not received any information that alters that analysis or the conclusions drawn from it. While WS-Nevada will not conduct PDM for wolves under this analysis, and impact to wolves as a federally-listed species have been considered, Section 1.12.3.4 reviewed the science associated with wolf PDM because it is frequently cited by commenters as applying to all predators. WS-Nevada is aware of the science related to wolves, has considered it, but it does not have direct applicability to the proposed actions.

Claims that PDM should result in long-term reductions to the target populations were addressed in Section 3.5 of the EA. The goal of PDM is not to reduce a population but to minimize damage and the analysis in the EA demonstrates that populations are not adversely affected by the proposed level of PDM. If that were the goal, WS-Nevada would not spend so much time and effort providing non-lethal assistance, nor would the proposed action be to only take a number of animals necessary to alleviate damage.

There are claims that PDM results in increased predator populations through compensatory reproduction, specific to coyotes. This would mean lethal PDM leads to increased predator populations. WS-Nevada discussed compensatory reproduction in Section 3.5.3.2. We are unaware of any data that indicates that recovery of coyote population directly correlates to an increase in livestock depredations.

Additionally, the commenter’s suggestion that WS-Nevada's action may result in an increase in the coyote population through compensatory reproduction supports the conclusion in section 3.5.3 that the proposed action is not likely to adversely affect coyote populations. WS-Nevada has also not seen drastic increases in requests for assistance over the years of conducting PDM as might be expected had the ongoing PDM activities caused a significant increase in depredation of livestock.

One commenter claimed that livestock depredations will increase following lethal control. However, the commenter cited a wolf study that was reviewed and was not applicable to this analysis.

5.9 EIS Required

Several commenters demanded WS-Nevada prepare an EIS for the proposed action. Reasons for this included significant impacts, work on public lands, work in wilderness, and invalidation of EAs in other states.

WS-Nevada’s decision to prepare an EA was addressed in Section 1.10. The results of the analysis indicated no significant impacts, which supports that decision. None of the reasons cited by commenters are triggers for preparation of an EIS on their own. The EA analyzed all of the potential effects of the cited issues and determined there was unlikely to be any significant impacts that would warrant the preparation of an EIS. Section 1.10.2 of the EA defines how WS-Nevada analyzed significance and cumulatively significant impacts.

5.10 Ethics and Humaneness

We received numerous comments on the topic of humaneness. Some commenters assert that Alternative 2, lethal PDM, and specific PDM methods are inhumane. Ethical concerns were raised in claims that is was unethical for APHIS-WS to work only for livestock producers. One commenter accused WS-Nevada of inflating numbers in the EA. One entity requested that WS-Nevada agree to a 24-hour trap check. Other comments includes various adjectives for PDM methods and WS-Nevada personnel.

The EA discussed and analyzed ethics and humaneness in depth in Sections 3.2.4 and 3.9. No new information was provided to alter the analysis presented. WS-Nevada recognizes that many people feel PDM methods are inhumane, cruel, and/or unacceptable, while other people feel that lambs, sheep, calves, or pets being injured or eaten by predators is equally inhumane, cruel, and/or unacceptable.

The statement that WS-Nevada works only for livestock producers, or caters to agribusiness, or is in the pocket of any interest group is factually inaccurate and a gross mischaracterization of the program and the way in which WS-Nevada serves the public, as described in Sections 1.4.3 and 1.5.2. WS-Nevada does not preclude any group from service.

WS-Nevada rejects the assertion that numbers in the EA were inflated or that APHIS-WS has an institutional problem with poor ethics and rules compliance. WS-Nevada presented accurate date for the state and national levels where appropriate to the context of the discussion. The commenter did not contest any specific information in the EA. EA Section 1.5.2.2 "How does APHIS-WS ensure the implementation of professional IWDM Practices?" addressed the accusations regarding APHIS-WS's ethics. Additionally, Section 3.9.5 explains how APHIS-WS approaches ethics and animal welfare.

In regard to the request for a 24 hour trap check policy, WS-Nevada follows applicable state laws and regulations regarding the frequency of trap checks (Section 2.4.4.3). When warranted, WS-Nevada employees may check traps more often than required, but no less often than agreed upon in APHIS-WS/NDOW MOU (12-73-32-6500-MU) signed 06/03/2015.

5.11 M-44 Devices

We received several comments regarding the use of M-44 devices and other chemicals. These comments oppose their use and assert that the use of M-44 devices and other chemicals under Alternative 2 would result in significant impacts on human safety, pet safety, non-targets, threatened and endangered species, public lands, and wilderness. Several comments also asserted that M-44 devices are indiscriminate and inhumane.

We understand that some individuals will oppose the use of M-44s due to the chemical they contain. The EA discusses the M-44 in detail, including risks to people, non-targets, the environment, humanness, and general selectivity in Section 3.2.4, 3.7, 3.9.5.2.1, 3.10.3.1, 3.12.2.1, and Appendix A. Risks of the method for federally-listed species was included in Section 7 Consultation and summarized in Section 3.6.4. The EA also incorporated information from the 2019 Risk Assessment on Sodium Cyanide, which is available to the public at https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/programs/nepa/ct-ws-risk_assessments. WS-Nevada specifically excluded the use of M-44s from PDM in WAs in EA Section 2.3.2.4.

One commenter indicated that they would like to see "cyanide bombs" dropped on Wildlife Services. This comment indicates a common misconception that an M-44 is some kind of explosive device deployed across the landscape similar to landmines. As described in Appendix A, the M-44 is spring-activated and is actuated when an animal pulls up on the capsule holder with its teeth; a plunger propelled by the spring breaks through a capsule containing dry NaCN (sodium cyanide) which delivers the chemical directly into the animal's mouth. There is no explosive charge or explosion. We encourage the public to look at the diagrams and information in the Formal Risk Assessment (https://www.aphis.usda.gov/wildlife_damage/nepa/risk_assessment/RA7%20Sodium%20Cyanide%20-%20amended%20-%20Peer%20Reviewed.pdf) for a better understanding of the M-44 device.

A couple of commenters noted past M-44 incidents that resulted in death or injury to humans and/or pets. The list provided to WS-Nevada in public comment includes several incidents of family pets dying after pulling an M-44 and a few incidents of human exposure to sodium cyanide from trying to treat an exposed pet or from directly pulling the device out of curiosity. APHIS-WS and WS-Nevada are aware of those incidents, as the information from the commenter was provided by APHIS-WS, and none of those incidents occurred in Nevada. APHIS-WS continually evaluates PDM methods and their implementation so that policies are as proactive as possible in preventing such incidents. In response to the 2017 incident in Idaho where a boy and his dog were exposed to an M-44, APHIS-WS conducted a formal, peer reviewed risk assessment on Sodium Cyanide, Updated WS Directive 2.415, and issued revised use guidelines that are detailed in section 2.4.1.6 of the EA. In December of 2019, EPA issued a revised interim decision for the use of M-44s, citing new and revised revisions that will better protect people and non-targets (https://www.epa.gov/newsreleases/epa-announces-revised-interim-decision-m-44-predator-control-devices). As reported by the MIS, WS-Nevada did not kill any pets or non-target feral/free-ranging dogs with M-44s in Nevada since at least February 2005 (Section 3.7, Appendix E). [12]The updated risk assessment and EPA registration, along with the use patterns in Nevada are presented in the EA and ensure that M-44s are used in a manner that will not result in significant risk or impact to the human environment.

5.12 Modern Wildlife Biology

Several commenters asked that WS-Nevada consider science for managing wildlife. One commenter stated that the EA is deficient because outdated scientific research was used, and that more relevant science must be considered. They specifically point to use of studies from the 1940s to the 1980s.

This assertion is true only to the extent that the EA contains some older citations generally related to species biology that has not changed in hundreds of years, or historic population trends provided as background information for the analysis. However, the commenter is inaccurate in their representation of the document on the whole. WS-Nevada has reviewed and cited the best available science in the preparation of this EA, with extensive literature citations provided in the Section 4, and Appendices A and F. These citations include relevant studies from the long list of papers that the commenter provided during public scoping in 2016, all of which were reviewed in the preparation of the EA. Additional studies provided during the recent 2019 public comment were also reviewed and included in the analysis as applicable. Many submitted papers were not included in the EA because they were either outside the scope of the EA, did not add to or change the analysis substantively, or were opinion pieces and not peer-reviewed literature. These include:

Belsky and Gelbard 2000	Livestock Grazing and Weed Invasions in the Arid West
Beschta et al 2013	Adapting to climate change on western public lands: addressing the ecological effects of domestic, wild, and feral ungulates

[12] 02/21/2005 was WS-Nevada's first recorded take entered into the MIS2K system. Data available prior to that date does not provide non-target take by method.

Carter et al 2010	Moderating Livestock Grazing effects on plant productivity, nitrogen and carbon storage
Fleischner 1994	Ecological Costs of Livestock Grazing in the Western North America
Gehring et al 2010	Utility of livestock-protection dogs for deterring wildlife from cattle farms
Gehring et al 2011	Good fences make good neighbors: implementation of electric fencing for establishing effective livestock protection dogs
Kimball and Schiffman	Different Effects of Cattle Grazing on Native and Alien Plants
Lambert et al. 2006	Cougar Population Dynamics and Viability in the Pacific Northwest
Lute et al. 2016	Moral dimensions of human-wildlife conflict
Peebles et al. 2013	Effects of remedial sport hunting on cougar complains and livestock depredations
Ripple and Beschta 2012	Trophic cascades in Yellowstone: the first 15 years after wolf reintroduction
Vucetich and Nelson 2013	The Infirm Ethical Foundations of Conservation
Wilmers et al 2003	Resource dispersion and consumer dominance: scavenging at wolf- and hunter-killed carcasses in greater Yellowstone
Bergstrom 2017	Carnivore Conservation; shifting the paradigm from control to coexistence
Carter et al 2020	Integrated Spatial Analysis for human-wildlife coexistence in the American West
Clark et al (In Press 2019)	Predicting Spatial Risk of Wolf-Cattle Encounters and Depredation
Draheim 2017	Why Killing Coyotes Doesn't Make Livestock Safer
Eklund et al 2017	Limited Evidence on the Effectiveness of Interventions to Reduce Livestock predation by Large Carnivores
EPA Water Quality Standards	Chapter 4: Antidegredation
Lance et al 2010	Biological, technical, and social aspects of applying electrified fladry for livestock protection from wolves
Levi et al 2012	Deer, predators, and the emergence of Lyme disease
Manfredo et al 2017	"Values, trust, and cultural backlash in conservation governance: The case of wildlife management in the United States"
Nirenberg et al 2016	Killing for fun(ds): the centerpiece of agency interactions with wildlife
Santiago-Avila et al 2018	Killing wolves to prevent predation on livestock may protect one farm but harm neighbors
Scasta et al 2017	Rancher-reported efficacy of lethal and non-lethal livestock predation mitigation strategies for a suite of carnivores
Shivik et al 2003	Nonlethal Techniques for Managing Predation: Primary and Secondary Repellents
Slagle et al 2017	Attitudes toward predator control in the United States: 1995 and 2014
Van Eeden et al 2018	Carnivore conservation needs evidence-based livestock protection
Flagel et al 2016	Natural and experimental test of trophic cascades: gray wolves and white-tailed deer in Great Lakes forest
Davidson-Nelson and Gehring 2010	Testing fladry as a nonlethal management tool for wolves and coyotes in Michigan
Bryan et al. 2015	Heavily Hunted wolves have higher stress and reproductive steroids than wolves with lower hunting pressure
Treves and Naughton-Treves 2005	Evaluating lethal control in the management of human-wildlife conflict

Beschta and Ripple 2016 Riparian vegetation recover in Yellowstone: The First 2 decades after wolf reintroduction
Belant et al 2011 Managing human-black bear conflicts. Human-wildlife conflict monograph
Thompson and Cassaigne 2017 The empowerment of livestock owners and the education of future generations to reduce human-feline carnivore conflict

News articles, professional communications, program reports, news articles, and other non-scientific literature publications are not included in this list. Those can be found on regulations.gov and were reviewed by WS-Nevada.

Documents that were provided to WS-Nevada that were either already in the EA or were subsequently added to the analysis include:

Leopold et al. 1964 Predator and rodent control in the US
Berger and Gese 2007 Does interference competition with wolves limit the distribution and abundance of coyotes?
Coates et al. 2016 Landscape characteristics and livestock presence influence on common ravens: relevance to greater sage grouse conservation
Crooks and Soule 1999 Mesopredator release and avifaunal extinctions in a fragmented system
Estes et al. 2011 Trophic Downgrading of Planet Earth
George et al 2016 Changes in attitudes toward animals in the US from 1978 to 2014
Gese 2005 Demographic can Spatial Responses of Coyotes to Changes in Food and Exploitation
Henke and Bryant 1999 Effects of Coyote removal on the faunal community in western Texas
Lute and Attari 2016 Public preference for species conservation: choosing between lethal control, habitat protection, and no action
Nelson et al. 2016 Emotions and Ethics in Conservation Decisions
Prugh et al. 2009 The Rise of the Mesopredator
Treves et al. 2015 Predators and the public trust
Treves et al. 2016 Predator Control should not be a shot in the dark
Vucetich et al 2015 Evaluating whether nature's intrinsic value is an axiom of or anathema to conservation
Wielgus and Peebles 2014 Effects of Wolf Mortality on Livestock Depredations
Wilmers et al 2003 Trophic facilitation by introduced to predators: grey wolf subsidies to scavengers in Yellowstone National Park
Manfredo et al 2018 American's Wildlife Values: The Social Context of Wildlife Management
Ripple et al 2014 Trophic cascades from wolves to grizzly bears in Yellowstone
Stone et al. 2017 Adaptive use of nonlethal strategies for minimizing wolf-sheep conflict in Idaho
Winnie and Creel 2016 The Many Effects of Carnivores on their Prey and Their Implications for Trophic Cascades, and Ecosystem Structure and Function
Rashford et al. 2010 Economic Analysis of Predator Control
Bergstrom et al 2014 License to Kill: Reforming Federal Wildlife Control to Restore

Biodiversity and Ecosystem Function

5.13 Lead

WS received several comments opposing the use of lead ammunition and claims that the EA failed to properly analyze the use of lead. A commenter stated that the EA fails to consider the impact of using lead shot on non-target species. One commenter also noted that WS-Nevada's use of lead ammunition is cumulatively significant.

We disagree that the use of lead shot in PDM activities was not adequately analyzed in the EA. Section 3.10.2.4 thoroughly analyzes the impacts of lead on non-target birds, while Section 3.10.2.5 analyzes the impacts to terrestrial mammals. Section 3.10.2.6 discussed the risks to human health from WS-Nevada's use of lead, also referencing the newly released formal Risk Assessment on Lead, prepared by APHIS and peer-reviewed. Nationwide, APHIS-WS contributes less than 0.01% of the amount of lead being introduced into the environment from hunting, fishing, and industrial activities (EA Section 3.10.2.2). That contribution is negligible, and no cumulative effects are anticipated. The analyses further indicated that the risk to humans of lead exposure from WS-Nevada activity is low. Commenters provided no facts or literature to alter or refute the analysis of effects provided in the EA, and we feel the analysis is comprehensive and sufficient.

5.14 Unintentional Take

Many commenters expressed concern for animals likely to be taken inadvertently in the course of PDM. PDM methods were characterized in comments as "being indiscriminate and often kill unintended victims". Commenters asserted that PDM methods would result in significant non-target take, including endangered species, that non-target take is higher than what was reported, and that the EA does not adequately address the risks. One commenter stated that trauma from trapping should be considered for animals subsequently released.

We disagree with these assertions. The potential for Alternative 2 to impact non-target species populations, including threatened and endangered species, is discussed and analyzed throughout In Section 3.6, and 3.7. WS-Nevada rarely takes non-target species during PDM, averaging only 7.8 non-target animals per year (Section 3.7). The reliability of APHIS-WS's data reporting was verified by the 2015 OIG Audit (Section 1.12.2.1). We determined that Alternative 2 was unlikely to have significant impact on non-target species populations, including threatened and endangered species (Section 3.6.5.2).

WS-Nevada personnel are skilled at employing PDM methods so they are extremely selective for the target species (0.1% of the intentional take total, EA Section 3.7). Section 2.4.1.2 lists the policies for capture devices under the proposed action. However, when non-target species are trapped, WS-Nevada personnel evaluate them to determine if they are likely to survive. If an animal is unlikely to survive, it may be humanely euthanized and reported. Precautions for federally listed species are include in Section 2.4.1.2.h, and were formulated as part of Section 7 ESA consultation with USFWS. Section 3.9.5.1 analyzes the humanness of the physical capture methods proposed for use. No additional science or literature was provided accompanying the comment on the effect of releasing trapped animals. As WS-Nevada takes only an average 7.8 non-target animals per year, we are confident that the proposed action will not indirectly lead to adverse population effects from releasing trapped animals.

One commenter requested additional analysis for unintentional take of wolverines, Sierra Nevada Red Fox, and Sierra Nevada Bighorn Sheep. Wolverines were addressed in Section 3.6.2. WS-Nevada determined they would not be affected by proposed activities because WS-Nevada will not be conducting PDM in areas where wolverines would live, and only one wolverine has been documented in the state in the last 80 years. Sierra Nevada bighorn sheep and red fox are not present in Nevada, so there is no potential for the proposed action to affect them.

5.15 Wolves

We received comments stating the analysis of impacts to wolves in the EA was inadequate because wolves are federally protected and may be impacted by WS-Nevada PDM. A lot of literature regarding wolves was provided as well.

WS-Nevada is a partner in the interagency wolf coordination effort and is well informed on the evolving policies and procedures implemented by USFWS and NDOW for wolves (EA Section 2.4.2.1). Effects of the proposed action, along with minimization measures for protection of wolves that may enter Nevada were analyzed in the Section 7 Consultation (Section 2.4.2). The consultation concluded that the proposed action was not likely to adversely affect gray wolves. Effects to gray wolves were also discussed in Section 3.6.4.1. We feel this is adequate to assess and minimize potential impacts to wolves.

5.16 Mesopredator Release

The potential for Mesopredator release due to WS-Nevada's proposed actions was raised by one commenter.

Discussed in Section 3.8.2, Sections 3.8.4.1-5, and Appendix F. We determined there was no risk of the proposed action contributing to mesopredator release.

5.17 Opposition to Human Interference

A few commenters indicated they would prefer that humans have no role in managing wildlife.

While WS-Nevada cannot limit other entities from PDM, Alternative 5 analyzed what would happen in the absence of federal WS-Nevada's involvement in PDM. Alternative 5 failed to meet the objectives and the need for action of the EA. Ending all wildlife management, by all entities, is outside the scope of the analysis.

5.18 Opposition to Lethal PDM/Prefers Non-Lethal Methods

We received numerous comments regarding the use of non-lethal PDM. Most of these comments asserted that non-lethal methods are effective. Many of these comments assert that non-lethal methods are more effective, cheaper, more socially acceptable, and/or longer-lasting than lethal PDM. Some comments address specific non-lethal methods (these are included in the response below).

WS-Nevada is aware that some people oppose lethal PDM. Section 1.4.2 of the EA addresses values related to wildlife, including the results from the Manfredo et al. (2018) publication on the diverse range of public attitudes towards wildlife. WS-Nevada considered 1 alternative that contained no lethal PDM (Alternative 5) and 1 that considered an almost entirely non-lethal PDM program, with exceptions for human and pet health and safety (Alternative 4). Studies cited by the commenter relate to wolves (outside of the scope) and do not add to the analysis in the EA. WS-Nevada works with the National Wildlife Research Center (NWRC) to develop and review methods available for PDM, as detailed in Sections 1.5 and 1.12.4.

5.19 Government Compensation

Government compensation was commented on in several ways. Commenters felt that ranchers should accept losses because they receive compensation from the government, that tax dollars should not be used to help the livestock industry, and that ranchers should receive compensation for their losses instead of using APHIS-WS.

The State of Nevada provides no compensation for wildlife damage caused by predators and none of the predators included in the EA are covered by the Agricultural Act of 2014. Compensation programs and economic aspects of livestock grazing on public lands were addressed in detail in the following Sections:

1.13.3.1	Use of Taxpayer Funds for Private Profit, Livestock Losses Considered a Tax Write-off, and Livestock Losses Should Be an Accepted Cost of Doing Business
1.13.3.2	Compensation for Losses or Damage Should Replace APHIS-WS PDM
1.13.3.3	Livestock Producers Should Pay All Costs of PDM
1.13.3.4	WS-Nevada Should Subsidize Non-lethal Methods Implemented by Resource Owners
1.13.3.5	Incorporate the Environmental Costs of Livestock Grazing on Public Lands into Cost Analyses
1.13.3.8	PDM Should be Funded through a State Head Tax

WS-Nevada also discussed other PDM alternatives related to compensation that were not considered for comparative analysis, including Sections

2.5.6	Providing Compensation for Losses
2.5.7	Livestock Producers Should Exceed Threshold of Loss Before IPDM Actions are Taken

2.5.24 Make Supplemental Payments to Livestock Producers Livestock Protection Program
2.5.25 WS-Nevada Should Subsidize Non-Lethal Methods Implemented by Resource Owners.

We feel these discussions thoroughly examined and analyzed potential alternatives to Lethal PDM and address the comments provided to the agency.

5.20 Public and Pet Safety

Several commenters states that they were concerned about their and their family's safety when on public lands, noting that the methods were known to kill or wound humans and wildlife. One commenter felt the analysis of M-44 take of non-target canines was not adequate and accused APHIS-WS of covering up incidents. Concerns about M-44s and lead were addressed in previous comment responses.

We disagree with the assertions that human or pet health or safety would be negatively impacted under Alternative 2. Potential impacts to human and pet safety under the Alternatives were analyzed in Section 3.10. Alternative 2 was determined not to result in any significant impact to human or pet health or safety in this Section. Non-target take under Alternative 2 was analyzed in Section 3.7, which includes any take of pets and non-target canines. WS-Nevada did not lethally take any pets during the analysis period and determined that risks to pets remains low under the proposed action (Section 3.7.1.2). Take of non-target canines was also analyzed in Section 3.7 and determined that risks to non-target canines remains low under the proposed action (Section 3.7.1.2).

We disagree with the assertion that humans would be negatively impacted on public lands under Alternative 2. The analyses in Section 3.10 considers the fact that humans use public lands in Nevada. The potential for impacts on public recreation was analyzed in Section 3.12. Alternative 2 was determined not to result in any significant impacts.

5.21 Bioterrorism

One commenter cited OIG Audits from 2004, 2005, and 2006 which stated that APHIS-WS was not in compliance with the Bioterrorism Preparedness and Response Act.

Between 2002 and 2006, there was one (1) OIG audit involving WS, which resulted in an audit report (OIG 2004, WS hazardous materials issues). Additionally, APHIS-WS has proactively conducted reviews and audits of the Pocatello Supply Depot and NWRC facilities. As of April 30, 2007, all corrective actions for the audit were completed, and the USDA Office of the Chief Financial Officer (OCFO) assigned closure dates for each recommendation. APHIS-WS has implemented a comprehensive inventory accounting system (CMITS) for hazardous materials and controlled drugs that APHIS WS uses in wildlife damage management, and has updated and strengthened its management Directives pertaining to pesticides and hazardous materials. APHIS-WS answered the OIG recommendations related to storage by updating the management directives containing the requirements for proper storage and security of hazardous materials. All audit recommendations were satisfied and closed during 2007.

The 2005 and 2006 OIG audit reports did not involve APHIS-WS. The audit report entitled, "Animal and Plant Health Inspection Service Evaluation of the Implementation of the Select Agent or Toxin Regulations Phase I (Report No: 33601-02-AT)" for 2005 involved APHIS Veterinary Services and Plant Protection and Quarantine programs. The audit report entitled, "Animal and Plant Health Inspection Service Evaluation of the Implementation of the Select Agent or Toxin Regulations Phase II (Report No: 33601-3-AT)" for 2006 involved APHIS Veterinary Services and Plant Protection and Quarantine programs. This audit is closed.

This report and the issues associated with it were rectified over a decade ago and there have been no bioterrorism incidents resulting from APHIS-WS activities.

5.22 2008 Notice of Warning from EPA

One commenter mentioned a letter of warning APHIS-WS received from the EPA in 2008 regarding use of sodium cyanide.

In March, 2008, WS-Utah received a Notice of Warning from the EPA regarding an allegation of a domestic dog being killed by an M-44 set by WS in 2006, allegedly because the device was set within an area "set aside for recreation" (M-44 Use Restriction, UR 8). WS-Utah's placement of the M-44 complied fully with UR 8, and was set more than 2 miles from a reservoir sometimes frequented by people, and the location was outside of "human safety zones" established by the BLM. The area was not set aside for recreation. The Utah Department of Agriculture and Food (UDAF, the EPA-delegated FIFRA enforcement agency) investigated the complaint and concluded that no violations occurred. APHIS-WS and UDAF have independently requested a rescission of the Notice, since APHIS-WS was in compliance with all laws and M-44 Use Restrictions. No carcass or other evidence was ever produced by the complainant to substantiate the claim. Placement of the M-44 was supported by BLM's Annual Work Plan with WS-Utah, which contained authorization for WS-Utah to use M-44's in the Vernal, Utah BLM District and was consistent with the product label, including Use Restrictions. APHIS-WS has submitted a follow-up request for rescission to EPA (March 26, 2009).

This incident occurred and the process was concluded over a decade ago. This has no bearing on the analysis in the EA.

5.23 Public Trust

Commenter stated that killing wildlife on public lands for the benefit of livestock producers "fails the government's public trust obligations".

WS-Nevada disagrees with this assertion. The Act of March 2, 1931 authorizes the Secretary of Agriculture to conduct a program of wildlife services. As amended in 1987, congress explicitly authorized Wildlife Services "to control nuisance mammals…". WS-

Nevada continues to act under that authority and in good faith with state and federal natural resource management partners. See EA Section 1.5.1.

5.24 Alternatives

We received numerous comments regarding the alternatives both supporting and opposing each one. Some commenters expressed opposition to our decision to not include certain alternatives in Section 2.5 (Alternatives and Strategies Not Considered For Comparative Analysis) in the analysis in Chapter 3. Some commenters requested that WS-Nevada consider alternatives outside the scope of the EA.

WS-Nevada holds that an Alternative that ends livestock grazing on public lands is outside the scope of the EA (Section 1.6). APHIS-WS does not make public land use management decisions. Policies that determine the multiple uses of public lands are based on Congressional acts through laws such as the Taylor Grazing Act of 1934 and the Federal Land Policy and Management Act for the BLM, and the Forest Service Organic Act of 1897 and the Multiple Use-Sustained Yield Act of 1960 for the Forest Service. Congressional appropriations support the implementation of these authorities. In contrast, WS-Nevada only addresses predator damage management upon request.

A commenter objected to WS-Nevada not considering a "No Use of M-44s in PDM" alternative. WS-Nevada considered a non-lethal methods only alternative, which would restrict M-44s along with other methods that the commenter expressed opposition to. So Alternative 4-Non-lethal Only (except for protection of human and pet safety) was analyzed in detail to reduce redundancy.

A commenter disagreed with WS-Nevada not considering the alternative of compensation for predator damage losses based on current laws. They assert that an agency must consider all reasonable alternatives even if they are outside the agency's jurisdiction. However, WS-Nevada did consider this alternative in Section 2.5.6 of the EA, and the subject is also discussed in Section 1.13.3.2. WS-Nevada has no authority or jurisdiction to make policy or change laws on the subject of compensation for predator damage. WS-Nevada maintains that this alternative is outside the jurisdiction of APHIS-WS, is infeasible, and is likely ineffective.

One commenter stated that all reasonable alternatives must be explored in detail, particularly those that might enhance environmental quality or avoid some or all of the adverse environmental effects. We disagree with these assertions. WS-Nevada determined that these are not reasonable alternatives, and the cited CEQ regulation states that agencies shall include only "reasonable" alternatives which meet this criterion. WS-Nevada considered all reasonable alternatives in the EA. The alternatives we considered which were outside of our jurisdiction were not analyzed in detail for the reasons provided in the analysis of these alternatives. We did not consider any alternatives in which we would refuse specific PDM services to anyone or any entity without cause, because they would not be consistent with the fairness standards of USDA, APHIS, or WS. Therefore, such alternatives would not be reasonable alternatives.

One commenter requested that WS-Nevada consider 4 alternatives, including Technical Assistance Only, Use of Only Non-Lethal Methods, WS-Nevada Verifies that All Possible Non-Lethal Methods are Exhausted Before Implementing Lethal Operations, and Producers Should Avoid Grazing Livestock in Areas of Predator Activity and Ensure Herders Constantly Present. In fact, all of these alternatives were considered in Section 2.5. WS-Nevada maintains that the analysis of these alternatives is sufficient and consistent with CEQ guidance, as explained in Section 2.5.

One commenter requested that the EA be rewritten to prioritize non-lethal PDM until all non-lethal methods have been exhausted. The EA considered 2 alternatives that are similar to those stipulations - Alternatives 3 and 4. The alternative for exhausting all non-lethal in all cases (EA Section 2.5.4) was not considered in detail because it would require use of non-lethal methods that are not appropriate or effective and 2) there was no allowance for human safety. So Alternatives 3 and 4 considered in detail (Sections 2.3.3 and 2.3.4) provide reasonable and viable approaches for addressing the needs of requesters and concerns of commenters without incurring unreasonable and unacceptable risks and losses.

5.25 Ravens

We received 3 comments related to proposed raven management activities. 2 of the comments supported the proposed action, and 1 opposed the action claiming there is no science supporting raven management for protection of sage-grouse. The commenter goes on to state that since ravens are not injurious to sage-grouse, that WS-Nevada has no authority to manage them.

WS-Nevada proposes conducting raven damage management for both livestock protection and sage-grouse protection, if requested and permitted by natural resource management agencies. The analysis in the EA was prepared jointly with USFWS, including Appendix D (Modeling Common Raven Population and Level of Take).

We disagree with the assertion that there is no science to show that raven management helps sage-grouse. Literature was reviewed and provided in Section 1.11.5.8 of the EA. Raven predation of sage-grouse has been documented since the 1940s, with recent confirmations in peer reviewed literature (e.g., Coates et al. 2008, Lochyer et al 2013, Peebles et al. 2017, and Dinkins et al. 2016). Further, sage-grouse protection is only one need for raven damage management included in the Need for Action and addressed by the proposed action. Raven damage to livestock, utilities, and at landfills are documented in Chapter 1 and are part of the Need for Action.

We disagree that WS-Nevada is not authorized to conduct PDM activities to reduce raven damage. APHIS-WS's authorities are detailed in section 1.5.1, including the Act of March 2, 1931 which gave the secretary of Agriculture the authority to protect American resources from wildlife damage.

5.26 Management Plans of Other Federal Agencies

Commenter claims that the EA does not explain how the proposed actions are consistent with U.S. Forest Service Land and Resource Management Plans (LRMPs) or BLM Resource Management Plans (RMPs).

Section 1.5.2.3 explains how WS-Nevada operates on federally-managed lands, while Section 1.8.2 explains how WS-Nevada works with other federal agencies. Work plans for PDM on federal lands are developed with the federal land management agency to ensure actions comply with their policies and plans.

5.27 Site-Specificity

One commenter stated that WS-Nevada did not analyze site specific impacts and that the geographic scope of the analysis should be smaller than state-wide.

We disagree with this statement. The EA discussed the application of the EA to site specific analyses in Section 1.9.3. In addition, take for the analysis period has been provided by method (Table 2.1), land class (Table 2.2.), County (Table 2.3), BLM jurisdiction (Table 2.4), USFS Ranger district (Table 2.5) and component (Appendix E; Table E.1). WS-Nevada anticipates the take/use patterns to continue in the future, but cannot predict when or where a request for assistance will come from with certainty.

Regarding the state-wide scale of the EA, we disagree with the assertion that it cannot be accurately analyzed at the state-wide level. WS-Nevada worked with other wildlife management agencies to determine the appropriate level of analysis for the proposed action based on the best available data. WS-Nevada uses the Decision Model to evaluate projects on a case by case basis, and if any of those are outside of the scope of the EA, additional NEPA analysis will be conducted.

5.28 Federally Listed Species

A commenter asserted that compliance with ESA does not alleviate an agency of compliance with NEPA. Subsequently, work in desert tortoise habitat, even in compliance with the section 7 consultation, is a risk to their survival. Similarly, the EA should provide detailed data about wolves and wolverine.

WS-Nevada disagrees with the claim that the inclusion of Minimization/Conservation Measures in the proposed action indicate the action presents a risk to the desert tortoise's survival. That logic is not supported by the science or detailed consultations on the subject matter. The EA provides minimization measures for all listed species in the state, based on Section 7 consultation with USFWS. The consultation for tortoise concluded that the proposed action may result in take, but was not likely to result in jeopardy of the species. WS-Nevada will implement the terms and conditions of the consultation, and in so doing, not have a significant effect on the desert tortoise population. As presented in Section 3.6.4.6, only 1 desert tortoise has been taken pursuant to WS-Nevada PDM activities in the last 17 years. That take was the result of extenuating circumstances and adherence to the conservation measures will likely preclude any future take of the species.

WS-Nevada thoroughly analyzed the effect of gray wolves in Section 3.6.4.1, based on the consultation with USFWS on the proposed action. The analysis was sufficient for USFWS to determine the action was not likely to adversely affect gray wolves, and WS-Nevada defers to USFWS as the experts in federally-listed species.

WS-Nevada determined that there would be no effect on wolverines. According to USFWS species assessment form, only one record of a wolverine in the Sierra Nevada Range since 1930 is when a male wolverine was discovered in 2008, based on genetic testing, this species was not from the extirpated Sierra Nevada wolverine population (believed to have gone extinct in the first half of the 1900's) (Moriarty et al. 2009 as cited by USFWS species assessment form). According to USFWS ECOS (undated), areas that wolverines are known or believed to have occurred in Nevada, include the far western edges of Washoe, Storey, Douglas, Lyon, Carson City, Mineral and Esmeralda Counties. Based on that only one wolverine account has occurred in the last 80+ years in the entire Sierra Nevada's, and the limited amount of livestock protection that would even occur in potential wolverine habitat, WS-Nevada PDM activities will have no effect on wolverine. That decision was documented in Section 3.6.

5.29 Predator Populations

One commenter stated that the proposed action contradicts WS-Nevada's claim that only a few animals are killed. Commenter states that targeting apex predators has unanticipated consequences, and provides literature from Yellowstone.

WS-Nevada discloses exactly how many animals may be killed under the proposed action in Section 3.5 and there is no misrepresentation of the proposed action. In Chapter 3, WS-Nevada thoroughly analyzed impacts to target, non-target, T&E species, and evaluated trophic cascades and other ecological consequences and determined there would be no significant impacts to the environment. The study cited by the commenter was on wolves in Yellowstone, and therefore did not add to or alter the analysis in the EA.

5.30 Trophic Cascades

We received several comments and literature related to trophic cascades. One commenter asserted that WS-Nevada failed to show that the proposed action will not result in a change to the ecosystem that may result in a trophic cascade. They state that even though the proposed action will not cause extirpation or extinction, trophic cascades may still occur.

Analysis in Chapter 3 of the EA determined that the proposed level of take will not have significant impacts on any populations. Studies provided regarding trophic cascades largely center on the Yellowstone ecosystem and the reintroduction of wolves. The science from that ecosystem is unique in that an extirpated predator was reintroduced. WS-Nevada is neither extirpating nor introducing any predators. Therefor the ecological conditions and processes that occurred in Yellowstone do not directly translate to activities in Nevada.

Further, we have determined that the proposed action will not result in significant impacts to any wildlife populations (Section 3.5, 3.6, 3.7). We feel that the analysis of whether the proposed level of take may result in a trophic cascade, as analyzed in depth in Section 3.8 and Appendix F, is accurate and sufficient.

5.31 Controversy of Lethal PDM

One commenter states that lethal PDM is often highly controversial.

The EA addressed controversy in Section 1.10.2.1. WS-Nevada is aware that some members of the public believe that some IPDM techniques are controversial. Dissenting or oppositional public opinion, rather than concerns expressed by agencies with jurisdiction by law or expertise and/or substantial doubts raised about an agency's methodology and data, is not enough to make an action "controversial." The EA reviewed all relevant literature, including all literature provided by the commenter, and found no scientific controversy regarding the effects of the PDM activities, as proposed.

5.32 Effects of livestock grazing on sage-grouse habitat

One commenter stated that livestock grazing is the main driver of sage-grouse habitat destruction.

EA Section 1.11.5 discusses the issues related to sage-grouse protection, including grazing and predation. Grazing can be positive, negative, or neutral for sage-grouse, depending on the details. The analysis in the EA determined that PDM for protection of sage-grouse is not likely to have significant effects on any part of the environment, however WS-Nevada would only conduct PDM for the protection of sage-grouse under this analysis when requested and permitted by NDOW or USFWS.

6 List of Persons and Agencies Consulted

Name	Organization, City/State, Title	Purpose of Consultation
Barbara Keleher	BLM, Reno, NV, Nevada Recreation & Nat'l Conservation Lands Lead	Wilderness area (WA) and Wilderness study area (WSA) Policy and impacts
BLM GIS Specialist	BLM, Reno, Nevada, GIS program	GIS Map of project area
Robert Becker	USFS, South Lake Tahoe, CA, Lake Tahoe Basin Management Unit, Recreation Specialist	WA and WSA policy
Peter Coates	USGS, Dixon, CA, Research Wildlife Biologist	Common raven population information
Kelly Gonzales	USFWS, Denver, Co, Migratory Bird Permit Office Legal examiner	Common raven population information
Eldon Brown	USFWS, New Mexico, Permit Chief, SW Region 2 Migratory Birds Office-Permits	Common raven population information
Mandy Lawrence	USFWS-Pacific Region, Oregon, Permit Specialist, Pacific Region Migratory Bird Permit Office	Common raven population information
Jennifer Brown	USFWS, Sacramento, California, Wildlife Biologist Migratory Bird Permit Office	Common raven population information
Mike Cox	NDOW, Reno, Nevada, Big Game Staff Biologist	Wild sheep population information
Russell Woolstenhulme	NDOW, Reno, Nevada, Migratory Game Bird/Furbearer Staff Biologist	Furbearer harvest information
J.J. Goicoechea	Nevada Department of Agriculture, Elko, Nevada, State Veterinarian	Disease information
Eric Gese	USDA APHIS WS-NWRC, Logan, Utah, Research Wildlife Biologist	Coyote population information
Jenny Washburn	USDA APHIS WS, Sandusky, Ohio, Staff Wildlife Biologist	Airport-wildlife statistics
Joseph Millison	USDA APHIS WS, Fort Collins, Colorado, IT Specialist (AD)	MIS2K database queries
Michael Moxcey	USDA APHIS WS, Fort Collins, Colorado, IT Specialist (AD)	MIS2K database queries

7 List of Preparers, Contributors, and Reviewers

Name	Organization/Title	Focus of Involvement
Mark Jensen	USDA-APHIS-WS-Nevada, Reno, NV, State Director	Editor
Jack Sengl	USDA-APHIS-WS-Nevada, Reno, NV, Staff Biologist	Project Management, NEPA, Analysis, Data, Editor
Erica Wells	USDA-APHIS-WS-OSS, Olympia, WA, Environmental Coordinator	NEPA, Planning Strategy, Analysis, Editor
Tom Hall	USDA-APHIS-WS-OSS, Fort Collins, WA, Environmental Coordinator	Target Species Impacts
Jamie Fields	BLM, Reno, NV Outdoor Recreation Planner (Wilderness Specialist)	WA and WSA policy and impact analysis and review of EA
Amedee Brickey	USFWS, Sacramento, CA, Chief, Migratory Birds and CA Condor Coordinator	Common raven information and review of EA
Chris Nicolai	USFWS, Reno, NV, Region 8 Waterfowl Biologist	Common raven population information and modeling
Patrick Devers	USFWS, Laurel, MD, Chief, Branch of Assessment and Decision Support-Division of Migratory Bird Management	Common raven population information and review of EA
Guthrie Zimmerman	USFWS, Sacramento, California, Division of Migratory Bird Management, Population Ecologist	Common raven population information and review of EA
Daniel Morris	USFS, UT, USFS Intermountain Region Wilderness Program	WA and WSA policy and review of EA
Kristie Boatner	USFS, Reno, NV, Wildlife Program Manager/Forest Wildlife Biologist	Review of EA
David Pritchett	BLM, Reno, NV, NEPA Program Lead	NEPA and review of EA
J.A. Vacca	BLM, Reno, NV, Wildlife & Fisheries Program Lead (interim)	Review of EA
Melissa Nelson	BLM, Susanville, CA, Wildlife Biologist-Eagle Lake Field Office	Review of EA
Brian Wakeling	Nevada Department of Wildlife (NDOW), Reno, Nevada, Game Division Administrator	Wild game information and regulation information, review of EA
Pat Jackson	NDOW, Reno, Nevada, Predator Management Staff Specialist	Wild game information, regulation information and review of EA

Appendix A. What Predator Damage Management Methods and Techniques Are Used in the Current Program?

Introduction

WS-Nevada works with federal, state, local agencies, private individuals, and associations to protect livestock, poultry, natural resources, property, and human safety from wildlife threats and damages. WS-Nevada conducts technical assistance (education, information, and advice) and operational wildlife damage management when requested.

Federal, state, tribal, and local regulations and APHIS-WS Directives govern APHIS-WS' use of damage management tools. The following methods and materials are recommended or used in technical assistance and operational damage management efforts of the WS-Nevada program. See Section 3.9 for a detailed discussion on humaneness of various IPDM methods.

What Non-Lethal IPDM Methods Are Available to WS-Nevada?

Non-lethal methods consist primarily of actions, tools, or devices used to disperse or capture a particular animal or a local population, modify habitat or animal behavior, create exclusion between predators and damage potential, and/or practicing husbandry to reduce the risk of or alleviate damage and conflicts. Most of the non-lethal methods available to WS-Nevada are also available to other entities within the state and could be used by those entities to damage. Depending on the method, the cooperator and/or the WS-Nevada employee may implement it. Livestock producers and property owners are encouraged by WS-Nevada to use non-lethal methods to prevent damage.

Each non-lethal method described below identifies its possible application as technical assistance and/or operational assistance.

Education: Technical Assistance

Education is an important element of IPDM activities and facilitates coexistence between people and wildlife. In addition to providing recommendations and information to entities experiencing damage, APHIS-WS provides lectures, courses, and demonstrations to government agencies, universities, and the public. Technical papers are presented at professional meetings and conferences to highlight recent developments in WDM technology, programs, laws and regulations, and agency policies. APHIS' Legislative and Public Affairs (LPA) program coordinates public outreach on WDM topics. APHIS-LPA and APHIS-WS work with agency partners, tribes, universities, extension programs, and others to develop educational materials about predator issues and methods to resolve problems.

Physical Exclusion: Technical Assistance

Physical exclusion methods can sometimes prevent predators from accessing valuable resources. Woven wire and other types of more permanent fencing, especially if it is installed with an underground skirt, can prevent many predator species that burrow, including coyotes, foxes, badgers, feral cats, and striped skunks. Areas such as airports, yards, or hay meadows may be fenced. Hardware cloth or other metal barriers can sometimes be used to prevent accessing protected resources through gaps in existing structures. Entrance barricades are used to exclude bobcats, coyotes, foxes, raccoons, or skunks from dwellings, storage areas, gardens, or other areas.

Temporary fences, such as electric polytape fence or fladry fencing, are often used to protect livestock in temporary pastures, as night pens for sheep, or for protection of small pastures. These systems may need to be maintained or moved frequently to avoid malfunctions or predator habituation.

Predator-proof fencing may be effective in confined situations or for protecting extremely high-value animals. These fences are designed with sufficient height and depth to prevent predators from jumping over or digging under. The initial cost of constructing a predator-proof fence often discourages their use, but may be economically practicable in small areas, such as calving grounds and bedding areas.

Electric fences have been used effectively to reduce predator damage to crops and livestock. Bears have been dissuaded from landfills, trash dumpsters, cabins, and other properties using electric fencing. However, electric fencing can be expensive and requires constant maintenance to avoid short-circuiting.

Animal Husbandry: Technical Assistance

Animal husbandry practices may reduce livestock exposure to predators. Animal husbandry includes actions such as 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, and introduction of human and animal custodians to protect livestock. The duration of animal husbandry techniques may range from daily to seasonal. Generally, as the frequency and intensity of livestock handling increases, so does the degree of protection, since the risk of depredation is greatest when livestock are left unattended.

Shifts in breeding schedules can reduce the risk of depredation by altering the timing of births to coincide with the greatest availability of natural prey to predators or to avoid seasonal concentrations of migrating predators. Hiring extra herders, building secure holding pens, and adjusting the timing of births may be expensive, but effective. The timing of births is often related to weather or seasonal marketing of young livestock, and therefore shifts in breeding schedules may not always be feasible.

Herders and range riders are often used by producers to monitor sheep and cattle pastures for the presence of predators. Herders and range riders employ a variety of non-lethal methods, such as carcass removal, guard dogs, propane cannons, non-lethal projectiles, and animal husbandry. Work often occurs during the day and night to effectively deter predators.

Pasture selection involves moving livestock to areas less susceptible to predation events, such as pastures near man-made structures. The risk of depredation diminishes as age and size increase and can be reduced by holding expectant females and newborn livestock in pens. Nightly gathering may not be possible where livestock are in many fenced pastures or where grazing conditions require livestock to scatter.

Behavior selection of livestock is practice of choosing animals with nurturing or protective temperaments for breeding. Livestock that are more wary of predators or protective of their offspring help protect the herd from predation, especially when left in unattended pastures.

Guard animals, such as dogs, burros, donkeys, and llamas, can effectively reduce coyote predation losses. Success in using guard animals is highly dependent on proper breeding and bonding with livestock, amount and type of predation loss, size and topography of the pasture, effectiveness of training, compatibility with humans. The effectiveness of guarding animals may not be sufficient in areas where there is a high density of predators to be deterred, especially territorial pack species, and where livestock are scattered. The use of Old World guarding dog breeds, such as Great Pyrenees, Kangal, and Komondor, have been effective in protecting livestock from coyote predation in the United States. Guard donkeys have been used to deter dog and coyote predation with varied success. Guard llamas readily bond with sheep and can reduce coyote predation. All technical assistance regarding guard dogs is conducted in compliance with WS Directive 2.440 (Section 2.4.1.14).

Habitat Management: Technical Assistance

Predator presence is often related to the type, quality, and quantity of suitable habitat. Habitat can be managed to reduce the attraction of certain predator species. The effectiveness of habitat management to reduce predator damage is dependent on the species involved, damage type, economic feasibility, and legal constraints on protected habitat types (e.g., wetlands). In most cases, the resource or property owner is responsible for implementing habitat modifications. WS-Nevada only provides advice on the type of modifications that have the best chance of achieving the desired effect. WS-Nevada advises landowners/managers that they are responsible for compliance with all applicable regulations related to habitat management, including the Endangered Species Act.

Architectural design can often help to avoid potential predator damage. For example, incorporating open areas into landscape designs that expose animals may significantly reduce potential problems. Additionally, selecting species of trees and shrubs that are not attractive to wildlife can reduce the likelihood of potential predator damage to parks, public spaces, or residential areas.

Managing the habitat, such as minimizing cover, planting lure crops, and tree removal, can sometimes reduce damage associated with predators that use vegetation and crops for foraging and hiding. Habitat management is a primary strategies at airports to reduce aircraft damage and protect human safety. Generally, many problems associated with predator loafing, breeding, or feeding on airport properties can be reduced through management of vegetation and water from areas adjacent to aircraft runways.

Reducing food attractants near homes, buildings, and pastures can reduce predator attraction. Sources include unprotected garbage, outdoor pet food, trash cans, and bird feeders. Removal or sealing of garbage, monitoring of small pets when outdoors, and elimination of outdoor pet food can reduce attracting unwanted predators. Additionally, proper and timely disposal of livestock carcasses also reduces predator attractants.

Modifying Animal Behaviors: Technical and/or Operational Assistance

Modifying animal behaviors involves techniques aimed at causing target animals to flee or remaining at a distance. Frightening and harassment devices are one of the oldest and most popular methods of reducing wildlife damage and depend on the animal's aversion to offensive stimuli. These methods usually use extreme and random noise or harassment and should be changed frequently as wildlife usually become habituated to scare devices. Motion-activated systems may also extend the effective period for a frightening devices. These techniques tend to be more effective when used in a strategy involving the use of multiple methods. However, their continued success may require reinforcement by limited lethal shooting to avoid habituation.

Electronic distress sounds and alarm calls are electronic devices that broadcast recorded or artificial wildlife distress sounds in the immediate area and are intended to cause a flight response from specific species. These sounds may be used alone or in conjunction with other scaring devices. Animals react differently to distress calls so their use depends on the species and problem. Calls may be played for short bursts, long periods, or even continually, depending on the severity of damage and relative effectiveness of different treatment or "playing" times. These calls can be used in urban effectively and without excessively disturbing humans.

Propane exploders/cannons are attached to a propane tank and produce loud explosions (similar to a firearm discharge) at controllable intervals. They are strategically used in areas of high wildlife. Because animals habituate to the sound, exploders must be moved frequently and used in conjunction with other scare devices. Propane cannons are generally inappropriate for urban/suburban areas due to the repeated loud explosions.

Pyrotechnics have a variety of forms, including firecrackers, shell crackers, noise bombs, whistle bombs, and racket bombs, and can be timed to explode at different intervals. Shell crackers are 12-gauge shotgun shells containing a firecracker that is projected up to 75 yards before exploding. The shells should be fired so they explode in front of, or underneath, the target animals. Noise bombs, whistle bombs, and racket bombs are similar to shell crackers, but are fired from 15-millimeter flare pistols. Noise bombs travel about 75 feet before exploding. Whistle bombs are non-explosive and produce a trail of smoke and a whistling sound. Racket bombs make a screaming noise, do not explode, and can travel up to 150 yards. Use of pyrotechnics may be precluded in some areas because of noise impacts. WS-Nevada employees receive safety training in transporting, using, and storing pyrotechnics, as required by WS Directives 2.615 and 2.625 (Sections 2.4.1.3 and 2.4.1.4). When pyrotechnics are recommended during technical assistance, WS-Nevada provides pyrotechnics safety information and instructions to the user.

Electronic Guard (siren strobe-light devices), developed by APHIS-WS NWRC, is a battery-powered unit operated by a photocell that emits a flashing strobe light and siren call at intervals throughout the night. Efficacy of strobe-sirens is highly variable and typically lasts less than three weeks, but in certain situations, has been used successfully to reduce coyote and black bear depredation on sheep. The device is a short-term tool used to deter predation until livestock can be moved to another pasture, brought to market, or other IPDM methods are implemented. This technique is most successful at bedding grounds where sheep gather at night and may be used in rural or urban settings.

Visual scaring techniques such as lights, fladry, and effigies can be effective. These techniques are generally used for small, enclosed areas. Fladry, consisting of hanging flags evenly spaced along rope or fence wire, move in the wind and create a novel disturbance for predators. However, predators may become accustomed to fladry and the technique requires regular maintenance to replace the flags. Turbo fladry, similar to regular fladry, consists of colored flagging spaced evenly along a length of electrical fence. This technique reinforces the effectiveness of regular fladry with the shock deterrent of an electric fence.

Non-lethal projectiles, such as rubber bullets, can be used as an aversion technique, but require continued use to avoid wildlife becoming habituated. This method requires prolonged presence and is most efficient when the landowner assists with monitoring and implementation. WS-Nevada and NDOW can provide technical assistance to property owners on how to safely implement this method. Non-lethal projectiles rarely result in death or injury to wildlife due to careful shot placement and avoiding close range use.

Aerial hazing/harassment/dispersal techniques use the noise and visual presence of fixed-wing aircraft or helicopters to discourage wildlife from congregating near livestock or other resources. Aerial hazing may be used in combination with other non-lethal methods, such as non-lethal projectiles, to further discourage wildlife. Aviation safety and operations SOPs are provided in WS Directive 2.620 (Section 2.4.1.12) and APHIS-WS Aviation Rules (WS 2009). All efforts are conducted in strict compliance with the APHIS-WS Aviation and Safety Manual, the Federal Aviation Regulations, applicable State and local laws and regulations, Aviation Safety Plans, Aviation Communication Plans, and Aviation Emergency Response Plans.

Live-Capture and Relocation: Operational Assistance

Live-capture and relocation, when not legally prohibited by state and local law, can be used by WS-Nevada personnel, per WS Directive 2.501 (Section 2.4.1.8). WS-Nevada only relocates predators at NDOW's direction and coordinates capture, transportation, and selection of relocation sites with NDOW. Relocating predators is generally prohibited and must be permitted by NDOW under Nevada law (Section 1.11.1, Section 2.5.9). Decisions to relocate wildlife are based on biological, ecological, economic, and social factors, such as availability of suitable habitat, likelihood of increased competition or predation stress on the relocated animal, likelihood of the animal returning, public attitudes, potential conflict or damage to resources near the relocation site, and potential disease transmission.

What IPDM Methods That May be Either Lethal or Non-Lethal Are Available to WS-Nevada?

WS-Nevada specialists can use a variety of devices to capture predators. Methods such as cage traps, cable restraints, and trained pursuit dogs are used to non-lethally capture predators, but can be used lethally depending on the circumstance. For instance, WS-Nevada can use a cage trap to capture an animal and then immobilize and relocate (non-lethal) or dispatch with a firearm (lethal), given the circumstances and applicable federal, state, and local laws and regulations.

All baits, scents, and attractants used to aid in capturing animals may consist of carcasses of game animals, furbearers, and fish, provided that the animals are not taken specifically for this purpose and that such use and possession is consistent with federal, state, and local laws or regulations per WS Directive 2.455. APHIS-WS Policy (WS Directive 2.450, Section 2.4 A2) states that the use of the BMP trapping guidelines developed by AFWA would be followed as practical. APHIS-WS policies and Nevada state laws for using traps and snares are listed in Sections 2.4.4. Most of these methods can also be used by NDOW, landowners, and their agents, as approved methods for IPDM or regulated fur trapping.

Cage/box traps are live-capture traps for capturing small mammals such as skunks, feral cats, bobcats, and raccoons. Cage traps come in a variety of sizes and are generally made of galvanized wire mesh, metal, plastic, or wood, and consist of a treadle inside the baited cage that triggers the door to close behind the animal being captured, preventing exit. Cage traps can range in size from small traps intended for the capture of smaller mammals to large corral/panel traps fitted with a routing or saloon-style repeating door, used to live-capture larger animals. Cage traps are species selective based on trap size which can physically exclude non-target animals. Traps are sometimes baited or set near signs of damage, known travel areas, or wildlife entrances to buildings or dens. Non-target animals are generally released with little or no injury. An adequate supply of food and water is placed in the trap to sustain captured animals for several days, but traps are typically checked more regularly. Cage traps are available to all entities to alleviate damage and can be purchased commercially.

Culvert traps are a type of large, baited, live-capture cage trap for large mammals. These traps have trigger systems attached to gravity doors, and are constructed of solid sheet metal or thick welded wire on a wheeled platform or trailer. APHIS-WS most often uses this type of trap for mountain lions or medium black bears in urban/suburban settings, but culvert traps can also be used in rural areas and for other species. APHIS-WS implements a daily trap check for all culvert traps. Non-target animals are generally released with little or no injury, mountain lions and target black bears are either euthanized or transferred to the custody of NDOW as appropriate and when authorized by NDOW.

Quick-Kill/Body Gripping Traps are used by APHIS-WS to capture various mammals, such as raccoons, skunks, red foxes, and badgers. The body-gripping trap is lightweight and consists of a pair of rectangular wire frames that close when triggered, killing the captured animal with a quick blow. Smaller-sized traps may also be set in the entrance of a wooden box or other structure with bait. Quick-kill traps set for predators are primarily used in rural areas, limiting non-target animal trap exposure. Quick-kill traps are lethal to both target and non-target animals. WS Directive 2.450 prohibits the use of body-gripping traps with a jaw spread exceeding 8 inches for land sets.

Foothold traps can be used for live-capture and release or hold for subsequent euthanasia. They are made of steel with springs that close the jaws of the trap around the foot of the target species. They are versatile for capturing small to large-sized predators. These traps usually permit the release of non-target animals unharmed. Foothold traps may have offset steel or padded jaws, which hold the animal while reducing the risk of injury. The padded foothold trap can be unreliable in rain, snow, or freezing weather.

Traps are placed in the travel paths of target animals and some are baited or scented, using an olfactory attractant, such as the species' preferred food, urine, or musk/gland oils. Use of baits also facilitates prompt capture of target predators by decreasing the total time traps are used, thereby lowering risks to non-target animals. In some situations a draw station, a carcass or large piece of meat, is used to attract target animals. In this approach, one or more traps are placed in the vicinity of the draw station. APHIS-WS program policy prohibits placement of traps closer than 30 feet to the draw station to reduce the risk to non-target animals (APHIS-WS Directive 2.450, Section 2.4.1.2).

Foothold traps set for coyotes, red foxes, bobcats, and similarly-sized predators are set with dirt or debris (e.g., leaf litter or rotting wood) sifted on top. The traps can be staked to the ground securely, attached to a solid structure (such as a tree trunk or heavy fence post), or used with a drag that becomes entangled in brush to prevent trapped animals from escaping. Anchoring systems should provide enough resistance that a larger animal that is unintentionally captured should be able to either pull free from the trap or be held to prevent escaping with the trap on its foot.

Effective trap placement also contributes to trap selectivity. To reduce risk of capturing non-target animals, the user must be experienced and consider the target species' behavior, habitat, environmental conditions, and habits of non-target animals. The pan tension, type of set, and attractant used greatly influences both capture efficiency and risks of catching non-target animals. The level of trap success is often determined by the training, skill, and experience of the user to adapt the trap's use for specific conditions and species. When determining how often to check traps, the user must balance the need for avoiding unnecessary disturbance of the trap area and humaneness of trapping to the captured animals. WS-Nevada follows APHIS-NDOW MOU (Section 1.8.1) regarding the setting and checking of traps and snares as follows per APHIS-WS Directive 2.450 and 2.210 (Sections 2.4.1.2 and 2.4.1.1).

Dog-proof/enclosed foothold traps are designed for particular species, such as raccoons or opossums, which use their foot to reach into small, enclosed spaces to gain access to bait. These traps are baited or scented, using an olfactory attractant, such as the species' preferred food, to attract the animal. When an animal reaches into the trap and pulls on the baited lever, a spring quickly closes the trap around the animal's foot. The traps are often made of rounded plastic or metal, which holds the animal while reducing the risk of harm. The dog-proof foothold trap can be set under a wide variety of conditions but can be unreliable in rain, snow, or freezing weather. The traps are either staked to the ground securely or attached to a solid structure (such as a tree trunk or heavy fence post).

The dog-proof foothold trap reduces unintentional capture due to the species-selective attractants, enclosed space that physically prevents larger species from being captured, and the behavioral differences between species by requiring the animal to put their foot into the trap to access the bait. These traps usually permit the release of unintentionally captured animals unharmed.

WS-Nevada follows APHIS-NDOW MOU (Section 1.8.1) regarding the setting and checking of traps and snares as follows per APHIS-WS Directive 2.450 and 2.210 (Sections 2.4.1.2 and 2.4.1.1).

Cable restraints (foot snares and neck/body snares) can be used for live-capture and release, for holding for subsequent euthanasia, or for a direct kill, depending on how and where they are set. They are traps made of strong, lightweight cable, wire, or monofilament line with a locking device, and are used to catch small- and medium-sized predators by the neck, body, or foot. Snares can be used effectively on animal travel corridors, such as under fences or trails through vegetation.

When an animal steps into the cable loop place horizontally on the ground, a spring is triggered, and the cable tightens around the foot to hold the animal. If the snare is placed vertically, the animal walks into the snare and the neck or body is captured or entangled. On standard cable snares, snare locks are typically used to prevent the loop from opening again once the loop has closed around an animal. Loop stops can also be incorporated to prevent the loop from either opening or closing beyond a minimum or maximum loop circumference, which can effectively excluding non-target animals or allow for live-captures of target animals.

Most snares are also equipped with a swivel to reduces injuries to the captured animal and reduce twisting and breakage of the snare cable. Breakaway devices can also be incorporated into snares, allowing the loop to break open and release the animal when a specific amount of force is applied. These devices can improve the selectivity of cable restraints to reduce non-target species capture, however only when the non-target species is capable of exerting a greater force to break the loop than the target species.

The Collarum™ is a non-lethal, spring-powered, modified neck snare device that is primarily used to capture coyotes and foxes. It is activated when an animal bites and pulls a cap with a lure attractive to coyotes, whereby the snare is projected from the ground up and over the head of the coyote or fox. As with other types of snares, the use of the Collarum™ device to capture coyotes is greatly dependent upon finding a location where coyotes frequently travel where the device can be set. A stop on the device limits loop closure. The trigger is designed specifically for canines, which use a distinct pulling motion to set off the device.

In general, cable restraints are available to all entities to alleviate damage within state law. Snares offer several advantages over foothold traps by being lighter to transport or carry and not being as affected by inclement weather.

Trap monitors are devices that send a radio signal to a receiver if a set trap is disturbed, alerting field personnel that an animal may be captured. Trap monitors can be attached directly to the trap or attached to a wire and placed away from the trap. When the monitor is hung above the ground, it can be transmit a signal for several miles, depending on the terrain. There are many benefits to using trap monitors, such as saving considerable time when checking traps, decreasing fuel usage, prioritizing trap checks, and decreasing the need for human presence in the area. By using trap monitors to prioritize trap checks, the amount of time a captured animal is restrained is decreased, minimizing pain and stress and allowing non-target animals to be released in a timely manner.

APHIS-WS continues to review trap monitoring systems that are commercially available (USDA 2007, 2013), but modern trap monitors are not sufficiently reliable due to variable terrain, poor signal reception, and rudimentary monitor technologies. Newer technologies, such as cell phone text messages, rely on cell reception to transmit signals which is not always available in rural areas. WS-Nevada continues to look for opportunities to test current and developing systems.

Catch poles consist of a long pole with a cable noose at one end. They can be used for live-capture and release, relocation, or subsequent euthanasia. The noose end is typically encased in plastic tubing to protect the neck of the animal. Catch poles can be used to safely catch and restrain animals such as feral cats, feral dogs, and raccoons.

Hand nets are used to catch small mammals in confined areas, such as buildings. They can be used for live-capture and release, relocation, or subsequent euthanasia. These nets resemble fishing dip nets, but are larger and have long handles.

Net guns and launchers are devices that project a net over a target animal using a specialized gun and are normally used for animals that do not avoid people. They can be used for live-capture and release, or for holding for subsequent euthanasia. They require mortar projectiles or compressed air to propel a net up and over animals that have been baited to a particular site. Net guns are manually discharged, while net launchers are discharged by remote from a nearby observation site. Net guns can be used in rural and urban situations and discharged from the ground, helicopter, or vehicle. Net guns are an animal-specific, live-capture technique, with target animals typically released unharmed.

Dart guns are non-lethal capture devices (specially-designed rifles) that fire darts filled with tranquilizer. Once tranquilized, the animal may be handled safely for research or relocation purposes, or subsequently euthanized. Use of dart guns are species-selective, as field personnel positively identify the species before tranquilizing the animal. Dart guns are generally limited in range to less than 120 feet. If other factors preclude setting of equipment or the use of firearms, such as proximity to urban or residential areas, dart guns may be the only option available. Chemical capture methods require specialized training and skill, and are limited to WS-Nevada and other certified entities.

Trained pursuit dogs are used by NDOW (and their agents) and APHIS-WS for coyote, mountain lion, and black bear damage management activities on both private and public lands, typically in rural settings. Pursuit dogs are trained to follow the scent of the target species and can be used to find coyote dens, decoy coyotes, and pursue problem black bears and mountain lions. Once the target animal is located by the pursuit dogs, field personnel use dart guns or firearms to euthanize the animal or immobilize for release. Pursuit dogs are always accompanied by field personnel and are redirected if found to be following the tracks or scent of non-target animals. Trained dogs are especially effective at indicating where predators have traveled, urinated, or defecated, which may be useful for setting cable restraints or traps and increase the certainty of capturing the target species.

Per WS Directive 2.445 (Section 2.4.1.15), the dogs are not allowed to have any physical contact with the animal either before or after capture. Individual dogs that cannot be restrained from physical contact with wildlife or continue to follow non-target scents are discontinued from use. All dogs shall have a safe and insulated transport box, food, water, medical care, and be licensed and vaccinated. State law regarding use of pursuit dogs is found at Section 2.4.4.2.

What Lethal IPDM Methods Are Available to WS-Nevada?

Aerial Shooting: Technical Assistance or Operational Assistance

Aircraft, both fixed-wing and rotary-wing (helicopters) are used by WS-Nevada only for removing coyotes or feral swine. The most frequent aircraft used for aerial shooting and harassment is the fixed-wing aircraft Piper PA-18 Super Cub ad CubCrafters CC-18 Top Cub and rotary-wing Hughes MD500. WS-Nevada conducts aerial activities on areas only under signed agreement or federal Annual Work Plans, and focuses efforts to specific areas during certain times of the year. During technical assistance, WS-Nevada may advise cooperators to hire private operators with an NDOW permit for aerial shooting of coyotes. Additionally, WS-Nevada may conduct the work operationally at the request of cooperators.

Aerial shooting consists of visually sighting target animals in the problem area and shooting them with a firearm from an aircraft. Aerial shooting is species-specific and can be used for immediate damage relief, providing that weather, topography and ground cover conditions are favorable. Aerial shooting can be effective in removing offending animals that have become trap-shy or are not susceptible to calling and shooting or other methods. This method may also be used proactively to reduce local coyote predations in lambing and calving areas with a history of predation.

Fixed-wing aircraft are useful for aerial shooting over flat and gently rolling terrain. Because of their maneuverability, helicopters have greater utility and are safer over timbered areas or broken land where animals are more difficult to spot. Aerial shooting typically occurs in remote areas with low densities of tree or vegetation cover, where the aerial visibility of target animals is greatest. WS-Nevada spends relatively little time flying and shooting over any one area.

The APHIS-WS program aircraft-use policy (WS Directive 2.620, Section 2.4.1.12) and APHIS-WS Aviation Rules (USDA MRP 2015) help ensure that aerial shooting is conducted in a safe and environmentally sound manner, in accordance with federal and state laws. State Directors and Program Managers are responsible for the supervision, management, and compliance for all aviation activities within the state, and all aircraft used by WS-Nevada activities through contract, agreement, or volunteer, shall have been approved by the office of the APHIS-WS National Aviation Coordinator (NAC). WS Directive 2.615 (Section 2.4.1.3) guides all APHIS-WS shooting activities. All efforts are conducted in strict compliance with the APHIS-WS Aviation and Safety Manual, the Federal Aviation Regulations, the Fish and Wildlife Act of 1956 (Airborne Hunting), any applicable State and local laws and regulations, individual WS-Nevada and APHIS-WS NWRC program Aviation Safety Plan, Aviation Communication Plans, and Aviation Emergency Response Plans.

The APHIS-WS Aviation Training and Operations Center (ATOC) located in Cedar City, Utah, mission is to improve aerial operations safety and provide training and guidance for APHIS-WS aviation personnel and aerial activities. The policy and primary focus of APHIS-WS and contract aviation personnel is ensuring the well-being through safety and accident prevention efforts. Pilots and aircraft must be certified under established APHIS-WS program procedures. Only properly trained APHIS-WS program employees are approved as crewmembers.

Ground crews are often used with aerial operations for safety and for providing assistance with locating and recovering target animals.

Ground Shooting: Technical or Operational Assistance

WS-Nevada personnel may either provide advice regarding ground shooting for predators as part of technical assistance or provide the service themselves. Ground shooting with firearms is highly-selective for target species. Shooting can be selective for offending individuals and has the advantage that it can be directed at specific damage situations. The majority of shooting occurs in rural areas on both private and public lands, as well as airports for health and human safety. Shooting is sometimes used as one of the first lethal damage management options because it offers the potential of resolving a problem quickly and selectively. Shooting is limited to locations where it is legal and safe to discharge a firearm.

Calling and shooting is a technique which uses electronic devices that broadcast recorded or artificial wildlife sounds in the immediate area and are intended to draw specific species to an area where they can be lethally removed with a firearm. Animals react differently to these calls so their use depends on the species and problem. Calls are often played for short bursts and cause minimal disturbance.

A handgun, shotgun, air gun, or rifle may be used. In addition, spotlights, night vision, thermal imagery for night shooting, decoy dogs, tracking/trailing dogs, predator calling, stalking, and/or baiting may be used to increase ground shooting efficiency and selectiveness. Spotlights are often covered with a red lens which nocturnal animals may not be able to see, making it easier to locate them undisturbed. Night shooting may be conducted in sensitive areas that have high public use or other activity during the day, which would make daytime shooting unsafe. The use of night vision and forward looking infrared (FLIR) devices can also be used to detect and shoot predators at night. Coyotes and red foxes that may be trap-wise and therefore difficult to trap, are often responsive to predator calling.

To ensure safe use and awareness, APHIS-WS employees who use firearms to conduct official duties are required to attend an approved firearms safety and use training program within 3 months of their appointment and a refresher course annually thereafter (WS Directive 2.615, Section 2.4.1.3). The use and possession of firearms must be in accordance with federal and applicable state, and local laws and regulations (also WS Directive 2.210, Section 2.4.1.1). APHIS-WS personnel must adhere to all safety standards of firearm operation as described in the APHIS-WS Firearms Safety Training Manual. Such personnel are subject to drug testing when considered for hire, randomly, when under reasonable suspicion, and after accidents have occurred. All employees who use firearms are subject to the Lautenburg Domestic Confiscation Law, which prohibits firearm possession by anyone convicted of a misdemeanor crime or domestic violence. WS-Nevada complies with applicable state laws and statutes for ground shooting.

While on duty, WS-Nevada employees are authorized to store, transport, carry, and use only the firearms necessary to perform official APHIS-WS duties. The maximum type of security available must be used to secure firearms when not directly in use and to ensure that unauthorized access is prevented. No firearms shall be left unattended unless securely stored. Authorization is required for leaving firearms stored in vehicles overnight. Ammunition, pyrotechnic pistols, net guns, dart guns, air rifles, and arrow guns will be stored securely unloaded as determined by the State Director.

NDOW, commercial operators, and landowners/resource owners can also use ground shooting for IPDM, in compliance with state laws and regulations.

Carcass Disposal: Technical Assistance or Operational Assistance

Carcass disposal methods are dependent on the species. WS-Nevada disposes of carcasses according to WS Directives 2.515 and 2.510 (Section 2.4.1.9) and Nevada state law and regulations (Section 2.4.4.6). Predator carcasses are disposed of in approved carcass disposal sites on public or private lands or on-site where captured. WS-Nevada does not bury predator carcasses.

What Lethal and Non-lethal Chemical Methods are Available to WS-Nevada?

Chemical Repellents (Non-lethal): Technical and Operational Assistance

Chemical repellents are usually naturally-occurring substances or formulated chemicals that are distasteful or to elicit temporary pain or discomfort for target animals when they are smelled, tasted, or contacted. Effective and practical chemical repellents should be non-toxic to target predators, other wildlife, plants, and humans; resistant to weathering; easily applied; and highly effective.

The reaction of different animals to a particular chemical varies, and for many species there may be variations in repellency between different habitat types. Effectiveness depends on the resource to be protected, time and length of application, and sensitivity of the species causing damage. Repellents are not available for many species that may cause damage problems. Chemicals are not used by WS-Nevada on public or private lands without authorization from the land management agency or property owner or manager.

Chemical Fumigants (Lethal): Operational Assistance

Denning is the practice of locating coyote, fox, and skunk dens and killing the young and/or adults by using a registered gas fumigant cartridge. This method used to manage present depredation of livestock by coyotes, fox, and skunks or anticipated depredation from coyotes. When the adults are killed and the den site is known, denning is used to euthanize the pups and prevent their starvation (See Section 3.9.5.2 of this EA). Denning is highly selective for the target species responsible for damage. Den hunting for coyotes and red foxes is often combined with other damage management activities such as aerial shooting and ground shooting.

Gas cartridges are normally applied in rural settings on both private and public lands. When dens are selected for fumigation, the fuse of the gas cartridge is ignited and hand-placed at least 3 to 4 feet inside in the active den. Soil is then placed in the den entrance to form a seal to prevent the carbon monoxide from escaping and oxygen entering. Sodium nitrate is the principal active chemical in gas cartridges and is a naturally-occurring substance. When ignited, the cartridge burns in the den, depleting the oxygen and producing large amounts of carbon monoxide, a colorless, odorless, tasteless, poisonous gas.

Use of gas cartridges may pose a risk to non-target animals that may also be found in burrows of target predators. Given the omnivorous nature of target predator diets, non-target rodents, reptiles or amphibians are highly unlikely to occur in a coyote or fox den. WS-Nevada conducts pretreatment site surveys to identify signs of use by non-target species (such as tracks or droppings).

All animals removed by denning are humanely euthanized per WS Directives 2.425 "Denning" (Section 2.4.1.7) and 2.505 "Lethal Control of Animals" (Section 2.4.1.10). The gas cartridges used for denning (EPA Reg. No. 56228-21, EPA Reg. No. 56228-2) are registered by WS-Nevada with NDA. All pesticides used by WS-Nevada are registered under the FIFRA and administered by EPA and NDA. All WS-Nevada personnel who apply restricted-use pesticides are state-certified pesticide applicators and have specific training by WS-Nevada for pesticide application per WS Directive 2.465 (Section 2.4.1.5).

What Tranquilizer and Immobilization Methods are Available to WS-Nevada?

Tranquilizer and immobilization chemicals may be used by WS-Nevada to aid in the humane handling of predators to avoid injury to the handler and the predator. Immobilization agents can eliminate pain and reduce stress of animals while being handled. Immobilizing agents are delivered to the target animal with a dart gun or syringe pole, depending on the circumstances and the species being immobilized. WS-Nevada field personnel may use immobilization drugs to safely release unintentionally captured animals. Immobilizing drugs may also be used to safely release animals after collecting biological samples for disease surveillance or research studies.

When administering tranquilizer or immobilization chemicals to any animal, field personnel must consider the animal's physical condition, size, age, and health. WS Directive 2.430 (Section 2.4.1.10) provides detailed training and certification requirements for APHIS-WS personnel administering immobilization drugs. The following immobilization chemicals are under the jurisdiction of the United States Food and Drug Administration (FDA) and/or DEA.

Ketamine (Ketamine HCl; Ketaset™) is a rapid acting, non-narcotic, non-barbiturate injectable anesthetic agent that immobilizes the animal and prevents the ability to feel pain (analgesia). The drug produces a state of dissociative unconsciousness, which does not affect the reflexes needed to sustain life, such as breathing, coughing, and swallowing. Ketamine is possibly the most versatile drug for chemical capture and has a wide safety margin (Fowler and Miller 1999). When used alone, this drug may produce muscle tension, resulting in shaking, staring, increased body heat, and, on occasion, seizures. Ketamine is often combined with other drugs, such as Xylazine, maximizing the reduction of stress and pain and increasing human and animal safety during handling. Following administration of recommended doses, animals become immobilized in about 5 minutes, with anesthesia lasting from 30 to 45 minutes. Depending on dosage, recovery may be as quick as four to five hours or may take as long as 24 hours. Recovery is generally smooth and uneventful.

Xylazine is a sedative (analgesic) that calms nervousness, irritability, and excitement, usually by depressing the central nervous system. Xylazine is commonly used with Ketamine HCl to produce a relaxed anesthesia. This combination can reduce heat production from muscle tension, but can lead to lower body temperatures when working in cold conditions. Xylazine can also be used alone to facilitate physical restraint. Because Xylazine is not an anesthetic, sedated animals are usually responsive to stimuli. Therefore, personnel must reduce sight, sound, and touch to reduce the animal stress. Recommended dosages are administered through intramuscular injection, allowing the animal to become immobilized in about 5 minutes and lasting from 30 to 45 minutes. Yohimbine is a useful drug for reversing the effects of Xylazine.

Capture-All 5™ is a combination of Ketaset™ and Xylazine, and is regulated by the FDA as an investigational new animal drug. The drug is available through licensed veterinarians to individuals sufficiently trained in the use of immobilization agents. Capture-All 5™ is administered by intramuscular injection; it requires no mixing, and has a relatively long shelf life without refrigeration, all of which make it ideal for the sedation of various species.

Telazol™ is a combination of equal parts of tiletamine hydrochloride and zolazepam hydrochloride, and is a powerful anesthetic for larger animals, such as black bears, coyotes, and mountain lions (Fowler and Miller 1999). Telazol™ produces dissociative unconsciousness, which does not affect the reflexes needed to sustain life, such as breathing, coughing, and swallowing. Following a deep intramuscular injection of Telazol™, onset of anesthetic effect usually occurs within 5 to 12 minutes. Muscle relaxation is optimum for about the first 20 to 25 minutes after administration, and then diminishes. Recovery varies with the age and physical condition of the animal and the dose of Telazol™ administered, but usually requires several hours.

What Euthanasia Methods are Available to WS-Nevada?

During IPDM activities, most captured animals are euthanized since predators rarely are permitted to be immobilized and relocated (Section 1.12.1). Euthanasia methods can include physical and chemical methods. Euthanasia techniques should result in rapid unconsciousness, quickly followed by death, in order to reduce stress, anxiety, and pain to the animal. In urban and suburban locations, chemical techniques can be more appropriate for euthanizing wildlife than shooting.

APHIS-WS personnel will exhibit a high level of respect and professionalism when taking an animal's life, regardless of method (WS Directive 2.505, Section 2.4.1.10). Only properly trained APHIS-WS personnel are certified to possess and use approved immobilization and euthanizing drugs. All acquisition, storage, and use of such drugs will be in compliance with applicable program, federal, state, and local laws and regulations.

The following chemical and gas methods are limited to WS-Nevada operational assistance. Physical euthanasia methods can be used by landowners in accordance with applicable laws and regulations, and can be recommended during technical assistance.

Chemical and Gas Euthanasia Methods (Lethal): Operational Assistance

Depending on the species, the following euthanizing drugs and gases (AVMA 2013) can be used by WS-Nevada and are under the jurisdiction of FDA and/or DEA. WS-Nevada personnel are trained and certified to use, record, and store euthanizing drugs in accordance with DEA and state regulations.

Sodium pentobarbital is a barbiturate that rapidly depresses the central nervous system to the point of respiratory arrest. Barbiturates are a recommended euthanasia drug for free-ranging wildlife (AVMA 2013). Sodium pentobarbital would only be administered after target animals were live-captured and properly immobilized to allow for direct injection. All animals euthanized using sodium pentobarbital and its dilutions (such as Beuthanasia-D™ and Fatal-Plus™) are disposed of at approved carcass disposal sites.

> **Beuthanasia®-D and Euthasol®** contain two active ingredients (sodium phenytoin and sodium pentobarbital) which are chemically compatible but pharmacologically different. When administered intravenously, sodium pentobarbital produces rapid anesthetic action followed by a smooth and rapid onset of unconsciousness. When administered intravenously, sodium phenytoin produces toxic signs of cardiovascular collapse and/or central nervous system depression, and hypotension can occur when the drug is administered rapidly. Sodium phenytoin exerts its effects during the deep anesthesia stage caused by sodium pentobarbital. Sodium phenytoin hastens the stoppage of electrical activity in the heart, causing a cerebral death in conjunction with and prior to respiratory arrest and circulatory collapse. This sequence of

events leads to a humane, painless and rapid euthanasia (Virbac 2011). Beuthanasia®-D and Euthasol® are regulated by the DEA and the FDA for rapid and painless euthanasia of dogs, but legally may be used on other animals if the animal is not intended for human consumption (WS Directive 2.430, Section 2.4.10). WS-Nevada has used Euthasol® on occasion.

Fatal-Plus® combines sodium pentobarbital with other substances to hasten cardiac arrest. Intravenous use is the preferred route of injection, however intra-cardiac injection is also acceptable as part of the two-step procedure. Animals are first anesthetized and sedated using a combination of Ketamine/Xylazine and, once completely unresponsive to stimuli and thoroughly sedated, Fatal-Plus® is administered.

Potassium chloride, a common laboratory salt, is intravenously injected as a euthanizing agent after an animal has been anesthetized (WS Directive 2.430, Section 2.4.1.10).

Carbon dioxide (CO_2) gas is a colorless, odorless, non-combustible gas approved by the AVMA as a euthanasia method. CO_2 is a common euthanasia agent because of its ease of use, safety, and ability to euthanize many animals in a short time span. The advantages for using CO_2 are: 1) the rapid depressant, analgesic, and anesthetic effects of CO_2 are well established, 2) CO_2 is readily available and can be purchased in compressed gas cylinders, 3) CO_2 is inexpensive, non-flammable, non-explosive, and poses minimal hazard to personnel when used with properly designed equipment, and 4) CO_2 does not result in accumulation of tissue residues. Inhalation of CO_2 at a concentration of 7.5% increases the pain threshold and higher concentrations of CO_2 have a rapid anesthetic effect.

WS-Nevada uses CO_2 on occasion to euthanize wildlife which have been captured in cage traps, by hand, or by chemical immobilization. Live animals are placed in a container and CO_2 gas from a cylinder is released into the container. The animals quickly expire after inhaling the gas. This method of euthanasia is appropriate for small predators, such as skunks and raccoons, and could be effective in urban/suburban areas where use of a firearm is not appropriate.

Carbon monoxide (CO) is one of the gaseous byproducts from M-44 devices. Carbon monoxide is poisonous to all animals that use hemoglobin to transport oxygen from the lungs to the cells of the body. Carbon monoxide prevents the binding of oxygen to blood cells, causing a decrease in oxygen to cells throughout the body, resulting in asphyxiation. CO induces the loss of consciousness without pain and with minimal discomfort. Death occurs rapidly at low concentrations.

Physical Euthanasia Methods: Technical or Operational

Assistance

Shooting is a humane field method of euthanasia when conducted by experienced personnel. A gunshot is placed between the ears to damage brain tissue, resulting in instantaneous death. Shooting may be the quickest and only method available under most field conditions and should be performed discretely by properly trained personnel (AVMA 2013).

What Chemical Pesticide Methods are Available to WS-Nevada?

Pesticides have been developed to reduce wildlife damage and are used because of their efficiency. The use of many pesticides may be hazardous unless used with care by knowledgeable, trained, and state-certified field personnel. The proper placement, size, type of bait, and time of year are keys to selectivity and successful use. Most chemicals are aimed at a specific target species.

Sodium cyanide is the only registered pesticide available for canid PDM in Nevada (EPA Reg. No. 56228-15). This pesticide can only be used by certified WS-Nevada personnel, and therefore is only available during operational assistance. The use of M-44s for IPDM activities occur in rural settings on both private and public properties. Use of M-44s on private, public, or sovereign tribal lands in Nevada must be agreed upon by the landowner or federal, state, or tribal land management agency.

Sodium cyanide is the active ingredient in the M-44, a spring-activated ejector device developed specifically for lethal removal of coyotes, and, to a substantially lesser degree, other canine predators. The M-44 device consists of a capsule holder wrapped with fur, cloth, or wool; a capsule containing 0.8 gram of powdered sodium cyanide; an ejector mechanism; and a 5- to 7-inch hollow stake. The hollow stake is driven into the ground, the ejector unit is set and placed in the stake, and the capsule holder containing the cyanide capsule is screwed onto the ejector unit. A rotten meat 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 is pulled, a spring-activated plunger propels sodium cyanide directly into the animal's mouth. Generally, death from respiratory arrest is immediate. The M-44 is generally selective for canids because of the attractants used and their feeding behavior. When properly used, the M-44 presents little risk to humans and the environment and provides an additional tool to reduce predator damage.

Sodium cyanide is highly toxic to all species, including humans. WS-Nevada personnel prevent exposure by wearing PPE as required per 26 use restrictions (e.g. full face mask) and WS Directives 2.401 and 2.415 (Sections 2.4.1.5 and 2.4.1.6). WS-Nevada personnel that use the M-44 must be certified by the NDA since it is a restricted-use pesticide. WS-Nevada personnel always follow the EPA's label of 26 use restrictions and WS Directives 2.401 and 2.415 (Sections 2.4.1.5 and 2.4.1.6). Per the EPA registration label, M-44 devices may only be used for control of coyotes, red foxes, gray foxes, and wild dogs that are vectors of communicable diseases or suspected of preying on livestock, poultry, and/or federally-listed T&E species.

In response to petition from an environmental advocacy organization, the EPA completed a review of complaints concerning risks to non-target species (including T&E species), environmental contamination, and human health and safety risks regarding use of sodium cyanide (EPA 2009). Based on the review and updated use restrictions, the EPA determined that use of M-44s are in accordance with label requirements. EPA determined that the revised APHIS-WS pesticide accounting and storage practices do not pose unreasonable risks to the environment.

Compound DRC-1339 Concentrate (3-Chloro-p-Toluidine Hydrochloride)-Livestock, Nest & Fodder Depredations-Nevada EPA SLN No. NV-150001; EPA Registration No. 56228-29 is the only pesticide registered by EPA and NDA for common raven, American crow and Black-billed magpie PDM in Nevada. This registration restricts use to WS-Nevada.

From Coates (2006), "*DRC-1339 is an avian-specific toxicant that causes irreversible kidney necrosis, resulting in the failure to excrete uric acid (DeCino et al. 1966). Following the ingestion of a lethal dose ravens experience a period of listlessness and a subsequent unconsciousness and death within approximately 24-72 hours (Cunningham et al. 1979). Laboratory tests provide evidence that DRC-1339 affects species differently, and ravens are highly sensitive to its effects (LD50 = 5.6 mg/kg; Larsen and Dietrich 1970), which allows the use of the compound to be species specific. Other avian species, reported in DeCino et al. (1966), are also highly sensitive to the effects of DRC-1339, and those that often occur in shrubsteppe communities include American crow (Corvus brachyrhynchos; LD50 = 1.8 mg/kg), red-winged blackbird (Agelaius phoeniceus; D50 = 1.8 to 3.2 mg/kg), mourning dove (Zenaida macroura; LD50 = 5.6 to 10.0 mg/kg), and American magpie (Pica hudsonia; LD50 = 5.6 to 17.7 mg/kg). However, managers may effectively select species by injecting DRC-1339 into food items that specific species consume. Egg baits are often injected with DRC-1339 and placed in the environment to select corvids and prevent non-target species that are sensitive to DRC-1339 effects from ingesting the compound (Spencer 2002). Further species selection (i.e., ravens only) is a function of when and where the egg baits are placed in the environment, in addition to close monitoring of baits allowing modifications that reduce exposure of non-target species. Also, no symptoms of secondary poisoning of predators and scavengers have been observed (Cunningham et al. 1979), perhaps because of rapid chemical degradation.*"

Following bait preparation and application from label **Compound DRC-1339 Concentrate (3-Chloro-p-Toluidine Hydrochloride)-Livestock, Nest & Fodder Depredations-Nevada EPA SLN No. NV-150001; EPA Registration No. 56228-29**.

"Bait Preparation: Dissolve 2 grams (0.07 oz) of Compound DRC-1339 Concentrate in 100 ml (0.2 pints) of warm potable water at 43.3°C (110 °F) to make an approximate 2% solution, or dissolve 4 grams (0.14 oz) of this product in 100 ml (0.2 pints) of warm potable water at 43.3 °C (110 °F) to make a 4% solution; or in other proportions appropriate to produce a 2% or 4% solution.

Using an 18-gauge hypodermic needle or similar-sized implement, make an entry hole in the end of each hard-boiled chicken, turkey, or duck egg to be used. Using a syringe and a 20-gauge hypodermic needle, slowly inject 1 ml of the 2% solution (or 0.5 ml of the 4% solution) into the yolk area of each egg. PREPARE ONLY ENOUGH SOLUTION TO TREAT THE DESIRED NUMBER OF EGGS. MARK TREATED EGGS WITH SMALL SKULL AND CROSSBONES OR THE WORD "POISON".

Bait Stability: Eggs treated with DRC-1339 as prescribed above and stored under cool conditions may be used up to 7 days after preparation. Baits that have been exposed to sunlight or heat in excess of 110 °F (43 °C) should be used immediately or disposed of as pesticide waste.

Application Directions: Place all egg baits used at one baited site within 25ft (7.6 m) of the center of the site. Place 1-4 eggs in each bait set, and do not use more than a total of 18 eggs per baited site. If a draw station (fresh, un-poisoned animal carcass) is used, all bait sets must be located at least 3m (10ft) from the carcass. Whenever practicable and permitted, bait sets may be made in "dummy" nests created by making small depressions in the ground. "Dummy" nests may be partially hidden by vegetation or other debris. In other situations, eggs may be placed on 1-ft^2 to 2-ft^2 elevated wooden platforms and restrained by wire or other method to prevent eggs from falling off platforms or being removed by birds. Use 2-3 eggs per platform.

DO NOT USE MORE EGGS THAN ARE NEEDED TO EFFECT CONTROL as ravens tend to cache surplus food.

Observe baited area from blinds early during the baiting or pre-baiting to determine whether non-target species are approaching egg baits. Haze away Threatened or Endangered species that may be at risk from baits. Remove baits if such Threatened or Endangered species continue to approach them.

Check treated egg bait sites at intervals of 72-hours or more frequently and rebait with additional treated eggs when more than 50% of the treated eggs offered have been removed. When replacing baits, take care not to frighten target birds actively feeding upon eggs. Retrieve unconsumed treated eggs within seven days of exposure. For ground placements, check baited areas for partially consumed treated egg contents, and recover any small pieces of egg with a scoop or other tool. Treated eggs and egg contents not consumed by the time control operations cease must be disposed of in accordance with applicable State and Federal laws and the label for EPA Reg. No. 56228-29.".

DRC-1339 is highly toxic to humans if inhaled and corrosive to eye and skin. It is also very highly toxic to birds and aquatic invertebrates. WS-Nevada personnel that use DRC-1339 must be certified by the NDA since it is a restricted-use pesticide. WS-Nevada personnel prevent exposure by following the EPA's label and WS Directives 2.401 (Section 2.4.1.5), which require donning of specific PPE. Per the EPA registration and NV Special Local Need (SLN) (referenced above), DRC-1339 NV SLN 150001 may only be used for common raven, American crow and Black-billed magpies that prey on or are suspected of preying on the eggs or the young of federally-designated Threatened or Endangered species or on other species designated to be in need of special protection by federal or state wildlife agencies; nest, roost, or loaf at landfills, deadpits, dump site locations or utility poles, electrical line towers, communication towers, or other man-made structures and cause fire threat, or that feed on the contents of silage/fodder bags or pose a threat to human health and safety, threat to sensitive wildlife species or damage structures.

Literature Cited

American Veterinary Medical Association (AVMA). 2013. AVMA Guidelines for the Euthanasia of Animals: 2013 Edition. AVMA, Schaumburg, IL. 102 pp.

EPA. 2009. Response to SINAPU et al. petition to the Environmental Protection Agency for Suspension and Cancellation of M-44 Sodium Cyanide Capsules and Sodium Fluoroacetate (Compound 1080) Livestock Protection Collars.

Fowler, M. E., and R. E. Miller. 1999. Zoo and wild animal medicine. W.B. Saunders Company, Philadelphia, Pennsylvania, USA.

Virbac. 2011. EUTHASOL ® (EUTHANASIA SOLUTION). Product Information. Labeler – Virbac AH, Inc. Revised 4/2011. Fort worth, Texas. 4 pp.

United States Department of Agriculture, Marketing and Regulatory Program, Animal and Plant Health Inspection Service, Wildlife Services. 2015. Wildlife Services AVIATION OPERATIONS AND SAFETY MANUAL. Revision 1 dated 07/24/2015. Cedar City, UT. USA.

Appendix B. Nevada Cooperator Employed Methods

West District Cooperator Employed Non-lethal Methods

Livestock producers in the West District of Nevada employ various non-lethal approaches as a first line of defense against losses to predation (summarized below). Methods used are dependent on situational conditions, such as: funding; number of livestock; land class; terrain; proximity to water; sustainable grazing capacity; remoteness; and weather.

Exclusion

Nevada's West District livestock producers occasionally have the resources and conditions to place livestock in protective confinement, such as night pens. Experienced drawbacks to night penning in Nevada include: not practical or ecologically sound for free ranging cattle and sheep that are dispersed over large geographical areas to be confined in a small area (over grazing does not benefit ranching for following years); restrains the livestock for predatory wildlife that are not hindered by penning (such as mountain lions or black bears) that can cause extreme losses in a very short amount of time.

Two large university ranches in Lyon and Washoe Counties have been using "predator proof" fencing in an effort to reduce livestock losses. Most coyotes readily cross over, under, or through conventional livestock fences that are used by many of the West Districts livestock producers on private land. A coyote's response to a fence is influenced by various factors, including the coyotes experience and motivation (e.g. to eat livestock) for crossing the fence. Total exclusion of all coyotes by fencing especially in large areas, is highly unlikely as some coyotes eventually learn to either dig deeper or climb higher to get over the fence. Nevada free range producers do not have the funding or the authority to develop large scale fencing projects as fencing interferes with public land multiple use and wildlife migration.

Predator proof fencing has been effective where livestock do not leave an area, however, even with the electric fences and five foot high fencing, predators such as black bears will climb over the tops of the fences and absorb the electric shock, whereas mountain lions leap over the fences to access and depredate the livestock. The cost for predator proof fences on private lands often outweighs the benefits of producing livestock when the fence is not capable of excluding all predators.

Frightening Agents

Nearly 100% of the largest free range sheep producers in the State of Nevada, use guard dogs. The use of guard dogs can and has significantly reduced coyote predation on sheep bands. Guard dogs are typically aggressive towards other canines such as coyotes and chase coyotes away from sheep flocks. Guard dogs, however, can be overwhelmed during the lambing period when sheep producers have ewes and lambs spread over a 20 mile or more area. Guard dogs can also become overwhelmed when several groups of coyotes come into sheep areas, thus reducing their effectiveness as a non-lethal approach.

Guard donkeys and llamas are used by numerous Nevada small sheep and cattle producers in small acre fields, several of which are in the West District. Unfortunately, several guard llamas in the West District have been killed by mountain lions and black bears. This non-lethal approach has worked best in small areas.

Audio/visual repellents

Nevada livestock producers use frightening devices as these devices are effective for reducing losses during short periods or until the offending predators are removed. West District livestock producers use frightening devices such as propane cannons, strobe lights and radios. Propane cannons produce loud explosions at timed intervals when a spark ignites a measured amount of propane gas. Strobe lights and radios are another non-lethal approach that is used and works well until predators learn that the lights and radios are not capable of harming them.

Carrion removal

Several Nevada West District livestock produces remove or bury dead livestock to reduce coyote attraction, unfortunately, this practice is not practical in many areas of Nevada due to: remoteness, rocky terrain, and accessibility. In short, removing dead carrion is employed when favorable conditions exist and will be a continued practice for Nevada livestock producers.

Season and location of lambing or calving areas

The highest predation loss of sheep and calves typically occurs from late spring through September, when coyotes increase their food intake to raise juvenile coyotes. Husbandry practices such as shortening the lambing and calving periods by using synchronized or group breeding is used by the majority of livestock producers in the West District to reduce predation. Additionally, several West District livestock producers shed lamb and keep calves in small pastures until they reach an age structure to help the vulnerable livestock elude predation. Many Nevada livestock producers practice early weaning and do not allow young to go out to large pastures or grazing areas, which reduces the likelihood of excessive predation. This practice is used for the livestock producers who operate solely on private land.

Herders

Almost all (conservatively 90%) of Nevada's large free range sheep operators employ the use of herders to tend sheep and they are often on the front lines when dealing with predatory wildlife causing injury or death of livestock. Herders often employ a wide variety of non-lethal control measures while performing their daily duties: caring for and training guard dogs; burying dead livestock where permitted by terrain; deploying, maintaining and moving propane cannons; shooting harassment and general animal husbandry. Herders will continue to be a permanent fixture near Nevada's livestock practicing non-lethal approaches and animal husbandry practices to protect livestock from predatory wildlife.

East District Cooperator Employed Non-lethal Methods.

The employment of non-lethal practices, by livestock producers, is far more used than the employment of lethal practices in Nevada. Employment of non-lethal practices in the East District differs slightly from those in other areas of Nevada. An integrated predation management practice is most effective in preventing livestock losses to predation. Many factors determine the most effective predation management practice(s). Below, is a very general description and discussion of non-lethal predation management practices employed by livestock producers in the **East District.**

Sheep and Goat Producers in the East District, Ely Nevada.

All sheep and goat producers in Nevada use a wide array of non-lethal practices to prevent direct and indirect losses to predation.

Exclusion:
All sheep and goat producers in the East District use predatory exclusion practices during some part of the year. Usually, exclusion practices are used when and where predation and the act of predation can have highly negative effects on livestock production. Of the large scale (800+ head) sheep and goat producers, only a fraction (around 20 %) use exclusion regularly throughout the year. This is due to the fact that it is feasible and cost effective at the locations. For the remaining (roughly 80%) large scale sheep and goat producers, exclusion on a regular basis isn't a reasonable practice. Portable electric fence and net wire fence are most often used forms of exclusion.

All of the small scale (400- head) sheep and goat producers use exclusion regularly throughout the year if predation is a problem. This is due to the fact that production is on private ground and access and facilities (corrals, barn yards, electricity, feed production, etc…) are present. Electric, permanent net wire and permanent corral fencing are most often used.

Guard Dogs:
All large scale sheep and goat producers, in the East District, use guard dogs to help reduce losses to predation. Guard dogs may not be used during some parts of the year, depending on a variety of factors, such as those that follow.

- Sheep scattered over a large lambing area (some producers don't like guard dogs around ewes that are lambing, due to a canid's natural tendency to eat raw flesh, placenta, blood covered lambs, etc…) and; area and number of coyotes is more than guard dogs can handle effectively.

- Guard dogs in heat; tend to lure male dogs from work. Whelping dogs stay with pups.

- In situations where a high volume of people pass by (human/pet and guard dog conflicts), like on hiking trails, urban areas (e.g. fire suppression around Carson, holistic weed management on parks, etc...) guard dogs are not the best tool to reduce predation losses.

- In Nevada, private trappers not familiar with guard dogs can cause significant conflict situations. A private trapper's goal is to catch as many furbearers (while still respecting the concept of sustainability) as possible to maximize profit. The density of predators is higher around a prey base, such as sheep and goats. Guard dogs are around sheep and goats, and travel similar places where predators do and can often be caught. As private trappers are seasonal, the sheep and goat producers would rather maintain their guard dogs as they are available longer.

Some of the small scale sheep and goat producers use guard dogs. Almost all of the small scale sheep and goat producers have dogs that will alert them to predators, which are then harassed away.

Other Guard Animals:
Some of the small scale sheep and goat producers, in the East District, use either guard llamas or guard donkeys.

Since the effectiveness is nil over large areas, no large scale producers use them.

Harassment/hazing:
All sheep and goat producers in the East District employ harassment/hazing techniques. Harassment/hazing used include sound and visual deterrents to help reduce predation. Everything from shooting to vehicle harassment techniques is employed.

Audio Repellents:
All of the sheep and goat producers employ the use of audio repellents to help reduce losses to predation. Radios, voice, dog barks, car horns, running vehicles and even gun shots are most commonly used in the East District.

Visual Repellents:
All large scale sheep and goat producers in the East District use visual repellents to help reduce losses to predation. Fladry, "scare crow" type figures, people, vehicles, and lights are most often used.

All small scale sheep and goat producers use visual repellents to help reduce losses to predation, with more limited success. Flashing lights, 'scare crow' structures, people, vehicles, and flagging are most commonly used.

Carrion Removal:
Most (75 + %) of the large scale sheep and goat producers will remove carrion when reasonably able, to help reduce losses to predation. Often times the carrion is hauled to a "dead" pit and buried.

All of the small scale sheep and goat producers remove carrion to help prevent losses to predation. Often times a "dead" pit is used or a local landfill is used for final disposition.

Location Change:
All of the large scale sheep and goat producers will change locations of livestock to help reduce losses to predation. This can range from a few hundred yards to a few hundred miles depending on the situation.

All of the small scale producers will also change location of livestock to help reduce losses to predation. Livestock are most often brought closer to where they are more easily visually inspected by the herders.

Change in Lambing Practices (timing and/or area and /or location):
Approximately 75 % of the large scale producers in the East District will change the timing or location of livestock lambing to reduce losses to predation. As predation losses can be exceedingly high in certain areas at certain times, changes made can be based on that alone. 'Shed lambing', change of lambing area, and early or late lambing are common practices. All large scale producers confine the timing of lambing to help reduce perpetual losses to predation.

More than 75 % of small scale producers may try to 'shed lamb' or confine the lambing area to help reduce losses to predation. Additionally, some will confine the timing of lambing to help reduce losses to predation.

Herders:
For the large scale sheep and goat producers, the most important practice in reducing sheep and goat losses to predation is using a herder. All large scale producers in the East District employ herders. The herder himself can and does use a variety of non-lethal practices to reduce predation on the livestock that they are tending. Herders are most effective, at reducing losses to predation, when supplied with a variety of tools and knowledge of such tools. Of course, the skill and motivation of the herder also influence effectiveness of non-lethal practices to reduce predation. Most herders are provided with a gun that is often times used as a harassment tool. Both during the daytime as well as night, herders will fire a shot when coyotes are heard vocalizing thus scaring the coyotes from the area.

Few, if any, of the small scale sheep and goat producers employ full time herders, as they either act as a herder themselves or delegate the task to other family members.

Integration of Non-lethal Practices:
All sheep and goat producers use integrated predation management practices to reduce losses to predation. A wide variety of variables influence the application of the variety of non-lethal practices and no two producers manage predation damage exactly the same.

Change Class of Livestock/ Stop Livestock Production:
Some sheep and goat producers stop production of sheep and goats. Some may sell out and run more cattle or other livestock. This can change the amount of losses to certain predators. For example; fewer cattle are lost to coyote predation where a high number of sheep were lost to coyote predation previously.

Some may quit livestock production all together. Then there is no livestock producer to employ non-lethal predation damage management.

Other Non-lethal Practices often used:
All sheep and goat producers in the East District will use some form of harassment to reduce losses to predation.

Most producers will or have used habitat modification to help reduce losses to predation.

A few of the small scale producers may try supplemental feeding in an effort to reduce predation.

Cattle Producers in the East District:
As cattle are much different than sheep and goats, the losses to predation are different than that of sheep and goats. As such, the predation damage management practices vary from those used by sheep and goat producers. Since most losses to cattle from predation occur during calving, most predation damage management practices are centered on that time.

Exclusion:
Some (probably 20 %) cattle producers, in the East District, employ exclusion when cows are in an area where they can be 'calved out' in the corrals or well fenced calving pasture. This is most common with small bunches of cattle such as heifers, a pure bred or registered herd, or a small scale producer on private ground.

Confinement of Livestock:
Most (75 + %) cattle producers in the area confine some cattle to an area that is easily accessible and visually inspected, to help reduce losses to predation.

Guard Dogs/ Llamas/ Donkeys:

Few Cattle Ranchers use guard dogs due to the fact that cows with calves don't like dogs. However, almost all cattle producers have dogs that will alert them to predators.

Few use guard llamas or donkeys.

Carrion Removal:
Most (75 + %) cattle producers will remove carrion when reasonably able, to help reduce losses to predation. Often times the carrion is hauled to a "dead" pit and buried.

Audio Repellents:
All East District cattle producers employ the use of audio repellents to help reduce losses to predation. Radios, voice, dog barks, car horns, running vehicles and even gun shots are most commonly used in the Elko field area.

Visual Repellents:
All large cattle producers in the East District use visual repellents to help reduce losses to predation. Fladry, "scare crow" type figures, people, vehicles, and lights are most often used.

Change in Calving practices (timing and/or area and /or location):
If losses to predation are high in certain areas, most producers may visit the area more often or move the cattle to a place more easily inspected. Many cattle producers confine the timing of calving to help reduce losses to predation. Some experience less predation loss by changing the time of calving to a little later in the spring or to fall to reduce predation losses.

"Cowboys" or "Buckaroos":
All the large scale cattle producers have people who regularly tend to the cattle, especially during calving. The cowboys or buckaroos as they say in the East District often perform the same role for cattle as sheep herders do for sheep. The buckaroos are responsible for the health and well-being of the cattle, this includes protecting them from predators. The effectiveness of reducing losses to predation is a result of the buckaroos tools, knowledge, and skill.

Integration of Non-lethal Practices:
Most cattle producers use integrated predation management practices to reduce losses to predation. A wide variety of variables influence the application of the variety of non-lethal practices and no two producers manage predation management exactly the same.

Change Class of Livestock/ Stop livestock Production:
Over 90 % of cattle producers breed cattle for their "mothering" ability, to help reduce losses to predation. A few will even breed cattle with a very outgoing temperament to protect themselves and their young; this is most common on

"outside" operations where the cattle have to fend for themselves. This type of breeding is also doubled with leaving horns on the mother cows, allowing them to better ward off predators.

Some cattle producers may quit livestock production all together. Then there is no livestock producer to employ non-lethal predation damage management.

Other Non-lethal Practices often used:
All cattle producers in the East District will use some form of harassment to reduce losses to predation.

Most producers will or have used habitat modification to help reduce losses to predation.

Appendix C. State Policies, Federal Laws and Executive Orders Relevant to WS-Nevada Actions

State of Nevada Wildlife Commission Policies

Commission Policy Number P-21:

"*Nevada Revised Statute (NRS) 501.181 states that: "The Commission shall establish broad policies for the protection, propagation, restoration, transplanting, introduction, and management of wildlife in this State". In addition, NRS 501.181 indicates that the Commission shall: "Establish policies for areas of interest including the management of big and small game mammals, upland and migratory game birds, fur-bearing mammals…the control of wildlife depredations…and the introduction, transplanting, or exporting of wildlife". Further, the statute requires the Commission to: "Establish regulations necessary to carry out the provisions of this title and of chapter 488 of NRS, including: (a) seasons for hunting big game mammals and game birds, for hunting or trapping fur-bearing mammal the manner and means of taking wildlife, including, but not limited to, the sex, size, or other physical differentiation for each species, and when necessary for management purposes, the emergency closing or extending of a season, reducing or increasing of the bag or possession limits of a species, or the closing of any area to hunting, fishing, or trapping. The regulations must be established after first considering the recommendations of the Department, the county advisory boards to manage wildlife and others who wish to present their views at an open meeting. Any regulations relating to the closure of a season must be based on scientific data concerning the management of wildlife. The data on which the regulations are based must be collected or developed by the Department".*

BACKGROUND

Game and fur-bearer species are important to the State of Nevada. Hunting and viewing activities related to these species are economically vital to rural areas, and the sale of licenses, tags, permits, and other hunting and trapping related fees are principle sources of income to the Department. More broadly, game animals and fur-bearers are capstone species and the population health of these species is a key indicator of the integrity of Nevada's diverse ecosystems under changing climatic regimes.

The Game Division of the Department is charged with the management of big game, small game, waterfowl, and fur-bearers and for the development and implementation of management plans for these species. This policy is intended to provide Division and other departmental personnel with guidance to be followed in the development of such plans.

POLICY

The Nevada Board of Wildlife Commissioners develops broad policies related to the conservation, restoration, maintenance, and utilization of Nevada's game *populations. This guidance serves as the basis for species-specific management plans developed by the Game Division in cooperation with other departmental personnel. Management plans shall contain elements that:*

(a) *document available information on each species and their critical seasonal habitats and implement efficient, accurate, and objective programs to obtain herd and habitat inventory information;*

(b) *outline strategies to assess the current status of big game habitat and the use of that habitat, identify challenges to habitat and habitat use, and prescribe management actions and research that benefit game and fur-bearer populations;*

(c) *recognize that game and fur-bearers may come into conflict with other land uses such as agriculture and develop strategies to eliminate or minimize conflicts. If impacts are unavoidable, develop appropriate mitigations;*

(d) *provide a range of biologically feasible alternatives for the management of habitat, herd size, and harvest strategies for game and fur-bearer species, as well as the preferred alternatives on the basis of the best available science;*

(e) *maintain, and whenever possible, increase the quality of critical seasonal habitats in cooperation with private landowners, federal land management agencies, and other entities;*

(f) *implement predator control to reduce mortalities and increase recruitment whenever predation may have negative impacts on meeting game and fur-bearer population objectives;*

(g) *Document wildlife disease impacts and outline mitigation strategies to reduce those impacts whenever and wherever feasible.*

Management plans will be regularly reviewed by the Commission and departmental personnel will apprise the Commission of successes, shortcoming, and changes in direction. The Division will apprise the Commission of the best biological information available, any social, economic, or political impacts that management strategies are likely to have, and shall advise the Commission of alternatives that might address these impacts. Whenever Division recommendations are based on considerations other than biological data, those considerations will be fully explained to the Commission. If management plans conflict with federal, other state, or local planning efforts or policies, and if these conflicts are likely to have adverse impacts on game resources, the Division will notify the Commission at the earliest possible date as to the herds affected. The Department also will outline any alternative remedial measures available to the Commission and the Department which might be taken to minimize or eliminate these impacts.";

Commission Policy Number P-23:

PURPOSE

The purpose of this policy is to inform the public and guide the Nevada Department of Wildlife (Department) in actions relating to Predation Management. This policy specifically seeks to establish an informed Predation Management Program, primarily governed by the Predator Management Plan, which complies with NRS 502.253 and other applicable laws and incorporates the tools of habitat restoration for protection of nonpredatory game animals and sensitive wildlife species, research necessary to determine successful techniques for managing and controlling predatory wildlife, and the use of proven and emerging, science-based techniques of predator population management and control.

DEFINITION OF "PREDATION MANAGEMENT"

Predation Management is herein defined as selective reduction (i.e., limited lethal removal) and/or management (i.e., nonlethal actions) of predator or corvid (common raven, American crow and black-billed magpie) populations when and where predation is identified by the Department as a limiting factor negatively affecting another wildlife population. This includes monitoring and modeling of select predator populations, maintaining and/or managing viable predator populations, and studying select predator- prey relationships to better understand ecosystem function. It may also include the enhancement of various wildlife habitats according to the best available science as it relates directly to predator-prey relationships.

AUTHORITY FOR PREDATION MANAGEMENT

Pursuant to Nevada Revised Statutes (NRS) 501.100 the Legislature has declared "wildlife in this State not domesticated and in its natural habitat is part of the natural resources belonging to the people of the State of Nevada. The preservation, protection, management and restoration of wildlife within the State contribute immeasurably to the aesthetic, recreational, and economic aspects of these natural resources."

In accordance with NRS 501.105 and 501.181, the Board of Wildlife Commissioners (Commission) shall establish policies necessary to the preservation, protection, propagation, restoration, transplanting, introduction, and management of wildlife and its habitat in this state.

Pursuant to NRS 502.253(1) a fee of $3 is charged for processing each application for a game tag to be used by the Department for costs related to:

(a) *Developing and implementing an annual program for the management and control of predatory wildlife;*
(b) *Wildlife management activities relating to the protection of non-predatory game animals and sensitive wildlife species; and*
(c) *Conducting research necessary to determine successful techniques for managing and controlling predatory wildlife.*

Pursuant to NRS 502.253(2) the Department is hereby authorized to expend a portion of the money collected pursuant to subsection 1 of NRS 502.253 to enable the State Department of Agriculture to develop and carry out programs described in subsection 1 of NRS 502.253.

Pursuant to NRS 502.253(3) any program developed or wildlife management activity or research so conducted must be developed or conducted under the guidance of the Commission pursuant to NRS 501.181(2). Pursuant to NRS 501.181(2) the Commission shall guide the Department in its administration and enforcement of provisions of Title 45, Wildlife (Chapters 501–506) of NRS by establishment of broad policies for the protection, propagation, restoration, transplanting, introduction, and management of wildlife in this State.

Pursuant to NRS 502.253(1) the revenue from the $3 fee must be accounted for separately and deposited in the Wildlife Fund Account, of which 80% of the revenues from the most recent fiscal year for which the Department has complete information must be spent for lethal management and control of predatory wildlife in accordance with NRS 502.253(4)(b).

Pursuant to NRS 502.253(4)(a), the Department will first consider the recommendations of the Commission and the State Predatory Animal and Rodent Committee (PARC) before adopting any program for the management and control of predatory wildlife.

PREDATION MANAGEMENT POLICIES

A. *POLICY FOR PROGRAMS FOR THE MANAGEMENT AND CONTROL OF PREDATORY WILDLIFE*

1. *Conduct projects in the most efficient and cost-effective manner possible, with clear goals, objectives, and timelines defined at the onset, and with an emphasis on identifying and refining prescriptive measures of Predation Management for use in the future. Lethal and/or nonlethal predator control efforts will be undertaken in a targeted fashion to reduce specific wildlife-related losses to wildlife populations without endangering long-term health, vigor and/or*

ecological services provided by balanced and viable predator and/or corvid wildlife populations.

2. *Geographical locations for project areas will be determined based on an objective analysis and on the needs of wildlife populations in the area. Priority will be given to act in areas where other efforts are completed, underway, or planned that will also benefit wildlife populations to provide the best data possible.*
3. *Control activities will be conducted where game and sensitive wildlife populations are at risk of being disproportionately affected by predation.*
4. *If needed to assess project viability, statewide and project area estimates of predator and corvid populations or densities will be based on an objective analysis.*
5. *Statewide and regional projects that allow the Department to engage in predator management programs as needed to protect game and sensitive wildlife populations.*
6. *The Commission recognizes the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (Wildlife Services) as a cooperating agency in lethal predatory wildlife control. The Commission also recognizes qualified contractors and cooperators may be available for predator population management, predator-prey research, and predator population monitoring efforts.*
7. *In terms of lethal control, Wildlife Services personnel or other contractors shall salvage (when practicable) and give the hide and skull of any mountain lion, black bear, and bobcat removed under authority of a contract with the Department within 96 hours of the removal.*

B. *POLICY FOR WILDLIFE MANAGEMENT ACTIVITIES FOR THE PROTECTION OF NONPREDATORY GAME ANIMALS AND SENSITIVE WILDLIFE SPECIES*

1. *Wildlife management activities will be undertaken in a targeted fashion to reduce specific wildlife losses including, but not limited to, enhancing habitat conditions to better provide adequate forage, water, or cover or remove naturally occurring habitat or corvid and raptor perches that increases the susceptibility to predation. Such wildlife management activities will be conducted in accordance with existing land use agreements.*
2. *Geographical locations for project areas will be determined based on an objective analysis and on the needs of wildlife populations in the area. Priority will be given to act in areas where other efforts are completed, under way, or planned that will also benefit wildlife populations to provide the best data possible.*
3. *Wildlife management activities will be conducted in the most efficient and cost- effective manner possible with clear goals, objectives, and timelines defined at the onset, with an emphasis on improving wildlife populations and their habitats.*

4. *Statewide and regional projects that allow the Department to engage in wildlife management activities as needed to protect game and sensitive wildlife populations.*
5. *If needed to assess project viability, statewide and project area estimates of predator and corvid populations or densities will be based on an objective analysis.*

C. *POLICY FOR CONDUCTING RESEARCH FOR MANAGING AND CONTROLLING PREDATORY WILDLIFE*

1. *Wildlife research activities will be undertaken in a targeted fashion to address questions regarding predator-prey or predator community relationships including improved control techniques, predator-prey responses to habitat restoration activities, and influences of large and medium-sized predators on ecosystems.*
2. *Geographical locations for project areas will be determined based on an objective analysis and on the needs of wildlife populations and habitats in the area, as well as the need for objective science on subjects related to Predation Management. Priority will be given to act in areas where other efforts are completed, underway, or planned that will also benefit wildlife populations to provide the best data possible.*
3. *Wildlife research efforts will be promoted that: a) provide wildlife managers with objective scientific analysis for making sound decisions regarding future wildlife population and habitat management; and b) provide insights into the role predators play in maintaining vigorous and healthy ecosystems.*
4. *If needed to assess project viability, statewide and project area estimates of predator and corvid populations or densities will be based on an objective analysis.*
5. *Statewide and regional projects that allow the Department to engage in wildlife research efforts as needed to identify better techniques for predator control and management.*

PREDATION MANAGEMENT PLAN

Pursuant to the above Commission policies, the Department, in coordination with and under the guidance of the Wildlife Damage Management Committee (WDMC), shall prepare a Predation Management Plan. The Predation Management Plan shall identify and implement (a) programs for the management and control of predatory wildlife for the benefit of other species of wildlife ("Control Program"), (b) wildlife management activities for the protection of non-predatory animals and related wildlife habitat ("Management Activity"), and (c) research relating to predatory wildlife and research to determine successful techniques and effective programs for managing and/or controlling *predatory wildlife and related habitats ("Research Program"), all to be conducted for the fiscal period beginning July 1 and ending June 30 of each year (Fiscal Year).*

Whenever possible, Control Programs, Management Activities, and Research Programs should be integrated on the landscape to provide the best possible outcome in terms of healthy functioning ecosystems and the furthering of wildlife management science.

The Predation Management Plan shall be developed each Fiscal Year according to the following procedure:

1. *The Department shall prepare a Draft Predation Management Plan (Draft Plan) outlining proposed actions needed for the protection, preservation, management, and restoration of wildlife populations and their habitats. Descriptions of Control Programs, Management Activities, and Research Programs, collectively referred to as "project(s)," shall include specific project goals, a detailed description of anticipated results, predator and prey wildlife species that may be affected, whether or not the project will span more than one Fiscal Year, and if the project is for a Control Program, a statement of why the Department believes that the predatory wildlife is a limiting factor in the growth and or maintenance of a target prey population. A description of the project area should be provided, including a map, an assessment of the habitat conditions, and identification if such habitat is a migratory corridor, summer range, winter range, fawning, calving, nesting or brood- rearing habitat, or a combination of any of the above. Regarding all projects proposed to be continued from the prior Fiscal Year, the Draft Plan shall address the Department's comments from the prior Fiscal Year's Status Report.*

2. *A Draft Plan shall be submitted to the Commission during its first meeting of the calendar year (typically February). In so doing, the Draft Plan will be made available to all "Stakeholders," including but not limited to contractors (including Wildlife Services), County Advisory Boards to Manage Wildlife (CABMWs), PARC, conservation organizations, and the general public. This Draft Plan shall serve as a vehicle to elicit suggestions for changes, adjustments, new ideas, and input from all Stakeholders.*

3. *The Department shall attend a meeting of the PARC between the Commission's first meeting of the year and the Commission's March meeting to present and discuss the Draft Plan.*

4. *The WDMC shall set a meeting in conjunction with the March meeting of the Commission to review all comments received on the Draft Plan. After consideration of findings and recommendations of the Department, and*

with respect to lethal control projects, recommendations of Wildlife Services and other contractors, PARC, as well as all comments and recommendations received, the Chairman of the WDMC shall make a preliminary report to the Commission on which projects should be funded in the subsequent Fiscal Year. At the March meeting, the Commission shall review the report of the WDMC and may vote to make a recommendation to the Department on the ranking of all projects. If the Commission determines that more projects are proposed than funding is available for the subsequent Fiscal Year, this will factor into their deliberations and recommendations to the Department.

5. *The Department shall prepare a Final Draft Predation Management Plan (Final Draft Plan) and present it to the WDMC and/or Commission at their May Meeting. The Final Draft Plan shall be posted on the Department's website and made available to the public and distributed to CABMWs and PARC. The Commission shall review the Final Draft Plan and shall take further comments from the Department, Stakeholders, PARC, and with respect to lethal Control Programs, from Wildlife Services and other contractors. After consideration of such comments, the Commission shall make its final recommendations to the Department on the Final Draft Plan.*

6. *On or before June 30, after consideration of all comments, the Department shall finalize the Predation Management Plan for the next Fiscal Year. The Final Predation Management Plan shall be posted on the Department's website and made available to the public and distributed to members of the Commission and CABMWs and to all contractors and cooperators.*

7. *If, at any other time of the year, the Department, in consultation with the WDMC and PARC, identifies additional or changing Predation Management needs and determines that money is available to fund additional projects, the Department may approve projects which are urgent in nature or which present unique opportunities.*

8. *Contracts or grants will be finalized and/or amended as soon as possible after the finalization of the Predation Management Plan.*

9. *Any time after June 30 but no later than August 1, each contractor or grantee of a project from the previous Fiscal Year shall submit a report to the Commission on a form prescribed by the Department and which has been developed in consultation with the WDMC. Such reports may include:*

   (a) *For a Control Program, (1) all of the information set forth in Section 1, above; (2) for lethal Control Programs, required quarterly removal reports, (3) for lethal and nonlethal Control Programs, a detailed description of results may include: a) estimated predator and* *prey population and demographic indices before and after treatment in the Control Program area; b) estimated predator and prey population and demographic indices in treatment and other areas; c) any other data sets pertinent to the analysis and interpretation of the Control Program (e.g., sport harvest data, climate patterns, fire regime, nonnative floral and/or faunal influences on predator and prey populations and their habitats, or other related items); and (4) all itemized costs incurred during previous Fiscal Years;*

(b) *For a Management Activity, (1) all of the information set forth in Section 1, above; (2) a detailed description of results may include: a) a complete analysis of acreages treated and habitat enhancement responses to date; b) estimated predator and prey population and demographic indices before and after treatment in the Management Activity area; c) estimated predator and prey population and demographic indices in treatment and other areas; d) any other data sets pertinent to the analysis and interpretation of Management Activities (e.g., sport harvest data, climate patterns, fire regime, nonnative floral and/or faunal influences on predator and prey populations and their habitats, or other related items); and (4) all itemized costs incurred during previous Fiscal Years; and*

(c) *For a Research Program, (1) all of the information set forth in Section 1, above; (2) a detailed description of results may include: a) a complete analysis of research results and conclusions to date; b) estimated predator and prey population and demographic indices before and after treatment (if applicable) in the Research Program area; c) estimated predator and prey population and demographic indices in treatment and other areas within designated project areas (if applicable); d) any other data sets pertinent to the analysis and interpretation of the Research Program (e.g., sport harvest data, climate patterns, fire regime, nonnative floral and/or faunal influences on predator and prey dynamics and their habitats, or other related items); and (4) all itemized costs incurred during previous Fiscal Years.*

10. *The Department shall prepare an annual Predation Management Status Report (Status Report) detailing results of the previous Fiscal Year's projects. This report will include a summary of all lethal removal reports, excluding any sensitive data, proprietary information, or time-sensitive locational information. This Status Report shall be presented at the last Commission meeting of each calendar year.*

This Status Report will be used in Department and Commission deliberations in subsequent years and in future Predation Management planning efforts.

Commission Policy Number P-25:

"PURPOSE

To inform the public and guide the Nevada Department of Wildlife (Department) in actions relating to Wildlife Damage Management.

In accordance with NRS 501.181, the Board of Wildlife Commissioners shall establish policies for the protection, propogation, restoration, transplanting, introduction and management of wildlife in this state. Further, the commission shall establish policies for areas of interest including wildlife damage management.

POLICY

1. *Wildlife damage management shall be undertaken to minimize wildlife related losses to private or natural resources without endangering the existence or natural role of offending wildlife species in the ecosystem.*

2. *Extension and educational efforts will be encouraged to assist private citizens in animal husbandry practices, property protection or human activities to minimize the vulnerability of loss, damage, or injury to livestock, pets, private property, or human health and safety.*

3. *The Commission supports continued federal leadership in wildlife damage management because of the national need for development and use of more efficient and humane control methods.*

4. *The Commission recognizes the U. S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, as the authority for predatory and nuisance wildlife damage management under cooperative agreement with the Department of Wildlife, where the Department of Wildlife is an active participant in documenting the need for wildlife damage management programs, in planning and execution of those programs, and in enhancing public understanding of those programs.*

   The Department shall prepare an annual wildlife damage management plan outlining proposed actions needed for the management of wildlife and, upon approval of the Commission, recommend that a sufficient amount of funding annually be forwarded from the Wildlife Account in the State General Fund to the state predator animal and rodent committee (PARC) for wildlife damage management work as provided in Chapter 567 of NRS.

5. *The Department shall conduct an evaluation of the potential needs for wildlife damage management activities in conjunction with preparing release proposal for big game, upland game, and migratory birds. Those evaluations shall be included in each site-specific release proposal in the*

draft biennial big game and upland game-migratory bird release plans.

6. *Initiate wildlife damage management efforts using the best scientific and biological information available.*

7. *Direct wildlife damage management efforts including sport hunting and trapping, whenever possible, to prevent damage to resources or threats to human health and safety before it occurs in specific areas known to be recurring problem areas, or to alleviate damage as soon as possible after it occurs.*

8. *Direct wildlife damage management efforts at the offending animal or localized offending species population insofar as possible, and feasible.*

9. *Wildlife damage management of major mammalian predators including coyotes, bobcats, mountain lion, and black bears, shall be directed towards specific geographic areas of the state where a predation problem has been documented by the Department of Wildlife or Wildlife Services. Within those documented areas, management and control efforts shall be undertaken to minimize livestock, pets, or natural resource losses that may or are about to occur through predation. In the event that any of the aforementioned major mammalian predators poses a legitimate immediate threat to human health and safety, based on the professional judgment of Department of Wildlife or Wildlife Services personnel, those animals shall be killed.*

10. *Employ wildlife damage management methods which are selected on the basis of the species involved, utilizing currently approved methods in the proper mix according to the needs. These methods may include aerial hunting, M-44 devices, trapping, snares, denning and registered pesticides.*

    a. *Pesticides must be federally and state registered, applied only by certified applicators, and should only be used in those proactive or reactive preventive damage management operations where its use and delivery system represent a selective, effective and efficient method of control.*

    b. *Aerial hunting will be conducted only under authorization of the Department of Wildlife through issuance of an aerial depredation permit, limited to bobcats, coyotes and ravens. Such permits shall be issued only to Wildlife Services or to landowners or tenants land or property that are being damaged by wildlife.*

11. *Department, upon issuance of a depredation permit and with the aid*

and cooperation of the complainant, may take all available professional and economically feasible measures to alleviate or lessen the depredation or safety problem.

PROCEDURE

NRS 503.595 provides that after the owner or tenant of any land or property has made a report to the Department indicating that such land or property is being damaged or destroyed, or is in danger of being damaged or destroyed, by wildlife, the Department may, after thorough investigation and pursuant to such regulations as the Commission may promulgate, cause such action to be taken as it may deem necessary, desirable and practical to prevent or alleviate such damage or threatened damage to such land or property.

The Commission has adopted regulations authorizing the Director or his designee to issue wildlife depredation permits. Specific permit programs include:

1. *An annual wildlife depredation permit may be issued to the State Supervisor, U.S. Department of Agriculture Wildlife Services, to kill mountain lion, black bear and/or bobcat causing or potentially causing a loss of private property, natural resources, or representing a threat to human health and safety.*

2. *Any report of natural resource, livestock, or pet loss, or threat to human health or safety received by the Department shall be forwarded immediately to Wildlife Services for action in accordance with subsection (b) of this section.*

3. *Upon receipt of a report from a property owner or the Department indicating that a mountain lion, black bear, or bobcat is causing or about to cause damage to private property or oppose a threat to human health and safety, the permittee shall conduct an on-site investigation. If the results of the investigation support the complaint, the permittee may kill the animal. If the permittee cannot determine if the complaint is valid, he shall notify a representative of the Department, who shall conduct a joint investigation to make the final determination.*

4. *The permittee shall salvage and give the hide and skull of mountain lion, black bear or bobcat killed under the authority of a permit, to the Department within 72 hours.*

5. *An annual wildlife depredation permit may be issued to State Supervisor, Wildlife Services to kill the minimum number of game, furbearers, protected or unprotected wildlife species as necessary to control threat or damage to and property or to human health and safety.*
6. *Upon receipt of a valid mountain lion, black bear or bobcat complaint from an*

individual landowner or tenant, the Department may issue a limited permit to the owner to pursue and kill an animal that is in the act of killing his livestock.

7. *The permittee shall notify a Department representative within 72 hours after killing a mountain lion, black bear or bobcat and shall salvage the hide and skull and give same to the Department of Wildlife.*

8. *The Department may issue permits authorizing the hunting or killing of coyotes and bobcats from an aircraft.*

9. *Furbearers may be taken or killed at any time in any manner, provided an individual or entity first obtains a permit from the Department. The Department or their agents are authorized to enter upon the lands of a landowner and remove beaver or otter for the relief of other landowners and the protection of the public welfare.*

10. *The Department may issue permits consistent with federal law to take bald eagles, golden eagles, ravens, or other birds protected by the Migratory Bird Treaty Act, whenever it determines that they have become seriously injurious to wildlife or agriculture or other interests that the injury can only be abated by killing some of the offending birds.*

11. *The State Predatory Animal and Rodent Committee shall enter into agreements with the U. S. Department of Agriculture covering cooperative control of crop-destroying birds in addition to predatory animals and rodents to assure maximum protection against losses of livestock, poultry, game birds, animals and crops on a statewide basis. The State Department of Agriculture in accordance with NRS 555.010 and 555.021 responds to complaints involving vertebrate pests that are injurious to agriculture or public health.*

12. *The Department may issue a wildlife depredation permit to a landowner if needed for the prevention or alleviation of damage to standing or stored agriculture crops."*

NDOW is also responsible for administering Section 13 of the Fish and Wildlife Act of 1956 (commonly referred to as the Airborne Hunting Act or Shooting from Aircraft Act), with the authority to approve permits for the owner or tenant of any land or property, or to a governmental agency, to engage in the hunting, killing or nonlethal control of bobcats or coyotes from an aircraft for the purpose of protecting land, wildlife, livestock, domestic animals or human life. The Department may also issue a permit to the State Director of the USDA APHIS WS to engage in the hunting, killing or nonlethal control of common ravens from an aircraft, although the WS-Nevada is exempt from the airborne hunting act and doesn't require said permit (16 U.S. Code §742j-1(b)(1)). Such permits will not be issued for hunting for sport (NAC 503.760, NRS 501.105, 501.181, and 503.005). Permittees must report their animals taken through aerial shooting on or before January 10 after the calendar year in which the permits was issued, the permittee shall submit to the Department, at an address specified on the appropriate form, a written report of the number of common ravens, bobcats or coyotes taken during each month in which the permit was valid (NAC 503.760).

The State of Nevada defines "pest" as "*any form of animal or vegetable life detrimental to the crops, horticulture, livestock, public health, wildlife, quality of water and beneficial uses of land in Nevada, including, any insect, snail, nematode, fungus, virus, bacterium, microorganism, mycoplasma, weed, parasitic plant or any other plant that is normally considered to be a pest of cultivated plants, uncultivated plants, agricultural commodities, horticultural products or nursery stock, or that the Nevada Director of Agriculture declares to be a pest*" (NRS 555.005). "Vertebrate pest" is defined by the State of Nevada as "*any animal of the subphylum Vertebrata, except predatory animals, which is normally considered to be a pest, including a gopher, ground squirrel, rat, mouse, starling, blackbird and any other animal which the Director may declare to be a pest*" (NRS 555.005). The NDA is authorized to investigate and control pests for the protection of crops, livestock, public health, wildlife, water quality and beneficial uses of land in the State of Nevada (NRS 555.010). "Livestock" includes all cattle or animals of the bovine species; all horses, mules, burros and asses or animals of the equine species; all swine or animals of the porcine species; all goats, or animals of the caprine species; all sheep or animals of the ovine species; all poultry or domesticated fowl or birds; and all alternative livestock (NRS 569.0085). Per NRS 555.021, the Director of the Nevada Department of Agriculture "*may cooperate, financially or otherwise, with any federal agency or Department, any other state agency or department, any county, city, public district or political subdivision of this State, any public or private corporation, and any natural person or group of natural persons is suppressing vertebrate pests injurious to the state agricultural interests and in suppressing vertebrate pest vectors of diseases transmissible and injurious to humans.*".

NRS 501.110 Classification of wildlife:

"*1. For the purposes of this title, wildlife (defined as any wild mammal, wild bird, fish, reptile, amphibian, mollusk or crustacean found natural in a wild state, whether indigenous to Nevada or not and whether raised in captivity or not (NRS 501.097)) must be classified as follows:*

(a) Wild mammals, which must be further classified as either game mammals, fur-bearing mammals, protected mammals or unprotected mammals.

(b) Wild birds, which must be further classified as either game birds, protected birds or unprotected birds. Game birds must be further classified as upland game birds or migratory game birds.

(c) Fish, which must be further classified as either game fish, protected fish or unprotected fish.

(d) Reptiles, which must be further classified as either protected reptiles or unprotected reptiles.

(e) Amphibians, which must be further classified as either game amphibians, protected amphibians or unprotected amphibians.

(f) Mollusks, which must be further classified as either protected mollusks or unprotected mollusks.

(g) Crustaceans, which must be further classified as either protected crustaceans or unprotected crustaceans.

2. Protected wildlife may be further classified as either sensitive, threatened or endangered.

3. Each species of wildlife must be placed in a classification by regulation of the Commission and, when it is in the public interest to do so, species may be moved from one classification to another."

Federal Laws

National Environmental Policy Act (NEPA)

Most federal actions are subject to the NEPA (Public Law 9-190, 42 USC 4321 et seq.). When APHIS-WS enters into an agreement to assist another federal agency to manage wildlife damage hazards, the other federal agency must also comply with NEPA. APHIS-WS policy is to work together for compliance. NEPA requires federal agencies to incorporate environmental planning into federal agency actions and decision-making processes. The two primary objectives of the NEPA are: 1) agencies must have available and fully consider detailed information regarding environmental effects of federal actions and 2) agencies must make information regarding environmental effects available to interested persons and agencies before decisions are made and before actions are taken.

APHIS-WS complies with CEQ regulations implementing the NEPA (40 CFR 1500 - 1508) along with USDA (7 CFR 1b) and APHIS Implementing Guidelines (7 CFR 372) as part of the decision-making process. Pursuant to the NEPA and CEQ regulations, WS NEPA documents the analyses resulting from proposed federal actions, informs decision-makers and the public of reasonable alternatives capable of avoiding or minimizing adverse impacts, and serves as a decision-aiding mechanism to ensure that the policies and goals of the NEPA are infused into federal agency actions. NEPA documents are prepared by integrating as many of the natural and social sciences as relevant to the decisions, based on the potential effects of the proposed actions. The direct, indirect, and cumulative impacts of the proposed action are analyzed.

Pursuant to the NEPA and CEQ regulations, WS NEPA documents the analyses resulting from proposed federal actions, informs decision-makers and the public of reasonable alternatives capable of avoiding or minimizing adverse impacts, and serves as a decision-aiding mechanism to ensure that the policies and goals of the NEPA are infused into federal agency actions.

Endangered Species Act

Under the ESA (16 United States Code (U.S.C.) 1531 et seq., Endangered Species Act (ESA) of 1973, as amended; 16 U.S.C. 703-712), all federal agencies will seek to conserve threatened and endangered species and will used their authorities in furtherance of the purposes of the Act (Sec. 2(c)). WS conducts Section 7 consultations with the United States Fish and Wildlife Service (USFWS) 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 or threatened species…Each agency will use the best scientific and commercial data available" (Sec.7 (a)(2)). Depending on the species, the US Fish and Wildlife Service (USFWS) and the NOAA National Marine Fisheries Service (NMFS) are charged with implementation and enforcement of the Endangered Species Act of 1973, as amended and with developing recovery plans for listed species. Under the authority of the ESA, the USFWS acts to prevent the extinction of plant and animal species. It does this by identifying species at risk of extinction, designating ("listing") these species as threatened or endangered, providing protection for these species and their habitats, developing and implementing recovery plans to improve their status, and ultimately "delisting" these species and returning full management authority to the states and tribes. While a species is listed, most management authority for the species rests with the USFWS/NMFS. However, the agencies continue to work with other Federal agencies, states, and tribes along with private landowners to protect and recover the species. The USFWS helps ensure protection of listed species through consultations (section 7 of the ESA) with other Federal agencies. Under section 10 of the ESA, the USFWS also issues permits which provide exceptions to the prohibitions established by other parts of the Act. These permits provide for conducting various activities including scientific research, enhancement of propagation or survival, and incidental take while minimizing potential harm to the species. For species federally classified as threatened, the USFWS may also issue 4(d) rules which may allow for greater management flexibility for the species. The USFWS also issues grants for protection and enhancement of habitat and for research intended to improve the status of a listed species.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and Amendments

FIFRA is the primary act under which the registration of pesticides is regulated. FIFRA authorizes Federal agencies to regulate the distribution, sale, and use of pesticides to protect human health and the environment. FIFRA authorizes EPA to review and register pesticides for specified uses. EPA also has the authority to suspend or cancel the registration of a pesticide if subsequent information shows that the continued use would pose unreasonable risks.

All pesticides distributed or sold in the United States must first be registered by EPA, and then within the individual State where it is being distributed, sold, or used. The EPA registration process requires that pesticides will be properly labeled and that, if used in accordance with the label, the pesticide should not cause unreasonable harm to humans or the environment. FIFRA does not fully preempt state, tribal, or local law, therefore each entity may also further regulate pesticide use.

National Historic Preservation Act (NHPA) of 1966, as amended

The NHPA and its implementing regulations (36 CFR 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. The Advisory Council on Historic Preservation (ACHP) and each state's State Historic Preservation Officer (SHPO) or the tribal government Tribal Historic Preservation Officer THPO) have the primary non-regulatory jurisdiction. 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, the site-specific consultation as required by Section 106 of the NHPA would be conducted with the SHPO or THPO as necessary.

The Native American Graves and Repatriation Act of 1990

The Native American Graves Protection and Repatriation Act (Public Law 101-106, 25 USC 3001) requires federal agencies to notify the Secretary of the Department that manages the federally managed lands upon the discovery of Native American cultural items on federal or tribal lands. Federal agencies are to discontinue work until the agency has made a reasonable effort to protect the items and notify the proper authority.

The Wilderness Act (Public Law 88-577(USC 1131-1136))

The Wilderness Act established a national preservation system to protect areas "where the earth and its community life are untrammeled by man" for the United States. Wilderness areas are devoted to the public for recreational, scenic, scientific, educational, conservation, and historical use. This includes the grazing of livestock where it was established prior to the enactment of the law (Sept. 3, 1964) and damage management is an integral part of a livestock grazing program. The Act did leave management authority for fish and wildlife with the state for those species under their jurisdiction.

Coastal Zone Management Act of 1972, as amended (16 USC 1451-1464, Chapter 33; P.L. 92-583, October 27, 1972; 86 Stat. 1280).

This law established a voluntary national program within the Department of Commerce to encourage coastal states to develop and implement coastal zone management plans. Funds were authorized for cost-sharing grants to states to develop their programs. Subsequent to federal approval of their plans, grants would be awarded for implementation purposes. In order to be eligible for federal approval, each state's plan was required to define boundaries of the coastal zone, identify uses of the area to be regulated by the state, determine the mechanism (criteria, standards or regulations) for controlling such uses, and develop broad guidelines for priorities of uses within the coastal zone. In addition, this law established a system of criteria and standards for requiring that federal actions be conducted in a manner consistent with the federally approved plan. The standard for determining consistency varied depending on whether the federal action involved a permit, license, financial assistance, or a federally authorized activity. As appropriate, a consistency determination would be conducted by WS to assure management actions would be consistent with the particular state's Coastal Zone Management Program established under the Coastal Zone Management Act CGS Sections 22a-90 to 22a-111.

Migratory Bird Treaty Act

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 FWS. The Migratory Bird Treaty Act established a Federal prohibition, unless permitted by regulations, to pursue, hunt, take, capture, kill, attempt to take, capture or kill, possess, offer for sale, sell, offer to purchase, purchase, deliver for shipment, ship, cause to be shipped, deliver for transportation, transport, cause to be transported, carry, or cause to be carried by any means whatever, receive for shipment, transportation or carriage, or export, at any time, or in any manner, any migratory bird or any part, nest, or egg of any such bird. FWS released a final rule on November 1, 2013 identifying 1,026 birds on the List of Migratory Birds (FWS 2013). Species not protected by the Migratory Bird Treaty Act include nonnative species introduced to the United States or its territories by humans and native species that are not mentioned by the Canadian, Mexican, or Russian Conventions that were implemented to protect migratory birds (FWS 2013). Based on evidence that migratory game birds have accumulated in such numbers to threaten or damage agriculture, horticulture or aquaculture, the Director of the USFWS is authorized to issue a depredation order or special use permit, as applicable, to permit the killing of such birds (50 CFR 21.42-47). In severe cases of bird damage, WS provides recommendations to the USFWS for the issuance of depredation permits to private entities (50 CFR 21.41). Starlings, pigeons, House Sparrows and domestic waterfowl are not classified as protected migratory birds and therefore have no protection under the MBTA. USFWS depredation permits are also not required for Yellow-headed, Red-winged, and Brewer's Blackbirds, cowbirds, all grackles, crows, and magpies found committing or about to commit depredation upon ornamental or shade trees, agricultural crops, livestock, or wildlife, or when concentrated in such numbers and manner as to constitute a health hazard or other nuisance (50 CFR 21.43).

Bald and Golden Eagle Protection Act (BGEPA)

This law provides special protection for bald and golden eagles. Similar to the Migratory Bird Treaty Act, the Bald and Golden Eagle Protection Act (16 U.S.C. 668 et seq.) prohibits the take of bald or golden eagles unless permitted by the Department of the Interior. The term "take" in the Act is defined as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." Disturb is defined as any activity that can result in injury to an eagle, or cause nest abandonment or decrease in productivity by impacting breeding, feeding, or sheltering behavior.

Occupational Safety and Health Act of 1970

The Occupational Safety and Health Act of 1970 and its implementing regulations (29 CFR 1910) on sanitation standards states that, "Every enclosed workplace shall be so constructed, equipped, and maintained, so far as reasonably practical, as to prevent the entrance or harborage of rodents, insects, and other vermin. A continuing and effective extermination program shall be instituted where their presence is detected." This standard includes mammals that may cause safety and health concerns at workplaces.

Federal Food, Drug, and Cosmetic Act (21 USC 360)

This law places administration of pharmaceutical drugs, including those immobilizing drugs used for wildlife capture and handling, under the Food and Drug Administration.

Controlled Substances Act of 1970 (21 USC 821 et seq.)

This law requires an individual or agency to have a special registration number from the United States Drug Enforcement Administration to possess controlled substances, including controlled substances used for wildlife capture and handling.

Animal Medicinal Drug Use Clarification Act of 1994

The Animal Medicinal Drug Use Clarification Act (AMDUCA) and its implementing regulations (21 CFR 530) establish several requirements for the use of animal drugs, including those animal drugs used to capture and handle wildlife in damage management programs. Those requirements are: (1) a valid "veterinarian-client-patient" relationship, (2) well defined record keeping, (3) a withdrawal period for animals that have been administered drugs, and (4) identification of animals. A veterinarian, either on staff or on an advisory basis, would be involved in the oversight of the use of animal capture and handling drugs under any alternative where WS could use those immobilizing and euthanasia drugs. Veterinary authorities in each state have the discretion under this law to establish withdrawal times (i.e., a period after a drug was administered that must lapse before an animal may be used for food) for specific drugs. Animals that people might consume within the withdrawal period must be identifiable (e.g., use of ear tags) and labeled with appropriate warnings.

Fish and Wildlife Act of 1956 (section 742j-1) - Airborne Hunting

The Airborne Hunting Act, passed in 1971 (Public Law 92-159), and amended in 1972 (Public Law 92-502) was added to the Fish and Wildlife Act of 1956 as a new section (16 USC 742j-l). The USFWS regulates the Airborne Hunting Act but has given implementation to the States. This act prohibits shooting or attempting to shoot, harassing, capturing or killing any bird, fish, or other animal from aircraft except for certain specified reasons. Under exception [see 16 USC 742j-l, (b)(1)], state and federal agencies are allowed to protect or aid in the protection of land, water, wildlife, livestock, domesticated animals, human life, or crops using aircraft.

Presidential Executive Orders

Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations (Executive Order 12898)

Executive Order 12898 promotes the equitable treatment of people of all races, income levels, and cultures with respect to the development and implementation of federal actions, and enforcement of environmental laws, regulations and policies. Executive Order 12898 requires federal agencies to make environmental justice part of their mission, and to identify and address, when appropriate, disproportionately high and adverse human health and environmental effects of federal programs, policies, and activities on minority and low-income persons or populations.

Protection of Children from Environmental Health and Safety Risks (Executive Order 13045)

Children may suffer disproportionately for many reasons from environmental health and safety risks, including the development of their physical and mental status. This executive order requires federal agencies to evaluate and consider during decision-making the adverse impacts that the federal actions may have on children.

Invasive Species (Executive Order 13112)

Executive Order 13112 establishes guidance for federal agencies to use their programs and authorities to prevent the spread or to control populations of invasive species that cause economic or environmental harm or harm to human health. The Order states that each federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law: 1) reduce invasion of exotic species and the associated damages, 2) monitor invasive species populations and provide for restoration of native species and habitats, 3) conduct research on invasive species and develop technologies to prevent introduction, and 4) provide for environmentally sound control and promote public education of invasive species. This EO created the National Invasive Species Council (NISC).

Consultation and Coordination with Indian Tribal Governments (EO 13175)

This EO directs federal agencies to provide federally recognized tribes the opportunity for government-to-government consultation and coordination in policy development and program activities that may have direct and substantial effects on their tribe. Its purpose is to ensure that tribal perspectives on the social, cultural, economic, and ecological aspects of agriculture, as well as tribal food and natural-resource priorities and goals, are heard and fully considered in the decision-making processes of all parts of the Federal Government.

Facilitation of Hunting Heritage and Wildlife Conservation (Executive Order 13443)

This order directs Federal agencies that have activities that have a measurable effect on outdoor recreation and wildlife management, to facilitate the expansion and enhancement of hunting opportunities and the management of game species and their habitat. It directs federal agencies to cooperate with states to conserve hunting opportunities. APHIS-WS cooperates with state wildlife and other resource management agencies in compliance with applicable state laws governing feral swine management. State, territorial, and tribal agencies, not APHIS, have the authority to determine which species are managed as a game species, hunted, eradicated, contained, or managed for local damages.

Incorporating Ecosystem Services into Federal Decision Making (Presidential Memorandum 10/7/2015)

This memorandum directs Federal agencies to develop and institutionalize policies to promote consideration of ecosystem services, where appropriate and practicable, in planning, investments, and regulatory contexts. This effort includes using a range of qualitative and quantitative methods to identify and characterize ecosystem services, affected communities' needs for those services, metrics for changes to those services, and, where appropriate, monetary and nonmonetary values for those services. It also directs federal agencies to integrate assessments of ecosystem services, at the appropriate scale, into relevant programs and projects, in accordance with their statutory authority.

Appendix D. Modeling Common Raven Population and Level of Take

Common Raven Prescribed Take Level for Greater Sage-Grouse in BCR 9 in Nevada

Developed by and modified from: Frank F. Rivera-Milán, Ph.D., U.S. Fish and Wildlife Service.

11510 American Holly Drive

Laurel, Maryland 20708, USA. frank_rivera@fws.gov

Modified by: Chris Nicolai, Ph.D., U. S. Fish and Wildlife Service

1340 Financial Blvd.

Reno, NV 89502, USA. chris_nicolai@fws.gov

Introduction

The U.S. Fish and Wildlife Service developed this population model to assess the potential effects of removing Common raven (common raven, *Corvus corax*) from Nevada under the WS-Nevada Predator Damage Management Program. This assessment was prepared to support National Environmental Policy Act (NEPA) compliance for the WS-Nevada Predator Damage Management Program and for the subsequent issuance of a depredation permit (50 CFR 21.41) by the U.S. Fish and Wildlife Service under the Migratory Bird Treaty Act.

In summary, USDA – Wildlife Services, Nevada applied for a depredation permit from the U.S. Fish and Wildlife Service seeking authorization to increase their lethal take from 5000 common ravens per year to 7500 common ravens per year in Nevada. In this report, we assess the potential annual take level which will allow for a stable common raven population size.

Prescribed Take Level

Assuming logistic population growth, Prescribed Take Level (PTL) is estimated as

$$PTL = F_o \frac{\tilde{r}_{max}}{2} \tilde{N} \qquad (1)$$

where;

F_o = management factor;

r_{max} = maximum population growth rate; and

N = population size.

The tilde (~) indicates that these parameters were randomly sampled from statistical distributions. For additional information about harvest theory, see Runge et al. (2009). Because a stable population size is desired, we assumed F_o = 1. That is,

$$PTL = \tilde{r}_{max}\tilde{N} \qquad (2)$$

Maximum Population Growth Rate

We used the Demographic Invariant Method (Niel and Lebreton 2005); and conducted Monte Carlo simulations with program R (Robert and Casella 2010) to estimate a maximum population growth rate (r_{max}), based on common raven demographic rates reported in Boarman and Heinrich (1999).

Population Size Estimates

Assuming population sizes (N) were lognormal (Dillingham and Fletcher 2008), we used Monte Carlo simulations from Baker County, Oregon (7,798 km^2) and the Baker Priority Area for Conservation (1,361 km^2), which were recently derived for a similar effort in Oregon; this is the best available demographic dataset for common ravens in the western United States known to us at this time.

Bayesian State-Space Model

The dynamics of the common raven population were modeled using Oregon's Breeding Bird Survey data collected in 1968–2017 (Sauer et al. 2017). The Bayesian state-space modeling framework was used to account for the variances of process and observation error (Rivera-Milán et al. 2016). The state dynamics of the population were modeled with a discrete form of the standard logistic equation. Annual changes in population state (N_t) were calculated with

$$N_{t+1} = N_t + r_{max}N_t\left[1 - \left(\frac{N_t}{K}\right)\right] - H_t \qquad (3)$$

where;

r_{max} = maximum intrinsic rate of population growth,

K = population carrying capacity,

N_t = true unknown state of the population, and

H_t = total number of common ravens harvested in year t. $H_t = N_t h_t$, where h_t is the harvest rate between time period t and t + 1 (Runge et al. 2009).

Harvest rates were randomly generated as part of the Markov chain Monte Carlo (MCMC) algorithm using the uniform distribution (i.e., $h \sim$ uniform [0.001, 0.150]). The unknown population state was reparameterized as a proportion of population carrying capacity (N_t/K) to reduce autocorrelation in the MCMC samples. The error of state model predictions (ε) was assumed to be lognormally distributed with mean 0 and an estimated standard deviation ($\sigma_{process}$). Based on this reparameterization, the state dynamics were projected forward in time according to

$$P_{t+1} = \left[P_t + r_{max} P_t (1 - P_t) - \frac{H_t}{K} \right] e^{\varepsilon_t} \quad (4)$$

The population proportion in year 1 (P_1) was modeled using a lognormal distribution with mean (P_0) and variance ($\sigma^2_{P_0}$). That is,

$$P_1 \sim \text{Lognormal}(P_0, \sigma^2_{P_0}). \quad (5)$$

Population size (y_t) and observation error ($\sigma^2_{t,\text{observation}}$) were directly estimated from the nearby Oregon's Breeding Bird Survey data. Because the distribution of abundance estimates tends to be positively skewed, the lognormal distribution was used for the observation error. The abundance estimates were transformed to the natural logarithm scale by transforming the bootstrap SE to the SD of the corresponding lognormal distribution. To complete the observation model of the state-space formulation, true unknown population state ($N_t = P_t K$) was related to observed population estimates with

$$\log(y_t) = \log(P_t K) + u_t \quad (6)$$

where

$$u_t \sim \text{Normal}(0, \sigma^2_{t,\text{observation}}). \quad (7)$$

Lastly, assuming linear density dependence, maximum sustainable harvest rate was derived as

$$h_{msy} = \frac{r_{max}}{2} \quad (8)$$

The model formulation was simplified by assuming that harvest mortality occurred after the common raven reproductive peak and that age classes (juveniles, adults) had equal mortality probability. In addition, additive mortality (i.e. all mortality resulting from this study would not have otherwise occurred) was assumed, although the model formulation allowed for density-dependent compensation. Uniform prior distributions were used for maximum population growth rate (r_{max} ~ uniform [0.001, 2.000]), population carrying capacity (K ~ uniform [100, 1,000]), and the mean of the initial population proportion on the logarithmic scale (P_0 ~ uniform [−5, 0]). For the process and initial population proportion SD, uniform priors were also used ($\sigma_{process}$ and σ_{P_0} ~ uniform [0, 5]).

To estimate the posterior distributions of r_{max} and h_{msy}, Markov chain Monte Carlo (MCMC) was used by running program JAGS, version 3.4.0 within R2JAGS (Su and

Yajima 2015, http://mcmc-jags.sourceforge.net). The first 50,000 of 250,000 iterations were used as a burn-in period. Three Markov chains with different initial parameter values were generated, and trace plots and node summary statistics were used to check for MCMC algorithm convergence. Markov chains were thinned by 25 to obtain samples of 8,000 points. Results are presented as means ± MCMC SD, and 2.5%, 50%, and 97.5% percentiles.

Results and Discussion

Based on the Demographic Invariant Method and equation 15 in Niel and Lebreton (2005), and assuming that annual survival rate and age at first breeding were 0.5, 0.7, 0.9 and 2, 3, 4 years-old, respectively, the 50% percentile for r_{max} was 0.230 (2.5–97.5% percentiles = 0.068–0.406). Similar results were obtained using the Bayesian state-space model, with mean r_{max} = 0.240 (MCMC SD = 0.051), and the 50% percentile for r_{max} = 0.234 (2.5–97.5% percentiles = 0.160–0.362). That is, mean h_{msy} = mean $r_{max}/2$ = 0.120 (MCMC SD = 0.026; and the 2.5%, 50%, and 97.5% percentiles = 0.080, 0.117, and 0.181, respectively).

Based on equations 4 and 5 in Dillingham and Fletcher (2008), and using a population size N = 190,000 common ravens in Nevada, using the posterior distributions for r_{max} and N estimates, and assuming that F_o = 1, the 50% percentile for PTL = 19,042 common ravens, with 2.5–97.5% percentiles = 3,212 – 46,305 common ravens for Nevada.

We therefore conclude that 19,042 common ravens could be removed annually, by all sources of human take, from the population of common ravens in Nevada, and a stable population would be preserved.

Literature Cited

Boarman, W. I. and B. Heinrich. 1999. Common Raven (*Corvus corax*), verion 2.0. In The Birds of North America (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. https://birdsna.org/Species-Account/bna/species/comrav/

Dillingham, P. W. and D. Fletcher. 2008. Estimating the ability of birds to sustain additional human-caused mortalities using a simple decision rule and allometric relationships. Biol. Cons. 141:1783–1792)

Niel, C. and J-D. Lebreton. 2005. Using demographic invariants to detect overharvested bird populations from incomplete data. Cons. Biol. 19:826–835.

Rivera-Milan, F. G. S. Boomer, and A. J. Martinez. 2016. Sustainability assessment of Plain Pigeons and White-crowned Pigeons illegally hunted in Puerto Rico. The Condor, 118:300-308.

Robert, C. P. and G. Casella. 2010. Introducing Monte Carlo Methods with R. Springer, New York, 284 pp

Runge, M. C., J. R. Sauer, M. L. Avery, B. F. Blackwell, M. D. Koneff. 2009. Assessing allowable take of migratory birds. J. Wildl. Mgmt. 73(4):556-565. Rivera-Milán et al., 2016, The Condor: Ornithological Applications 118:300–308)

Sauer, J. R., D. K. Niven, J. E. Hines, J. D. J. Ziolkowski, K. L. Pardieck, J. E. Fallon, and W. A. Link. 2017. The North American Breeding Bird Survey, Analysis Results 1966 - 2015. Version 2.07.2017. Available at: https://www.mbr-pwrc.usgs.gov/bbs/bbs.html

Su, Y., Yajima, M. (2015). R2jags (R package version 0.5-7, pp. 1–12). Vienna, Austria: The Comprehensive R Archive Network. , http://mcmc-jags.sourceforge.net

Appendix E. Supplemental Details for Section 3.5. Impacts on Predator Species Populations

Table E.1. Annual average intentional take of predators by WS-Nevada during PDM activities, FY 2012- 2016.

Method: 5 year total/annual average	Coyote	Common raven	Badger	Mountain lion	Striped skunk	Raccoon	Red fox	Free-ranging/ Feral dog	Bobcat	Black bear	Kit fox	Spotted skunk	5 yr. total /Ave per yr.
Fixed wing	12,271/ 2,454.2	0	0	0	0	0	0	0	0	0	0	0	**12,271/ 2,452.2**
Helicopter	674/ 134.8	0	0	0	0	0	0	0	0	0	0	0	**674/ 134.8**
Foot-hold trap	3,452/ 690.4	0	211/ 42.2	3/ 0.6	10/ 2	5/ 1	13/ 2.6	5/ 1	6/ 1.2	0	0	0	**3,705/ 741**
Cage trap	0	0	0	6/ 1.2	20/ 4	31/ 6.2	0	0	0	0	0	0	**57/ 11.4**
Neck snare	1,708/ 341.6	0	15/ 3	42/ 8.4	9/ 1.8	6/ 1.2	0	2/ 0.4	4/ 0.8	1/ 0.2	1/ 0.2	0	**1,788/ 357.6**
Foot snare	0	0	0	0	0	0	0	0	0	2/ 0.4	0	0	**2/ .04**
Body-grip trap	0	0	0	0	1/ 0.2	0	0	0	0	0	0	0	**1/ 0.2**
Padded foot-hold trap	27/ 5.4	0	0	0	2/ 0.4	7/ 1.4	0	0	0	0	0	0	**36/ 7.2**
DRC-1339	0	18,895/ 3,779	0	0	0	0	0	0	0	0	0	0	**18,895/ 3,779**
Firearms	1,783/ 356.6	81/ 16.2	9/ 1.8	65/ 13	1/ 0.2	2/ 0.4	1/ 0.2	0	1/ 0.2	2/ 0.4	0	0	**1,945/ 389**
M-44 cyanide capsule	1,115/ 223	0	0	0	0	0	0	5/ 1	0	0	0	0	**1,120/ 224**

Chemical euthanasia	0	0	0	0	34/ 6.8	0	0	0	0	0	0	1/ 0.2	**35/ 7**
Handcaught-gathered	0	55/ 11	1/ 0.2	0	1/ 0.2	6/ 1.2	0	0	0	0	0	0	**63/ 12.6**
Dens destroyed sodium nitrate	205/ 41	0	0	0	0	0	0	0	0	0	0	0	**205/ 41**
5 year total take by species	**21,030**	**19,031**	**236**	**116**	**78**	**57**	**14**	**12**	**11**	**5**	**1**	**1**	**40,592**
Annual Avg. take by species	4,206	3,806.2	47.2	23.2	15.6	11.4	2.8	2.4	2.2	1	0.2	0.2	8,118.4

Appendix F. Summary of the Relevant Scientific Literature: Trophic Cascades

What is the Purpose of this Appendix?

The study of ecological trophic cascades is relatively new and very complex, with potentially many highly interrelated factors and inherent complications to developing and implementing robust studies and ecological computer models. Statistical analyses must be carefully chosen and applied to develop strong correlations and reasonable interpretation of study results. Different ecosystems may have inherently higher productivity than others, resulting in different comparative study outcomes. Each study looks at a very small question related to very broad and complicated interrelated systems, and a particular study addressing a specific question cannot be expected to provide an answer that can be applied broadly.

Therefore, this appendix simply briefly summarizes the scientific literature relevant to the broader questions related to trophic cascades and related factors subsumed within that possible ecological relationship. It is not intended to be an impact analysis related to WS-Nevada IPDM actions, but rather provides the context for the impact analysis in Section 3.8. This appendix focuses on peer-reviewed published scientific literature, but because certain unpublished or non-peer-reviewed documents are frequently raised by commenters, they are included for context.

What Foundational Ecological Topics Inform the Discussion on Trophic Cascades?

How do Carnivores Contribute to Ecosystem Biodiversity?

Large terrestrial mammalian carnivores, such as wolves, coyotes, and dingoes, have been historically seen as threats to human lives, property, and domestic livestock (Schwartz et al. 2003, Ray et al. 2005, Prugh et al. 2009, Estes et al. 2011). Large mammalian carnivores have high metabolic demands due to being warm-blooded, and they have a large body size with large surface to volume ratio. Therefore, they typically require large prey and expansive, connected, unfragmented habitats. These characteristics often bring them into conflict with humans, their property, and livestock, and compete for wildlife that are also regulated game species.

Large carnivores are vulnerable to many human-created conditions, including habitat loss, degradation, and fragmentation, invasive and exotic species, climate change, and hunting, as well as to widespread lethal control conducted in response to human intolerance, often resulting in population depletion, extirpations, and extinctions (Ripple et al. 2014). Hunting by humans does not duplicate or replace natural predation because it differs in intensity and timing, resulting in dissimilar effects on prey behavior, age, and sex (Ripple et al. 2014, Ray et al. 2005). However, where large carnivores were once seen as impediments to conservation goals, including for protection of endangered species, they are now increasingly considered as essential players in efforts to preserve ecosystem biodiversity through structuring ecosystem interactions and providing ecological services (Ray et al. 2005, Wallach et al. 2009a).

How are Ecosystems Structured?

Ecosystems are structured through the dynamic interactions of abiotic factors such as weather, soil productivity, climate change, and surface and subsurface hydrology, natural perturbations such as wildfire, and the variety, composition, and abundance of fauna and vegetation present. Those dynamics change in abundance, variety, and distribution as components of the ecosystems change.

Studies suggest that large carnivores may directly and/or indirectly affect the populations of certain species in terms of presence, abundance, reproductive success, activities, and function within the ecosystem. These effects may partially result from their predatory activities on smaller animals, including other carnivorous predators (such as foxes, coyotes, and cats), animals that eat only vegetation (herbivores, such as rabbits and deer), and animals that eat both vegetation and meat (omnivores, such as black bears, badgers, and raccoons). These effects can also change the biomass, variety, and productivity of the vegetation that is eaten by herbivores and omnivores. These relationships based on consumption is called a **food web**, which recognizes the web-like interaction of a set of interrelated food chains, including species that share the same foods and carnivores that consume other carnivorous species.

Within these webs, animals with similar food habits create **trophic levels**, where energy is transferred and transformed as animals from one level feed on animals or plants from a lower level. If interactions occur from one trophic level of the web to a higher or lower trophic level, this is considered a **vertical relationship**. If the interaction occurs within the same trophic level, such as when a larger predator kills or feeds on a smaller predator or omnivore, it is considered a **horizontal relationship**. Therefore, the large carnivores are considered apex predators (in the vertical relationship), because they are not naturally preyed on by other animals, except by humans (Duffy et al. 2007).

Therefore, an **apex** or **top predator** is defined as a species that feeds at or near the top of the food web of their supporting ecosystem and that are relatively free from predation themselves once they reach adult size (Sergio et al. 2014). As animals in each trophic level need to use some of the energy obtained through consumption for maintenance, growth, activities, and reproduction, a much smaller amount of energy is transferred from a lower trophic level to a higher one. This generally results in a fewer number of animals within each higher trophic level. The top trophic level of a food web generally has fewer species and smaller population sizes than lower levels (and typically larger body sizes), resulting in the need to feed on larger prey with less energy expended in order to meet their energy requirements for survival. Top carnivores also tend to be more vulnerable to sustained adverse perturbations in their environment and persistent high mortality rates, and therefore more susceptible to extirpation and extinction.

What is the History of the Study of Ecosystem Functions and Roles of Apex Predators?

The history of recognizing the ecological roles of apex predators as something other than vermin or pests is relatively new (Ray et al. 2005). The concept was popularly introduced by Charles Darwin's *Origin of Species* (1859) in his concept of mutualism (domestic cats controlling mice, that that would otherwise eat bee honeycombs, affecting plants and pollinators; Ripple et al. 2016) In more contemporary times, the concept of top predators was publicized primarily by Aldo Leopold in 1943. In the 1950s and 1960s, relatively simple studies were conducted on the dynamic interrelationships of predators and their prey, using uncomplicated models and limited field experiments. In the 1970s, simple modeling and empirical field studies began to test the capabilities of top predators to ecologically structure lower trophic levels, evaluate the relationships between predator and prey, confer stability to populations, and cause ecosystem shifts between alternative stable states (e.g., Smith, 1974; Stenseth et al. 1977).

In the 1980s, modeling and field studies expanded in complexity to include predator-prey relationships, population dynamics, and adaptive social behavior in response to the risk of being predated, including how behavior changes affected foraging behavior and life history of prey and how these dynamics interrelate ecologically. Studies also began considering the potential for some predators to eat other predators, acknowledging a food web that interacts both vertically and horizontally, and the potential to cause trophic cascades. In the 1990s, these studies became increasingly complex, further investigating the roles of predation risk and anti-predator behavior adaptations, and how these affect the fitness of an individual animals, populations, and communities, potentially contributing to behavior-mediated trophic cascades (Sergio et al. 2014).

Presently, studies are branching into increased use of field and interdisciplinary research to investigate more realistic community, food web, population, ecological community, and individual animal responses to manipulations, and intended perturbations of communities of predators and prey, including direct and indirect behavior adaptations, ecological roles, predators killing other predators, and individual and species specializations of apex predators. Empirical field studies are increasingly using more sophisticated technologies to study wide ranging and secretive top predators, such as GPS satellite tags and collars (Sergio et al. 2014).

Originally, field studies were conducted on mostly sessile or low mobility species and webs, such as invertebrates, spiders, plankton, and small fish in localized ecosystems in relatively high productivity streams, lakes, intertidal zones, grasslands, and agricultural areas (e.g., Schmitz et al. 2004, Ray et al. 2005, Beschta and Ripple 2006). Expanding these studies to open ocean marine and terrestrial ecosystems with more wide-ranging predators and prey that are inherently more difficult to manipulate and create perturbations in, especially without causing moral, ethical, and political controversy, created extensive challenges in methodologies and complexity (e.g., Ray et al. 2005, Brashares et al. 2010, Estes et al. 2011, Sergio et al. 2014). Researchers also questioned whether the correlative results of studies that are small scale in time and/or space and conducted in ecologically relatively simple and localized ecosystems such as grasslands, agricultural fields, salt marshes, and marine intertidal zones could be extrapolated and applied to larger scale circumstances associated with trophic interactions in marine and terrestrial ecosystems across broad land and seascapes (e.g., Loreau et al. 2001, Srivasta and Vellend 2005).

It is extremely difficult to establish complex causal links between the indirect effects of top predators cascading over several trophic levels, and is still the subject of modern studies. Only recently have researchers conducted empirical studies of the roles of large carnivores in structuring communities, including the roles in ecosystem stability, biodiversity, and ecosystem functions (Ray et al. 2005).

What is a Trophic Cascade?

In theory, apex predators may shape major shifts in the structure and function of ecosystems, as their predation and behavior ripple down and across food webs. These apparent ripple effects can create alternative and possibly long-term ecologically stable states that differ from the original state before the perturbation to apex predators, which ultimately becomes the persistent state (**homeostasis**). These changes may progress smoothly over time as the changes themselves occur, or, more likely, may occur when some threshold or "tipping point" is reached, at which point the structure and/or function shifts to different stable condition. During this phase shift, the conditions may rapidly fluctuate and species populations may rapidly increase then crash, before settling into the subsequent new and persistent condition.

Theoretically, the loss of one or more apex predators may result in shorter links within the food web because the apex predator is no longer present. This can potentially result in the release (in terms of numbers, distribution, biomass, etc.) of smaller predator and/or omnivore species that the apex predator preyed upon or behaviorally controlled. **Behavioral control** means that the prey exhibited adaptive anti-predator behavior that lowered its ability to forage optimally or kept individual animals in chronic physiological stress, resulting in lower overall fitness at the individual and community levels. In other words, the species' population was controlled by apex predators in such a way that the prey population could not reach the **carrying capacity**, or the maximum number of a species that the environment can support indefinitely (i.e., due to natural abundance of food and habitat resources). When the apex predator is at too low an abundance or density to create ecological restrictions on the prey population, or is no longer present, the controlled predator species may be released from the top-down control formerly exerted by the apex predator, and typically becomes the apex predator of the now-shifted system.

Theoretically, populations controlled by the new top predator may now release control on their prey, which may be herbivores, small mammals, or even vegetation. For a simple example, coyotes may now exert a greater predatory pressure on red foxes, decreasing their numbers, which may then release control on small rodents, resulting in increasing rodent populations. If this release is sufficiently high, the small rodent population may then increase dramatically, which may subsequently suppress the species composition or biomass of the vegetation eaten by the mice. This vertical control from top predators that may ripple through the food web is called **top-down control**.

The web is further complicated by a horizontal interaction within a food web, when one predator preys upon or otherwise controls another predator. This sideways feeding is called **intraguild predation** or **IGP**. A **guild** is made up of species that tend to play similar roles within a food web, such as carnivore, omnivore, or herbivore. See Section F.8.1 for more information on IGP.

When the population of the smaller predator (intraguild prey) is released by the extirpation, extinction, or severe control of the intraguild predator, that dynamic is called **mesopredator release**. A mesopredator species tends to be an intermediate predator within a food web, one that is typically smaller than the lost apex predator species, more of a generalist in terms of diet, and may be small enough to exploit more potential food niches. Mesopredator species often have a relatively high intrinsic rate of increase because of high reproductive rates and/or because they respond with higher reproductive rates when their populations are below carrying capacity (called a **density dependent response**) and the populations are released from suppression. Examples of mesopredators that may be released when wolves (as top carnivore) are severely suppressed or extirpated from an area could be coyotes, badgers, foxes, raccoons, and feral and free-ranging cats, depending on the composition of the ecological community. Generally, under these circumstances, the coyote population then fills the trophic role of apex predator, alternatively exerting control and releasing species, depending on whether the impact is direct or indirect on the particular trophic level. See Section F.8.2 for more information on mesopredator release.

It is also possible that predator species may be indirectly controlled by lack of prey or low vegetative productivity. For example, a multi-year drought may reduce the plant forage of rabbits, reducing both the rabbit population and its intrinsic reproductive rate. This, in turn (with a lag time), may suppress the physiological fitness and intrinsic reproductive rate of its primary predator, for example, a coyote. This is called **bottom-up control**. Coyotes may then begin to feed more on foxes (an IGP situation occurring within the relatively same trophic level), which were not affected by the drought, because the plants that the small rodents fed on (different from the plants that the rabbits fed on) were more resistant to the effects of drought. If the IGP by coyotes on foxes is sufficiently high, the fox population may again be suppressed, releasing the mouse populations. Complicating this concept is that both top-down and bottom-up controls may occur simultaneously for the same and different components within the same ecosystem (Borer et al. 2005, Ritchie and Johnson 2009). Such top-down and bottom-up effects can be complicated by **interference competition** (where dominant predators interfere in the ability of subordinate predators to obtain resources), site productivity, behavioral adaptation to avoiding the risk of predation and obtaining high quality resources, and intrinsic "noise" in the ecosystem due to natural variation (Elmhagen et al. 2010). In the above example, coyotes could switch from rabbits to other smaller rodents and insects (prey switching) that foxes prey on and compete with the foxes for the same prey base.

These apparent up and down (or lateral) alternating trophic interrelationships (when one population increases, it may cause a decrease in another (a direct effect) and increase in a species in the next lower trophic level (an indirect effect), which may indicate an interrelationship among trophic levels called a **statistical correlation**. However, such correlations do not indicate that one relationship is actually caused by the other. For example, large irruptions of mouse populations may be interpreted as being indirectly related to, for example, removal of a predator that feeds on mice, but may actually be caused by factors that were not considered, such as human food subsidies.

Polis et al. (2000) also recommend that researchers distinguish between potential cascading or rippling interactions at the species level (those occurring within a subset of the food web of a community, such that changes in predator numbers affect the success of one or more subsets of the plant species) and at the community level (those occurring where cascades considerably alter the distribution of plant biomass through the trophic levels of the entire system). This adds further complexity to empirical studies and interpreting results.

It is inherently extremely difficult, if not impossible in many circumstances, to develop and implement study protocols for field experiments resulting in statistically strong correlations. It is also inherently difficult to determine, even with replication of studies resulting in similar correlations, that inter- and intra-trophic relationships are caused by ecological perturbations, such as the removal of an apex predator, or that the removal results in a trophic cascade. Frequently, top-down effects do not appear as strong or to produce predicted cascading effects in terrestrial ecosystems due to the complexity of factors, such as the effects of dispersal and immigration, social regulation, and interference competition among predators, and abiotic factors, such as weather, soil, ecosystem productivity, and spatial and temporal habitat heterogeneity (Halaj and Wise 2001, Ray et al. 2005, Berger et al. 2008, Estes et al. 2011).

The section below titled "***Challenges to Conducting and Interpreting Research and Modeling on Complex and Dynamic Ecological Systems***" details the inherent challenges of modeling and designing empirical field studies that determine statistically-correlated interrelationships between ecological factors. These studies may indicate needs for further investigation or potentially establish factors that can be shown to create a direct causation for the observed effect through study replications. Terrestrial ecosystems, food webs, and their processes are especially complex, with wide-ranging apex predators and intricate and adaptive predator and prey behaviors.

What is the History of the Concept of Trophic Cascades and its Definitions?

Since the 1980s when Paine (1980) used the term "trophic cascade" to describe food webs in intertidal marine communities, trophic cascade has been a central or major theme of more than 2,000 scientific articles across many different ecosystems worldwide. Polis et al. (2000) and Ripple et al. (2016) expressed concern that, after decades of studies and modeling in many different ecosystems, the definitions and language used to describe trophic cascades have become inconsistent, obscuring and impeding both communication among researchers and the usefulness of the concepts for application in ecological management and conservation. To be useful and contribute to clarity, the definition must be both widely applicable yet sufficiently explicit to exclude extraneous interactions.

Ripple et al. (2016) provide a summary of the various definitions provided by researchers between 1994 and 2006. Trophic cascades were thought to only occur from upper trophic levels to lower trophic levels (top-down), until Terbough (2006) suggested that cascades can ripple either up or down a food web, with alternating negative and positive effects at successive levels. The first indirect effects of predators on plankton in lakes were suggested in the 1960s (Brooks and Dodson 1965, Hrbacek et al. 1966). Subsequently, Estes and Palmisano (1974) described the role of sea otters in structuring nearshore communities of sea urchins and kelp, later modified to include orcas and sea lions, based on changes caused by humans (Estes et al. 1998), a frequently cited example in the literature to this day. The research on trophic cascades began to shift from being dominated by studies in freshwater systems and old field grasslands and croplands to being dominated by terrestrial and marine systems in the early 2000s.

Based on a recent meta-analysis of scientific literature, Ripple et al. (2016) suggest trophic cascades be defined as indirect species interactions that originate with predators and spread downward through food webs. According to the authors, this definition does not require that trophic cascades begin with apex predators, nor that trophic cascades end with plants. The authors suggest that bottom-up effects are not downward trophic cascades, but what they call **knock-on effects**, in which effects spin-off from the main top-down interactions. Whether or not bottom-up effects are incorporated into the definition of trophic cascades (as Terbough et al. 2001, Ripple et al. 2013, and Ripple et al. 2015 suggest), research has indicated that effects may flow both directions at different times in dynamic ecological systems in which top and mesopredators are present and active. Such top-down and bottom-up effects can be complicated by **interference competition** (as mentioned in the coyote example above).

What is the Difference between Correlation and Causation in Interpreting Statistical Study Results?

Before evaluating the scientific literature, it is important to explicitly define the difference between correlation and causation in order to better understand the statistical results of these studies. These terms are often misunderstood and misused when interpreting scientific papers. This discussion on correlation and causation is adapted from the Australian Bureau of Statistics (ABS 2013).

Correlation

A **correlation** is a statistical measure (expressed as a number) that describes the size and direction of a relationship between two or more variables. A correlation is suggested by a positive or negative relationship – when one factor increases, another may also increase (**positive correlation**) or decrease (**negative**, or **inverse**, **correlation**). If an apparent correlation is observed statistically, it does not mean that one factor causes the other, only that the one factor either goes up or down in relation to the other factor.

The strength of the apparent correlation, or the indication that there truly is some level of interrelationship, is determined using statistical formulas that should meet assumptions pertinent to the context of the data and the system being studied. The formulae provide a figure, known as the square of the correlation coefficient, or R^2, which is always a number between 0 and 1. A value closer to 1 suggests that a stronger correlation exists, indicating that the relationship may warrant further investigation and study. However, it is possible to identify strong, but meaningless, correlations, and many other factors may introduce complexity into the relationships as well as confound the apparent results.

As an example of an apparent, but not necessarily actual, correlation, we can use the observance of the onset of cold weather in the winter and increasing numbers of colds. As the temperature decreases in December, it may appear that people get more colds, an apparent inverse correlation. That could be a correlation, and an R^2 value may actually indicate a strong correlation. However, the cold temperatures also tend to occur during the holiday season. The suggested correlation between decreasing temperatures and increasing rates of illness may actually be more closely related to depressed immune systems from eating more sugar and increased exposure to viruses from greater contact with people. Despite an apparent correlation, it is also possible that decreasing December temperatures themselves do not directly cause increased rates of illness, and therefore wearing warmer clothes will not necessarily decrease the number of colds or the risk that an individual person will catch one.

The suggested statistical correlation can be confounded by many variables that may or may not have been incorporated into the statistical analysis, potentially resulting in misleading results. In another well-known example, the R^2 for the number of highway fatalities in the US between 1996 and 2000 and the quantity of lemons imported from Mexico during the same period is R^2=0.97 – a very strong correlation – but it is extremely unlikely that one causes the other. Generally, scientists and researchers will reject factors that show a weak correlation, but completely irrelevant factors can produce a statistically high R^2 coefficient, potentially leading researchers in the wrong direction.

Causation

Causation indicates that one event is the result of the occurrence of the other event. Proving that a strong statistical correlation is directly responsible for an observed result requires more than a high R^2 value. Once a strong correlation is indicated, researchers experimentally need to test their hypotheses for causation to determine if indeed the factor(s) considered in the statistical analysis caused the result (cause-and-effect relationship), rather than just suggesting a relationship. They need to determine that the result is not just varying up or down statistically in unrelated or potentially indirect ways, or that the results may be confounded by untested or unmeasured factors. For strengthening a potentially causal relationship, the tests must be replicated by other researchers using the same methods, scale, and contexts to determine if the results are truly causative.

A powerful research protocol is one that holds all factors constant but one, and then tests for statistically significant changes that indicate a causative relationship. The variable factor can also be changed and the results tested to further clarify a causative relationship. A statistically significant finding is one that would occur more often than it would if it were to occur randomly.

Conclusion

When relying on studies, it is critical to understand that statistical correlations, which are offered by researchers as suggestive or indicative results often without replication, are different from conclusions of statistically significant causation. Ray et al. (2005) state that researchers are often influenced by numerous factors, including their education, cultural background, and inherent conditions of the ecological systems on which they work. Ecologists who specialize in some systems often favor certain hypotheses, interpretations, and factors measured, and discount others developed, to inform work on other systems.

Misinterpreting weak, or even strong, correlations or the results of theoretical models as indicative of causation is inappropriate and does not credibly represent the state of the science or the robustness of data and research protocols. More importantly, it can lead to uninformed decision-making and poor choices regarding conservation and management actions that may have unintended and damaging consequences. APHIS-WS reviews the pertinent literature and places priorities on studies that accurately account for correlations, have relevant assumptions, and disclose study and statistical limitations and strengths.

What do Relevant Studies Suggest about Trophic Cascades?

The following studies are representative of empirical field research conducted on large predators in terrestrial ecosystems that are useful for understanding the complexities of trophic cascades and contributing processes:

- **Hebblewhite et al. (2005)**, in a study in Banff National Park (NP), suggested that human activity, including recreation, in one valley restricted the use of the area by wolves, while limited human activity in an adjacent valley allowed higher wolf use. Survival recruitment of female elk and recruitment of calves was higher in the valley with human activity and lower wolf numbers. Elk competed with beaver for willow in riparian areas could have important impacts on biodiversity and ecosystem function and structure. The authors suspected wolves were the primary correlating factor in the observed cascading effect, but recognized that other predators may be implicated to an unknown degree.

- **Ripple and Beschta (2006)** hypothesize that an increase in human recreation in Zion NP resulted in a catastrophic regime shift to lower cougar densities and higher mule deer densities, higher herbivory on cottonwood trees, lower recruitment of young trees, increased bank erosion, and reductions in both terrestrial and aquatic species abundance. A top-down trophic cascade model would predict an increase in producer biomass following predator removal, while a bottom-up model would predict little or no change in consumer or producer biomass. Additionally, other likely interaction pathways include increased species interactions, improved nutrient cycling, limited mesopredator populations, and food web support for scavengers. The canyon with low human activity showed high recruitment of cottonwoods, hydrophytic plants, wildlife, amphibians, lizards, and butterflies along the creek, as well as presence of small endemic fish, with fewer eroded banks and altered channel widths. The diminishment of cottonwood forests in the riparian area reflects a potentially strong trophic cascade with ultimate effects on the structure and ecology of stream floodways, with decreased biodiversity. Without an appreciation of the potential for abrupt regime shifts and resulting new and persistent ecological stasis, the authors hypothesize that studies involving the removal of top predators are likely to provide conflicting results regarding function and structure of perturbed systems.
- **Ripple and Beschta (2007)** reported evidence of reduced browsing and increased heights of young aspen, particularly at areas with high predation risk (riparian areas with downed logs) after wolves were reintroduced into Yellowstone NP. Young aspen in upland settings showed continued suppression, consistent with the combined effects of trophic cascades, mediated by adaptive behavior related to predator risk avoidance by elk and lower densities of elk, indicating a recovering ecosystem. Much of the aspen growth observed in riparian areas after the reintroduction of wolves appears due to reduced browsing by elk at sites with poor escape terrain and reduced visibility, rather than climate change or site productivity. The patchy recovery of as evidenced by increases in aspen height in the uplands as compared to riparian areas is consistent with recently reported patchy release of willow in Yellowstone (Ripple and Beschta 2006). The authors suggest that elk may be avoiding browsing certain riparian areas as an anti-predator strategy. The authors recognized that the broad-scale application of the results of this study are limited by the lack of an experimental control (area with no wolves) since the entire area was recolonized by wolves and

that the data most likely represent the beginning of aspen recovery and not aspen population responses across Yellowstone's northern range. Concurrent increases in bison populations in Yellowstone's northern range may also be affecting the status of aspen communities.

- **Berger et al. (2008)**, in an often-cited article, suggested that wolf predation on coyotes in the Greater Yellowstone Ecosystem released the heavy coyote predation on pronghorn antelope fawns, resulting in increased pronghorn survival. The pronghorn population studied had not recovered from heavy market hunting, and the study found that fawn survival was four times higher in areas used by wolves where wolves predated on coyotes than in areas not used by wolves. Observed differences in fawn survival in areas with wolves may be sufficient to reverse the currently declining pronghorn population.
- **Kauffman et al. (2010)** suggest that, contrary to Ripple and Beschta (2006, 2007), survivorship of young browsable aspen are not currently recovering in Yellowstone NP, even in the presence of a large wolf population. A marked reduction in elk followed wolf reintroduction at the same time that drought reduced forage availability and hunting by humans increased outside the park during and after winter elk migration, indicating that the difference in aspen recover may be based on factors other than response to predation. Contrary to findings of previous researchers, the authors suggest that much of the variation in aspen reproduction was not due to elk browsing levels in response to predation risk, but to site productivity. Patterns of aspen recruitment are consistent with the effects of a slow and steady increase in elk abundance following the end of market hunting in the late 1800s and wolf extirpation in the 1920s. The authors' interpretation suggests that landscape level differences in habitat more strongly determined where wolves killed elk. Also contrary to Ripple and Beschta (2007), these authors suggest that aspen growth differences were due to the confounding patterns associated with abiotic factors such soil moisture, mineral content or patterns of snow accumulations, which vary widely across the landscape. Aspen sucker survivorship was lower near wolf territory core areas, likely due to wolves maintaining territories in areas of high elk densities, limiting the cascading impacts of behavioral changes due to predation risk, which apparently occur only in response to the near imminent threat of wolf predation. The authors suggest that aspen recovery across the northern range of Yellowstone NP will occur only if wolves in combination with climate and other predators further reduce elk populations.
- **Brown and Conover (2011)** conducted a large-scale removal of coyotes on twelve large areas in Utah and Wyoming to study effects on pronghorn antelope and mule deer populations. Their data suggest that coyote removal conducted during the winter and spring provided greater benefit than removals conducted during the prior fall or summer for increasing pronghorn survival and abundance. Unlike that for pronghorn, the data

suggest that coyote removal during any season does not affect mule deer populations.

- **Ripple and Beschta (2012)** repeat earlier aspen and cottonwood surveys and measure browsing heights to determine recovery of aspen in the northern range of Yellowstone NP. The authors suggest that browsing on the tallest aspen stems decreased from 100% in 1998 to averages of less than 25% in the uplands and less than 20% in the riparian areas by 2010, increasing aspen recruitment and growth. Synthesis of trophic cascade studies conducted in Yellowstone NP within 15 years after wolf reintroduction generally indicate that the reintroduction of wolves restored trophic cascade with woody browse species growing taller and canopy cover increasing in some areas. After wolf reintroduction, elk populations decreased and beaver and bison populations increased. Despite indications that wolf reintroduction created substantial initial effects on both plants and animals, northern Yellowstone NP appears to be in the early stages of ecosystem recovery and results may differ over time.
- **Ripple et al. (2011)** suggest that it is possible that disrupted trophic and competitive interactions among wolves, coyotes, lynx and snowshoe hares after wolf extirpation may be sufficient to chronically depress hare and lynx populations; human-caused habitat fragmentation and livestock presence may have added to the depressed populations in Banff NP. With wolf extirpation, coyotes predated on hares, competing with lynx. The authors hypothesize that warming climates may increase coyote predation on hares in areas with lower snowpack even at higher elevations typically used by lynx, because coyotes can better traverse areas with less deep snow.
- **Beschta and Ripple (2012)** report that, following extirpation of large predators (wolves, cougar, and grizzly bears) in Yellowstone, Olympic, and Zion National Parks in the early 1900s, large ungulate populations irrupted, with increased herbivory on riparian cottonwood, willow, and aspen communities. Beavers abandoned willow communities, resulting in loss of pond habitat and deepening of streams with bank erosion within twenty years. Nearly two-thirds of Neotropical migrant birds depend on riparian vegetation during the breeding season, even though riparian systems make up 1% to 2% of total land areas in the western US. As streambanks eroded, the level of coarse streambed sediments decrease with an influx of finer sediments during the erosion of floodplains which effectively fill in gravel interstices, changing benthic habitats in streams, increasing water temperature degrading fish habitats with losses of stable overhanging banks and ripple flows with low sediment loads. If apex predators are reintroduced, the effects may or may not be reversible, depending on whether the level of reduced herbivory can be sufficiently maintained.
- **Levi and Wilmers (2012)** analyzed 30 years of data involving intraguild predation involving wolves, coyotes, and foxes to determine any effect on trophic cascades found correlational interrelationships, based on a plausible

mechanism of increased interference competition between closely-sized canids. Theory suggests that guild interactions with an even number of species will result in the smallest competitor being suppressed, while guild interactions with an odd number of species may result in the smaller predator being released (Levi and Wilmers 2012).

- **Squires et al. (2012)** question the interpretations of the data published by Ripple et al. (2011), finding the correlations between recovering wolf populations and benefits to lynx populations through reduced coyote populations and through reduced competition among ungulates and snowshoe hare have weak or contradictory empirical support in the available literature. The authors believe that these findings cast doubt on the usefulness of Ripple et al.'s (2011) hypotheses and demonstrate the importance of experimental and comparative documentation when proposing trophic cascades in complex food webs. The authors caution against "publishing unsupported opinions as hypotheses that concern complex trophic interactions is a potential disservice to lynx conservation through misallocated research, conservation funding, and misplaced public perception."
- **Callan et al. (2013)** suggest that deer in Wisconsin were more abundant at the peripheries of wolf territories, based on evidence of higher deer herbivory (deer feeding on plants) on the territory margins than in core wolf territories. Understory vegetation in white cedar stands may be more influenced by bottom-up hydrology and ecological edge effects than by trophic effects. Areas with high plant diversity may increase deer densities that then attract and maintain higher wolf densities. Addressing wolf impacts at the scale of wolf territory rather than at a regional scale (rather than studying results within particular wolf territory, studies are conducted on whether wolves are present in a larger area) could have implications for study results. Research is essential to determine the level of scale at which a pattern becomes detectable above the ambient noise of ecological variation for understanding relationships between patterns and process.
- **Marshall et al. (2013)** refute conclusions of previous researchers regarding willow recovery after wolf reintroduction. In Yellowstone NP, the authors found that moderating browsing by elk alone is not sufficient to restore willows in riparian areas along small streams – such recovery depends on eliminating browsing and restoring hydrological conditions that occurred before wolves were extirpated. Beavers were common in the park, and interacted symbiotically with ecologically healthy riparian systems by the ecosystem. The riparian system provided tall willows that the beavers used to provide food and build dams, which created the hydrological conditions for healthy and sustained willow communities. Loss of beavers in the 20th century amplified the direct effects of herbivory by elk, lowered water tables, and compressed bare moist soils needed for willow establishment. In the absence of beaver creating necessary hydrologic conditions, ten years of total

protection from elk browsing was not sufficient to allow willows to grow greater than two meters tall (resilient to browsing). This study indicated clearly that bottom-up control of willow productivity due to beavers exceeded top-down control by herbivory.

- **Painter et al. (2015)** further and refute the conclusions of both Kauffman (2010) and Ripple and Beschta (2007). The authors suggest that increased wolf predation on elk after wolf reintroduction played a role in substantial decreases in elk populations, interacting with other influences such as increased predation by grizzly bears, competition for forage with expanding bison populations, and shifting patterns of human land use outside the park towards irrigated agriculture (which become more important during droughts), reduced livestock densities, and increased hunting on the elk winter ranges. Currently, a large proportion of elk now winter on irrigated fields outside the park, a strong shift in distribution. Even with the near elimination of winter elk hunting after 2005, lower wolf numbers after 2007, mild winters after 1999, a major wildfire in 1988, and the end of the regional drought in 2007, the trend of declining elk density inside the park continued through 2012. Increasing bison populations inside the park (growth of three times between 1998 and 2012), either expanded into vacated elk winter range or perhaps displaced elk. The authors argue that research conducted by Kauffman et al. (2010) and Ripple and Beschta (2007) used protocols that differed in both timing and design, potentially missing patchy aspen recovery or recovery that was in the initial stages. Where herbivory has been reduced, bottom-up factors such as site productivity may become more important drivers of young aspen and willow height. The authors conclude that changing elk dynamics and beginning aspen recovery are consistent with top-down control of large herbivores by large carnivores.

- **Ripple et al. (2015)** suggest that increases in wolf numbers after reintroduction into Yellowstone NP resulted in decreased elk populations and increases in berry-producing shrubs, including serviceberry. Increases in serviceberry may partially be due to the 1988 wildfires or other factors. With increases in berries, grizzly bears increased fruit consumption, possibly in associated with decreased whitebark pine nuts rather than the effects of trophic cascades. Evidence of a trophic cascade associated with increases in wolf populations, decreases in elk populations, and associated increases in berries, may have resulted in grizzly bears increasing consumption of berries. This may show both a top-down cascade from wolf-elk-berries, and a bottom-up response with increased berry production and grizzly bears switching to now-available berries during periods of low production of whitebark pine nuts.

- **Benson et al. (2017)** suggest that eastern coyotes have ascended to the role of apex predators since the extirpation of wolves in northeastern North America. Eastern coyote packs consumed less ungulate prey and more human-provided food than wolf packs, being more generalists. Eastern coyotes are effective deer predators and are larger than western coyote (eastern wolves are smaller than western wolves), but their dietary flexibility as generalists and low kill rates on moose suggest that they have not replaced the ecological role of wolves as apex carnivores in eastern North America.

What is the Relationship of Intraguild Predation (IGP) and Mesopredator Release (MPR) to the Potential Occurrence of Trophic Cascades?

Intraguild Predation

Interference competition, also known as competitive exclusion (Polis et al. 1989, Arjo et al. 2002, Finke and Denno 2005), is a system in which species in a community use similar diets and/or space and one species interferes with the ability of the other to optimize the use of food and habitat. Individuals of one or both species attempt to avoid this competition by using different parts of the same habitat, using the habitat at different times, and/or shifting to different foods (**resource partitioning**).

The **competitive exclusion theory** implies that coexistence of closely-related competitive species depends on resource partitioning and the degree to which shared resources are limited (Arjo et al. 2002). This is especially important when one or more predators interfere with other predator(s), called **IGP**. Relative body size and degree of trophic specialization are the two most important factors influencing the frequency and direction of IGP (Polis et al. 1989). Inherent live history characteristics such as litter size, growth rates, social structure, and density dependent interactions may influence the strength and direction of IGP correlations. IGP interactions may be directed preferentially towards predators with the closest rate of competition, often with the larger predator being dominant over the smaller (Polis et al. 1989). A review of the IGP literature found that the effects of IGP vary across different ecosystems, with the strongest patterns of IGP in terrestrial invertebrate systems. However, it is difficult to compare across systems and literature because of differences among study scales, sample sizes, and sampling methods (Vance-Chalcraft et al. 2007).

Polis et al. (1989) identified the complexities of potential types of interactions and responses associated with IGP at the population level: intraguild predators may benefit from reduced competition, especially when local resources are limited; IGP may be sufficiently intense to control populations of intraguild prey populations; intraguild predators may paradoxically increase populations of intraguild prey if the prey has density dependent responses to decreased abundance and competition; and/or presence of the IG predator may increase competition for habitat refugia.

At the community level, interactions over ecological and evolutionary time strongly influence the abundance of species. These interactions may influence distribution, resource use, and body structure, as intraguild prey often use habitat differently than their intraguild predator in space and time to avoid the risk of predation. In these early papers, Polis et al. (1989) and Arim and Marquet (2004) suggest that IGP is ubiquitous through various ecosystems, is not due to chance (found by Arim and Marquet (2004) to be statistically significant), and is a powerful interaction central to the structure and functioning of many natural communities.

Many researchers agree that the effect of IGP on trophic systems is understudied (e.g., Palomares 1995, Litvaitis and Villafuerte 1996, Palomares et al. 1996, Finke and Denno 2005). IGP is more likely to occur in predator guilds with many predator species, which increases the chances of IGP interactions (the intra-guild predator competing for shared prey and predating on other predators) and the potential for dampening trophic cascades (Finke and Denno 2005, Daugherty et al. 2007). Based on a review of the literature on IGP theory and modeling, Holt and Huxel (2007) concluded that most models are oversimplifications of natural systems, including by not considering richer webs of interacting species across heterogeneous landscapes.

Wolves may control coyote populations through IGP and competition (Berger and Gese (2007) found a statistically significant correlation) in the Greater Yellowstone Ecosystem and Grand Teton NP. Survival rates of resident coyotes were higher than that of transient coyotes. Humans were responsible for 88% of all resident coyote deaths; predation caused 67% of all transient coyote deaths, with wolves causing 83% and cougars 17% of that predation. Despite IGP on coyotes by wolves, it is possible that coyotes may arrange their territories to overlap wolf activity areas, possibly in response to increased scavenging opportunities within wolf territories.

Mesopredator Release

Early studies related to the conservation effectiveness of removing large predators indicated that such removals may result in unintended increases of populations of smaller predators. The increase of smaller predator populations may have further impacts on the prey populations of those smaller predators. This concept is now referred to as **mesopredator release**.

Coté and Sutherland (1977), in an analysis of the literature, concluded that predator control is often the one factor, other than human exploitation, that can be directly managed (the others being climate, productivity, diseases and parasites, availability of territories, and accidents). Predator control may increase target populations of breeding birds, but not reliably, based on immigration and the availability of the area's carrying capacity to support more birds.

On closed systems associated with oceanic islands (systems with highly restricted opportunities for emigration and immigration) on which exotic predators such as feral cats or rats are introduced, removing the apex predator may result in irruptions of mesopredators (removing the cats eliminated the suppressive effects on rats), which may lead to extinction of the shared prey. Rats, being omnivores, may maintain high abundance and high levels of predation, even when bird populations are low (Courchamp et al. 1999, Bergstrom et al. 2009, Roemer et al. 2009). Release of mesopredators by removal of apex predators on insular islands may have many unintended consequences, including reducing nutrient subsidies from predation by small mammalian predators on large colonies of birds, altering vegetation communities; driving native species to extinction or extremely low abundance; filling niches that can no longer be filled by apex predators; and creating reservoirs of diseases carried by mesopredators (Roemer et al. 2009). Despite these problems, Russell et al. (2009) argue that removing apex predators from oceanic islands may outweigh the negative effects of MPR.

Large mammalian carnivores are particularly vulnerable to extirpation and extinction in fragmented habitat due to human development, which may result in MPR of smaller predators, which are more resilient to extirpation (Crooks and Soulé 1999, Roemer et al. 2009). In an area highly fragmented due to residential development, the authors found positive statistical correlation between coyote abundance and mesopredator abundance, especially opossums and foxes, and negative correlation between bird diversity and grey foxes, domestic cats, opossums, and raccoons. Mesopredators avoided areas of high coyote presence both temporally and spatially. Because domestic cats are recreational hunters subsidized by their owners, approximately 35 cats (from a neighborhood of 100 homes) were present in bird habitat fragments containing a very small number of birds (Crooks and Soulé 1999).

Prugh et al. (2009) asserted that collapses in top predators caused by human influences are often associated with dramatic increases in the abundance of smaller mesopredators across many types of communities and ecosystems. The authors defined a **mesopredator** as a mid-ranking predator in a food web regardless of size or taxonomy. A mesopredator in one food web may be an apex predator in another, and may not directly fulfill the original apex predator's ecological role in the web. The occurrence of a MPR is often symptomatic of fundamental ecological imbalances due to human activities, such as habitat fragmentation, introduction of exotic species, and provision of human subsidies. Overabundant populations of mesopredators are difficult to control because the species are usually characterized by the potential for high densities, high reproductive rates and rates of recruitment, and high rates of dispersal. The authors also assert that it is difficult to root out alternative explanations for mesopredator overabundance, such as habitat changes, that often occur with or cause the loss of apex predators. Uncertainty regarding the causal mechanisms underlying mesopredator outbreaks muddies prescriptions for management.

In a commonly cited meta-analysis by Ritchie and Johnson (2009), the authors reported that more than 95% of the papers reviewed suggested evidence of MPR and/or suppression of mesopredator populations by apex predators. The only exceptions involved species with specialized defenses, such as skunks or those that use specialized structural niches, such as arboreal behavior. Apex predators can affect mesopredator abundance through killing (and sometimes eating) them; through forcing behavioral shifts in foraging or use of habitats in time and space; and through direct aggressive interactions. These changes can have effects on population growth, predation rates, fitness, and survival. Bottom-up effects of vegetation productivity and community composition and distribution can affect abundance of species at all trophic levels, including IGP, attenuating or exacerbating the nature, strength, and direction of interactions among species (Thompson and Gese 2007, Ritchie and Johnson 2009). Apex predators may be more effective in controlling mesopredators in productive ecosystems (Ritchie and Johnson 2009).

In another commonly cited meta-analysis, Brashares et al. (2010) found evidence that MPR is a common result of the loss of apex predators in many systems throughout the world. Many current apex predators in some systems are exotic or invasive species. Loss of apex predators may or may not result in MPR, depending on the context. Additionally, increased abundance of mesopredators may or may not cause prey populations to decline, with mesopredators gaining dominance in areas of low productivity and high habitat fragmentation, and apex predators having more resilience in areas with high productivity and low habitat fragmentation. If a high diversity of apex and mesopredators consume a wide variety of prey, the potential for MPR and trophic cascades is weakened. Challenges in detecting MPR is difficult because of short duration studies, inherent natural variation, complex interactions among trophic levels, and researchers often invoke MPR when the apex predator has already been extirpated.

Another recent meta-analysis conducted by Ripple et al. (2013) suggested that any MPR effects due to wolves could be dependent on the context, and may be influenced by bottom-up factors, such as the productivity of a system without wolves. Factors such as human-provided food subsidies, scavenging opportunities on livestock and large ungulates, and existence of alternative prey may confound results. The authors suggest that a link exists between wolf population declines and expansion in the ecological influence of coyotes. The strength of any trophic cascade created by wolf recolonization may be dependent on whether wolf populations may reach ecologically-effective densities (also suggested by Letnic et al. (2011)), the amount of unfragmented habitat available, levels of wolf harvests and removals, and presence of refugia and food subsidies available to coyotes.

In Australia, researchers have suggested that widespread and intensive control of dingoes using aerial distribution of 1080-poisoned baits has resulted in releases of mesopredators, especially introduced foxes and cats (Letnic et al. 2011, Wallach et al. 2009a, Brook et al. 2012), although Allen et al. (2014) argues that other plausible explanations may exist. Letnic et al. (2011) suggested factors that may also limit the control of dingoes on foxes include the abundance of prey (particularly introduced rabbits), seasonal activity patterns, levels of site and vegetation productivity, predator control regimes used, human food subsidies, and reproductive rates. Importantly, the authors argue that it is possible that top predators can ecologically express control over mesopredator populations only when apex predator population densities reach a certain threshold (also suggested by Ripple et al. 2013), which is likely to be above that at which apex predators pose a threat to livestock of human safety. Lack of human tolerance to predators may not allow that ecological threshold of abundance to be reached.

Similarly, Newsome et al. (2017) found that top predators suppressed mesopredators in areas where top predator densities were highest (core area), supporting the notion that removal of top predators can cause MPR. At areas outside the top predators core area, mesopredators and top predators have been shown to coexist, indicating that MPR may not occur when top predators are removed in those areas since mesopredators already had a realized ecological role. However, there is uncertainty with their results, since mesopredators could coexist in the high density core of a top predator's territory, but those individual animals are thought to be difficult to detect. The authors note that abiotic factors, such as human disturbance and agriculture, caused both top predators and mesopredators to be absent from the area, dampening the strength of top-down forces enough to create a bottom-up driven system.

Wallach et al. (2009a) suggest that dingoes originally coexisted with 2 endangered species (a ground-nesting bird and a rock-wallaby), and extensive dingo baiting may be the unintended cause of Australia's extinction crisis due to MPR of introduced foxes and cats. Intensively baited dingoes may have managed to preserve pack cohesiveness due to learned behavior in response to human persecution, including becoming difficult to sample and highly secretive in areas of human presence and where they were expected to be exterminated. After intensive baiting of dingoes, endangered species may either crash (which is improperly attributed to the baiting program) or exhibit an exponential increase followed by a crash after a lag period (mesopredator populations increase during the lag period before adversely affecting the population of the endangered species). Brook et al. (2012) found evidence that controlled dingo populations hunted less at dusk (dusk being their common hunting period concurrent with prey activity), and therefore feral cats hunted more at dusk with higher efficiency. Cats may also have the additional behavioral advantage of climbing trees both to access prey and avoid predation by dingoes. Dingo densities may actually increase for a time following intense baiting due to dispersal of young dingoes.

Allen et al. (2013) demonstrated that the removal of dingoes did not result in increased mesopredator abundance. Further, Allen et al. (2014) argues that three often-cited studies purporting to provide evidence of MPR in Australia are actually plagued by imprecise sampling of predator populations. Additionally, none of the studies provide reliable evidence of MPR because there was no verification of reduced dingo populations due to baiting. The authors assert that, despite broad patterns of MPR demonstrations in some contexts, MPR cannot be reliably separated from other equally plausible explanations for the suggested interrelationships among dingoes, foxes, and cats. Additional research by Allen et al. (2018) has indicated that bottom-up effects (habitat and food availability) have a greater influence on hopping-mice (prey item of mesopredators) than the abundance of dingoes.

What is the Relationship of Adaptive Behavior, Resource Partitioning, and Human Subsidies to the Potential for Terrestrial Trophic Cascades?

Adaptive Behavior

Since the late 1990s, researchers have recognized that individuals and groups of herbivorous and/or carnivorous prey animals use behavior that may be evolutionary-based or learned as part of a social system to reduce the risk of predation. Other non-consumptive and abiotic factors such as snowpack, system productivity, rainfall, and climate change may also affect how predators and prey (including predators as prey, or IGP) interact (Peckarsky et al. 2008). Although top predators will kill smaller predators, other factors, including behavioral responses such as shifting territories, adapting anti-predator behavior, and resource partitioning, are the primary mechanisms by which dominant predators can limit smaller predator populations (Casanovas et al. 2012).

Berger-Tal et al. (2011) suggest that adaptive behavior by predators and prey should be integrated into models of conservation theory, and recognize the role that human behavior plays in impacting animal behavior, such as overharvesting, habitat fragmentation, disturbance, and the introduction of exotic species. The key animal behaviors affecting survival, reproduction, and recruitment are changes in movements and use of space, behaviors related to foraging and avoidance of predation, and social behaviors.

Gese (1999) reported that elk and bison act more aggressively toward the alpha pair of wolves than toward betas and juveniles. Female elk with young act more aggressively toward predators than males to determine the most effective level of anti-predator behavior with the least use of energy (Gese 1999), perhaps responding to behavioral clues emitted by the predators themselves (Peckarsky et al. 2008). The type of hunting style use by different terrestrial large predators, such as "coursing" versus "sit-and-wait" may cause different anti-predator responses by prey. For example, it may be easier to respond with less energy to coursing predators, such as wolves and coyotes, because it is easier to know if they are present or absent from an area than an animal that may be hiding and waiting for prey to mistakenly enter their attack range (Schmitz et al. 2004, Ritchie and Johnson 2009). However, Orrock et al. (2010), working primarily with fish and invertebrates, suggested that predators may change prey movements and behavior by "remote threat," even when the predator is not present (the predator causing a threat has been called a "keystone intimidator" by Peckarsky et al. 2008).

It is difficult to interpret the rationale for certain wildlife behaviors. Creel and Winnie (2005) disagreed with Hebblewhite and Pletcher's (2002) interpretation of elk grouping behavior near and far from cover. The latter interpreted elk foraging in meadows as a means to avoid predator attacks emerging from cover, the former reinterpreted the same behavior as release from anti-predator behavior when the short-term risk of predation was low, providing an opportunity for foraging in the best habitats. Creel and Winnie (2005) suggested that elk can assess temporal variations in predation risk on a sufficiently fine scale to determine the daily comings and goings of wolves through the senses, patterns of predator presence, and/or distribution of prey carcasses.

Prey may change their behavior to avoid chronic predation, including by humans, by changing the timing of activity (temporal behavioral change during the day or night) or the how they use the available habitat spatially in relation to the activity of the larger predator (Kitchen et al. 2000, Wilson et al. 2010). For example, Kitchen et al. (2000) reported coyote populations being significantly more active during the time period when predators are not (for coyotes, more active during the night while their eyesight is more adapted for optimal hunting during the day or dawn). Social animals may also be forced into behavioral and associated physiological changes under heavy human predation. Wallach et al. (2009b) asserted that heavy predator control against dingoes (wolf-like canid) in Australia through aerial 1080 baiting fractured the social structure of packs, leading to changes in age composition, group size, survival rates, hunting abilities, territory size and stability, and genetic identity and diversity. When heavily controlled, dingoes learned to survive in areas deep in reserves and, conversely, directly near humans, livestock and areas of heavy baiting, utilizing additional food sources and passing on the anti-predator/human behavior to offspring.

Free-ranging domestic dogs were found to control distribution and habitat use of a small wild deer in South America due to high potential for harassment and attacks and resulting high lethality of attacks. Recreational hunting by subsidized domestic predators can cause behavioral and habitat shifts, reduction in fitness, and populations declines (Silva-Rodríguez and Sieving 2012).

Other important behaviors affecting the role of species abundance and recovery within trophic systems is dispersal, immigration into and out of a system or population, and territoriality. In species with social structures, such as wolves, dingoes, and coyotes, dispersal by beta and juvenile individuals may be due to little interaction with other pack members, lack of breeding opportunities, restriction to food resources by higher ranking members, and increased social aggressions from more dominant pack members (Gese et al. 1996a, Gese et al. 1996b). Territories are areas that are defended from emigration by individuals that are not pack members, usually by the dominant pair, to limit or exclude competition for mates, food, and space (Gese 1998). Berger and Gese (2007) suggested that differential effects of wolf competition with coyotes on transient coyote survival and dispersal are important mechanisms by which wolves reduce coyote densities.

A challenge to interpreting the role of adaptive behaviors and other non-consumptive traits such as habitat or temporal shifts that are acquired over evolutionary time is that, when evaluating statistical correlations, these factors may have the same sign as consumptive factors (factors related to trophic interrelationships), moving in the same direction, so they may be overlooked or masked. Conversely, adaptive behaviors may also potentially increase the magnitude of trophic cascades that would otherwise be mediated by consumption. Non-consumptive effects may also be easily interpreted as bottom-up effects, or be considered as an afterthought to explain observations inconsistent with consumption-based theory, further confounding interpretation of study results (Peckarsky et al. 2008).

Resource Partitioning

Partitioning of resources in time and space are key behavioral methods for coexisting and minimizing competition between predators and prey, including predators that kill and/or eat other predators (IGP). Polis et al. (1989) identified **interference competition** (also called **competitive exclusion**; Arjo et al. 2002, Finke and Denno 2005, Brook et al. 2012), in which taxa in a community use similar diets and/or space and one interferes with the ability of the other to optimize the use of such resources. For example, hungry consumers may have greater movement in search of food, encountering predators or prey more frequently. Behavioral adaptations to reduce the risk of prey encountering predators can involve switching the use of habitats by using them at a time when it is likely that the predator would not be present (Palomares et al. 1996, Finke and Denno 2005, Hunter and Caro 2008) or switching their diet to reduce competition (Schmitz et al. 2004, Thompson and Gese 2007, Elbroch et al. 2015).

Several authors have reported that coyotes may eat smaller prey compared to wolves (such as deer, rabbits, or rodents rather than elk), while at the same time obtaining food directly provided by wolves through scavenging on large carcasses that the wolf pack cannot completely consume, such as elk and moose (Paquet 1992, Wilmers et al. 2003). Prior to wolf reintroduction in Yellowstone NP, coyotes depended on small mammals and scavenging carcasses late in the winter season, when animals were naturally weakened and died (Gese et al. 1996b, Wilmers et al. 2003). However, after wolves are reintroduced or they recolonize an area after extirpation, carcasses are provided throughout the winter, making direct interaction with wolves at a carcass, despite increased aggression and the risk of being killed, more energetically efficient than hunting (Arjo et al. 2002, Atwood et al. 2007, Thomson and Gese 2007, Wilmers et al. 2003). Food subsidies provided by scavenging introduces complexity into food webs. In Rocky Mountain National Park, over 30 species of mammalian and avian scavengers use wolf kills (Wilmers et al. 2003).

After reintroduction of wolves into Yellowstone NP, competition between cougars and wolves suggested that cougars significantly increased the proportion of deer in their summer diet and decreased the proportion of elk. Both wolves and cougars predated on elk calves in the summer, but elk had shifted their winter range to irrigated fields outside the park, as well as institutionalized winter feeding subsidies. This resulted in elk populations no longer being limited by natural carrying capacity, so neither wolf nor elk were limited in the summer by elk calf availability (Elbroch et al. 2015).

Atwood et al. (2007) found that cougars and wolves ate the same prey (elk) but in different habitats. Female cougars select habitat based on opportunities for hunting more than male cougars do. Lendrum et al. (2014) suggest that competition with reintroduced wolves in Yellowstone NP caused cougars to select habitat removed from known wolf pack territories and with buffers to reduce the potential for interactions with wolves. Avoiding wolves may result in use of less optimal habitat, especially for female cougars, which may have implications for survival of dispersing juvenile cougars and overall cougar dynamics.

Swift and kit foxes, closely related foxes that are much smaller than coyotes, are often killed by coyotes in areas where their home ranges overlap (Kamler et al. 2003, Moehrenschlager et al. 2007, Kozlowski et al. 2008); however, fox populations having higher survival rates tended to use portions of the overlapping home ranges that had more heterogenity, especially areas providing burrow and den refugia that allow rapid escape from coyotes. Home range sizes decreased as the availability of burrows increased, as it did in areas with lower shrub densities in which predators can be readily viewed and escaped more quickly (Moehrenschlager et al. 2007, Kozlowski et al. 2008).

More than body size and behavior, especially in non-canid mammalian predators, may cause resource partitioning. Even when raccoon and coyote home ranges overlapped, researchers found little evidence of coyotes killing raccoons, and little evidence that raccoons avoided coyotes. Since raccoons are opportunistic omnivores, there is little potential for direct competition. Raccoons also climb trees, which may provide a structural habitat partitioning (Gehrt and Prange 2006). Skunks avoid direct predation by larger carnivores through distinctive coloration and toxic emissions (Hunter and Caro 2008, Ritchie and Johnson 2009).

Human influence on habitat use, especially habitat fragmentation, human activity, and human food subsidies, is an important consideration for how individuals and populations interact and thrive (Litvaitis and Villafuerte 1996, Palomares et al. 1996, Fedriani et al. 2001, Fischer et al. 2012).

Human Food Subsidies

A review of the literature by Newsome et al. (2015) found that 36 terrestrial species in 34 countries used food provided by humans, such as discarded food, livestock carcasses, crops, and landscaping. With such subsidies, predator abundance increased (no longer limited by resources), diets were altered to include human-provided food, survival increased, and social interactions shifted to either the benefit or disadvantage of the predator. Predators also changed their home ranges, activity, and movements. Subsidies can result in induced behavioral or population changes and may result in trophic cascades, causing predator populations to no longer cycle with prey cycles. Top predators used primarily livestock, mesopredators used livestock carcasses and waste food, cats continued to use live prey, and bears mostly used crops, waste foods, and carcasses. Prey also used human presence and activities as shields from predators in some cases.

Fedriani et al. (2001) found that areas in southern California with high and patchy human residential development provided sufficient human food subsidies through trash, landfills, livestock, and domestic fruit, as well as providing subsidized habitat for rabbits. The study also found that coyote densities were eight times higher than in more natural areas (also, Fischer et al. 2012). As predator size increases, human tolerance tends to decrease (Fischer et al. 2012).

In urban areas, coyotes tended to avoid urban and crop areas, using safer corridors between patches of forest areas used for cover during the day and hunting (Arim and Marquet 2004, Gehrt et al. 2009). Gehrt et al. (2009) found mostly "invisible" coyotes avoiding humans and human-provided food in core areas of downtown Chicago and at O'Hare International Airport (similar to Wallach et al. 2009a, Wallach et al. 2009b). Raccoons, however, heavily used dumpsters and trashcans at night in areas with high human activity during the day (Gehrt et al. 2009). Bino et al. (2010) found that foxes, when human food subsidies were rapidly removed, responded by increasing or shifting their home ranges or dispersing from the area, and that fox densities in the urban area decreased substantially within a year.

How Do Predator Population and Social Dynamics Affect Ecosystem Structure and Function?

The territory of an animal has been defined as the area that an animal will defend against individuals of the same species (Mech 1970, in: Gese 1998). Since the Knowlton and Stoddart (1983) study (and further clarified by Gese 1998), it is clear that the territorial alpha pair is the basic unit of wolf and coyote populations. According to Gese (1998), the alpha pair is responsible for monitoring and defending the territory and its resources from other conspecific predators from adjacent packs through patrolling and scent marking. Pack size varies geographically, with wolf packs more commonly composed of more individuals than coyote groups. Ecologically, the socially intact and operating wolf pack, not individual animals or even the alpha pair, is the unit that appears to control the structure and function of the ecological system (Wallach et al. 2009b).

Maintaining the structure of the pack is critical for ensuring that the pack has the needed resources through shared hunting strategies and scavenging, collaborative care of the alpha pair's young, and learned behavior of the young for hunting efficiency and wariness of novel changes in the territory. In coyotes, only the alpha pair breeds and only 10% of the young from a given pair need to survive and reproduce to replace the pair. The remaining 90% of the beta (subdominant) and transient animals either stay in the pack without reproducing, die, or disperse, and often die before establishment in a new territory (Knowlton et al. 1999). Therefore, in the absence of human hunting, territories and associated population densities tend to remain relatively stable over time.

Population control of socially complex species like wolves may have profound ecological impacts that remain largely invisible if only abundance is considered. Heavy predator control (in this case intensive aerial baiting of dingoes with 1080) can seriously fracture pack social structure, leading to changes in age composition, group size, survival rates, hunting abilities, territory size and stability, social behavior, genetic identify, and diversity. Controlled populations tend to have a higher proportion of young breeding pairs and litters due to loss of dominant adults in the pack structure controlling access to breeding. Packs may disperse after the loss of the breeding pair and territory boundaries may weaken or dissolve, creating transient individuals that are more vulnerable to predation. The pack may also shift to another area under heavy exploitation and breakup of territories. Learned and practiced coordinated hunting behaviors within packs may be lost due to loss of social structure and changes to social traditions. A symptom of pack disintegration may be a decreased ability to take down larger prey and predators may shift to smaller and or more vulnerable prey. Smaller packs may reduce success at scavenging in the winter due to competition from larger predators. Intensive human removals may teach remaining animals to be highly secretive (Wallach et al. 2009b).

Studies suggest that coyote territories do not remain vacant for very long after members 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 within a few weeks, 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 alpha territorial pair. Williams et al. (2003) suggested that temporal genetic variation in coyote populations experiencing high predator removal indicated that localized removal did not negatively impact population size. Gese (2005) found that after heavy removal rates (populations reduced between 44% and 61% over two years) there was a younger age structure in packs and increased reproduction by yearlings, with pack size and density rebounding to pre-removal levels within eight months post-removal. The author attributed some of the response to immigration of animals from outside the territory and increased lagomorph prey availability that apparently increased mean litter size in both the removal and control areas. Young animals, which are low in the social structure and subjected to lower resource accessibility, and some betas with no potential for becoming breeding alpha members of the pack, generally disperse (Gese et al. 1996b), which may also keep genetic diversity high as dispersing animals fill vacated openings within another pack.

While it is true that wolf removal can have a short-term disruptive impact on pack structure, that disruption does not appear to result in adverse impact on the overall wolf population (Nadeau et al. 2008, Nadeau et al. 2009, Mack et al. 2010). Pack resilience to mortality is inherent in wolf behavioral adaptation and reproductive capabilities (Brainerd et al. 2008). Based on mean pack size of eight, mean litter size of 5, and 38% pups in packs, Boertje and Stephenson (1992) suggested 42% of juveniles and 36% of adults must be removed annually to achieve population stability. Researchers have indicated declines may occur with human-caused mortality at 40% or less of autumn wolf populations (Peterson et al. 1984, Ballard et al. 1997).

The data on wolf mortality rates suggest some wolf populations tend to compensate for losses and return to pre-removal levels rapidly, potentially within a year. Wolf populations have sustained human-caused mortality rates of 30% to 50% without experiencing declines in abundance (Fuller et al. 2003). In addition, Brainerd et al.

(2008) found that 62% of packs in recovering populations retained territories despite breeder loss. Furthermore, pup survival was primarily dependent on size of pack and age of pup because multiple pack members feed pups despite loss of an alpha breeder. Pup survival in 84% of packs with breeder loss was similar or higher than packs without breeder loss (Mech and Boitani 2003).

Wolves and coyotes with strong social structures can be resilient in the face of moderate levels of exploitation, and can recover abundance relatively rapidly. However it is not known at what population densities these species can exert top-down control through the ecosystem. Many populations are simply too small to actually cause top-down trophic cascades (Ray et al. 2005, Letnic et al. 2011, Ripple et al. 2013).

What is the Relationship of Trophic Cascades to Ecological Biodiversity and Ecosystem Function?

Humans are the top predator in all systems, but the roles humans play as predator in trophic cascades, biodiversity, and ecosystem function are rarely considered (Ray et al. 2005). Most predators cannot directly and intentionally change their habitats and condition to serve their own purposes; only humans can do that.

Humans are altering the composition, ecosystem structures, and impacted diversity of biological communities through a variety of activities, such as logging, agriculture, grazing, development, climate change, loss of native species and additions of exotic or invasive species, with new functions that increase the rates of species invasions and extinctions, at all scales. Many human-altered ecosystems are difficult and expensive to recover, or may be impossible to reverse (Hooper et al. 2005, Ritchie et al. 2012). Biodiversity is declining a thousand times faster now than at rates found in the fossil record, and is becoming increasingly confined to formally protected areas, which may fail to function as intended due to size and lack of connectivity to other protected areas (Balvanera et al. 2006, Estes et al. 2011). Concern is growing that the loss of ecosystem services provided by biodiversity are adversely impacting human well-being (Hooper et al. 2005, Balvanera et al. 2006, Cleland 2011).

Despite compelling experimental evidence, the relationship of biodiversity to ecosystem functioning and provision of ecological services has great uncertainty and is still contentious among researchers because the differences in experimental design, the results obtained, and interpretations of those results have not been consistent or universally accepted among the research community (Balvanera et al. 2006, Hooper et al. 2005).

Biodiversity can be described at many scales, from genetic to global (Hooper et al. 2005, Cleland 2011). Biodiversity can be measured in many ways as well, including **species richness** (the number of species in a system), richness of functional groups (the number of ecological functions performed by groups of species in a system), **evenness** (the distribution of species or functional groups across the system), species composition (the identity of species occurring in the system), and diversity indices (comparative measures, using whatever factors are measured). Typically, biodiversity is measured in terms of species richness, because it can be readily measured and compared, but that measurement ignores the complex interactions among species, population, communities, and abiotic factors (Ray et al. 2005, Balvanera et al. 2006, Cleland 2011).

The 5 top reasons for losses of biodiversity are human-caused habitat loss, fragmentation, and conversion; climate change; introduction of invasive and exotic species; pollution and nutrient enrichment (such as additions of farm fertilizers to aquatic systems); and overharvesting (Srivasta and Vellend 2005). However, these effects can be mediated to a degree by immigration and dispersal (France and Duffy 2006). The effects of biodiversity change in ecosystem processes are weaker at the ecosystem level than at the community level, and have a negative correlation at the population level (Balvanera et al. 2006).

Four mechanisms that account for biodiversity can influence the combined densities of predators and prey and their resources: sampling effects; resource partitioning; indirect effects caused by IGP, including diverse ecosystems with multi-trophic levels and multiple indirect effects; and non-additive effects resulting from consumers with non-linear complex functional responses (Ives et al. 2005).

Biodiversity can enhance the reliability and stability of ecosystem services and functions through more diverse communities and spatial heterogeneity (France and Duffy 2006). **Ecosystem stability** is defined as a system that changes little, even when disturbed; **ecological resilience** is defined as a system that, when perturbed, can recover to its original stasis (Cleland 2011). Ecosystems with low biodiversity have low resilience and are sensitive to disruptions, including perturbations caused by humans (Ritchie et al. 2012). Having a variety of species, including top predators, which responds differently to environmental perturbations can stabilize ecosystem processes (Hooper et al. 2005, Duffy et al. 2007).

Ecosystem functioning is a broad term that encompasses a variety of processes and reflects how the interrelated ecosystems involving biotic and abiotic factors work together. It depends on biodiversity and is the basis of the capability of the ecosystem to provide ecological services of value to humans (Hooper et al. 2005). Variation in ecosystem functions and processes can result from natural annual environmental fluctuations, directional correlational changes in conditions, and abiotic and biotic disturbances (Hooper et al. 2005).

Functional redundancy of species refers to the degree to which organisms do similar things within a system and that one species can potentially compensate for the loss of another (Hooper et al. 2005, Casula et al. 2006, Cleland 2011). A relevant example of lack of functional redundancy involves human hunting (with human as the top predator) and natural predation. Human hunting cannot replace the roles that top predators play because the timing and intensity of predation is different; different age and sex classes are targeted; hunting does not generally result in impacts to mesopredators; trapping can result in take of non-target animals; hunting requires infrastructure such as roads that have effects on animals and vegetation (such as mortality caused by collisions with vehicles). In many cases, human hunting and poaching are unsustainable in many parts of the world (Ray et al. 2005).

It is suspected that greater variations in response to changes in biodiversity occur than is reported in the literature, based on inherent complexities associated with variations in prey use patterns, prey use rates by predators, predator abundance, and predator-prey distributions and interactions. This complexity results in many plausible theoretical explanations for results obtained by modeling biodiversity (Casula et al. 2006), none of which are certain. Studies incorporating multi-trophic levels that more realistically reflect nature and that consider interrelationships are still rare in this discipline (Hooper et al. 2005).

Ecosystem services are the conditions and processes through which natural ecosystems and the species that comprise them sustain and fulfill human life, including purification of air and water, support of soil fertility, decomposing waste, climate regulation, pollination, regulation of pests and human diseases, creating conditions of aesthetic beauty, and maintenance of biodiversity (Srivasta and Vellend 2005, Balvanera et al. 2006). As human populations increase and human domination of the biosphere expands, managing ecosystems for human services will become increasingly important to prevent shortages of water, energy, and food, while attempting to decrease disease and war (Kremen 2005).

Substantial theoretical and empirical evidence exists that biodiversity is able to effect ecosystem function for plant communities, but it is not clear if these patterns hold for conditions involving large predator extinctions, multi-trophic communities, or larger spatial scales (Loreau et al. 2001, Ray et al. 2005, Srivasta and Vellend 2005). The major challenge is to determine how the dynamics of biodiversity, ecosystem function, and abiotic factors interact, especially with steadily increasing human-caused ecosystem degradations. Considering factors other than species abundance and richness (the number of species occurring in an ecosystem and the number of animals in each species), a more predictive science might be achieved if researchers developed an appropriate classification of ecosystem function integrating changes in biodiversity, ecosystem function, and abiotic factors into a single, unified theory that can be empirically tested (Loreau et al. 2001). This is extremely difficult to develop.

Understanding how biodiversity affects ecosystem function requires integrating diversity within trophic levels horizontally and across trophic levels vertically. Multi-trophic interactions may produce a richer variety of diversity and functioning relationships, depending on the degree of dietary generalization and specialization, trade-offs between competitive ability and resistance to predation, IGP, and immigration/dispersal. Little is known about how reducing the number of trophic levels or species or removing predator species affects ecosystem processes. Integrating more mobile large carnivores into research is an especially difficult challenge empirically (Duffy et al. 2007).

Experiments are often conducted at small scales with insufficient duration to account for turnover of the components in order to provide evidence for true change (as opposed to inherent natural variation), and biodiversity often includes exotic and invasive species. The effects of biodiversity on ecosystem function depend on the system being studied and the functions that are sampled and measured. Few studies have been conducted considering interactive effects of extinctions between two trophic levels, and those studies have mixed results (Srivasta and Velland 2005).

Srivasta and Vellend (2005) conclude that biodiversity is declining at global scales, but the scales at which empirical studies are being conducted are not scaled up to appropriate levels to reflect nature. The results of studies are inconsistent on whether biodiversity has positive effects on ecosystem function, especially because it is not known how these studies are being scaled up; ecosystem effects of extinctions in multi-trophic food webs are difficult to predict because of numerous and complex indirect effects and the likelihood of simultaneous or cascading extinctions through the trophic levels; and human-caused drivers of extinction effect ecosystem function to a large magnitude directly and indirectly.

Decreases in biodiversity often lead to reductions in ecosystem functions, then in the resultant ecosystem services. Declines in providing services are initially slow, but become more rapid as species from higher trophic levels are lost at faster rates. Different ecosystem services respond differently to losses of habitat and biodiversity, introductions of exotic or invasive species, and the variety of interactions among species within and between trophic levels. Because different ecosystem services tend to be performed by species at different trophic levels, and trophic webs tend to first thin before collapsing from top to bottom, the processes should be predictable and foreseeable. The best way to address biodiversity and ecosystem function is to ensure that the ecosystems remain viable for species with larger area requirements that tend to have less readily identifiable economic value, such as large carnivores (Dobson et al. 2006).

Sustainable and healthy populations of large predators have the potential to restore ecosystem stability and confer resiliency against global processes, including climate change and biological invasions (Duffy et al. 2007). Because the roles of predators are dependent on their context, the emphasis of research must be more focused on predator functions in ecosystems, including the importance of social structures and adaptive behaviors in influencing the dynamics of trophic interactions, and less on the identities and abundance of species. There is great variability and uncertainty surrounding the ecological functions of predators, including unpredictable and even counter-intuitive outcomes that may be caused by species interactions such as IGP and mesopredator release (Ritchie et al. 2012). However, it is inappropriate to assume that the mere presence of large carnivores ensures persistence of biodiversity (Ray et al. 2005).

The first species that tends to be lost or rendered ecologically extinct in both terrestrial and marine systems is almost invariably the large carnivorous predator, primarily due to their intrinsic rarity at the top of the trophic web, small population sizes, restricted geographic ranges, generally slow population growth rates, and specialized ecological habits. Top predators are especially vulnerable to human-caused habitat destruction and fragmentation, as well as exploitation and persecution due to conflicts with humans (Duffy 2003). Humans, as the top predator, have eliminated the largest predators from over 90% of the Earth, globally extinguishing ecological functions (Pace et al. 1999, Ray et al. 2005).

Evidence suggests that the loss of one or more large carnivorous predator species often has impacts comparable in magnitude to impacts associated with a large reduction in plant diversity. This results in large changes in community organization, ecosystem properties and system functions (Duffy 2003). Apex predators tend to be the determinants of biodiversity structure and function, and the most challenging to conserve (Ray et al. 2005). Studying the results of the impacts of the loss of large carnivores on the structure and function of ecosystems is extremely difficult because of a complexity in trophic interactions. Evidence from ecological studies indicate that the largest contribution of changes in biodiversity on ecosystem function occurs when humans introduce exotic or invasive plant and/or animal species, which may increase the number of species in a system (species richness), while reducing ecosystem functions. Biodiversity will continue to erode under human influence (Duffy 2003).

Despite increasing research on the tangled complexity of food webs and trophic interactions, we have no better understanding of how to apply the results to conserving biodiversity and ecosystem function. Marine ecosystem cascades are generally caused by overexploitation of species eaten by humans; in terrestrial ecosystems, changes in biodiversity are generally caused by human-caused habitat destruction, fragmentation, and conversion. Large carnivores are generally not specialized in function or diet, so pristine conditions are not needed for survival; large carnivores are mostly resilient in the face of human perturbations, provided they have their basic baseline conditions. The primary problem with restoring large carnivores is competition with humans for space, resources, and property such as livestock (Ray et al. 2005), which can often lead to legal and illegal removals, concerns with human health and safety, and further pressures on endangered species (Ritchie et al. 2012).

Biodiversity, broadly defined, and the roles of large predators potentially contributing to biodiversity, clearly has strong effects on ecosystem functioning and provision of ecosystem services, which must be communicated to those charged with economic and policy decision-making to avoid ineffective and costly management actions (Hooper et al. 2005).

However, researchers have identified the need for consideration of ecological complexities in study designs for better determining true levels of biodiversity and their roles within ecosystems, including factors such as resource partitioning, indirect and additive effects (including IGP and MPR), multiple effects, social stability of packs of socially complex top predators, and multi-trophic systems. Studies must also be upscaled to more realistically represent larger systems, the results of which may then overturn the more general findings of the current studies of simplified systems (Ives et al. 2005, Srivasta and Vellend 2005, Wallach et al. 2009b). More studies are also needed on the sequence of system collapse and replacement of ecosystem services as systems are further degraded (Dobson et al. 2006). The ecological roles of predators in supporting ecosystem biodiversity and functions and providing ecosystem services to humans are substantially unknown.

What Should Be the Role of Top Predators in Conservation Plans?

Predator management is characterized by complex ecological, economic, and social tradeoffs that are often not readily apparent or mutually exclusive, as well as being very expensive. Large carnivore conservation is impeded because much of the habitat is already destroyed or has uses that conflict with predators, they can be perceived to be threatening to human safety, and they kill game species and livestock (Prugh et al. 2009, McShane et al. 2011, Ritchie et al. 2012). Replicating the full suite of influences provided by apex predators is exceptionally challenging if not impossible.

The ability to better predict mesopredator responses to reintroduction or gradual recolonization of apex predators would enhance effectiveness of management efforts. The daunting task of conservation of top predators requires substantial habitat restoration, greater public acceptance of large carnivores, and compromises among people most directly affected by these predators (Prugh et al. 2009). Also, little is known about the impact of trophic interactions, particularly predator-prey and predator-predator interactions on the relationship of biodiversity and ecosystem functioning in natural systems. Increasing predator diversity could promote trophic cascades if predator species act additively or hide trophic cascades if IGP is likely to occur in diverse predator assemblages (Finke and Denno 2005).

Because top predators need lots of room, have symbolic value, and can structure ecosystems under certain circumstances, they have the potential to gain public support for conservation programs to achieve higher scale conservation goals to restore degraded ecosystems. Large scale conservation should not be confused with the ecological roles and importance of apex predators to conservation. In areas where top predators were extirpated but the system was protected, such as in national parks, top predators may be effective in improving biodiversity and ecosystem function.

In areas with high levels of human-caused habitat change, development, and relatively unlimited prey (large populations of deer), gradual recolonization by top predators, such as by wolves in the northern Midwestern US, often increase the potential for conflicts with humans. The ability of top predators to reach a threshold density to play an ecological role for conservation may be limited by population reductions in response to human conflicts, including in areas surrounding reserves. The conservation goal must focus on reaching population levels and distribution of top predators that the threshold for creating ecological structure is reached and sustained (Ray et al. 2005, Letnic 2011, Ripple et al. 2013).

The best chances for using top predators for conservation purposes is where the extirpation of predators has been clearly shown to result in adverse ecosystem impacts and where the system has not been degraded by other factors. In terrestrial systems, where habitat conversion has created so many changes to biodiversity, the return of top predators may require long periods of time to reach conservation objectives, if recovery can be achieved at all (Ray et al. 2005).

The precautionary principle when designing conservation plans is important, shifting the burden of proof to those who discount the ecological role of predation, because thresholds of change may result in large and sudden phase shifts that may be impossible to reverse (Ray et al. 2005, Estes et al. 2011).

The most important questions regarding conservation of large predators, biodiversity, and ecosystem function remain unanswered:

> In what locations and under what conditions to large carnivores play an ecologically significant role?
>
> In what locations and under what conditions would restoration of large carnivores result in restoration of biodiversity?
>
> What densities of large carnivores are necessary to produce the desired restoration of biodiversity?
>
> What are the interactions between hunting by carnivores and hunting by humans? (Ray et al. 2005).

What are the Challenges Associated with Interpreting and Applying the Results from Studies Conducted in Different Ecosystems?

Regardless of the context, Litvaitis and Villafuerte (1996) warn researchers not to confuse declines in apex predators and changes in lower trophic level species abundance as a cause-and-effect relationship, as both are likely a response to human activity, including collisions with vehicles, legal and illegal take, habitat fragmentation, development, and/or human subsidies. Interpretations of results must look for factors beyond those naturally occurring in the study area.

A primary challenge to testing the presence and strength of a trophic cascade involves removing predators from systems in which they are abundant or adding them to systems where they are absent, creating an intended perturbation that can be tested statistically (Estes et al. 2011, Ripple et al. 2016). With large free-ranging carnivores, intended removal of predators as part of a study is typically socially, ethically, and politically challenging or impossible (Ray et al. 2005, Estes et al. 2011). Therefore, many studies rely on areas in which large apex predators were extirpated and either reintroduced or rapidly recolonized the area, while the original conditions remain substantially the same, such as in older national parks, including Yellowstone National Park, Zion NP, and Banff NP (e.g., Heeblewhite et al. 2005, Ripple and Beschta 2006, Berger et al. 2008, Estes et al. 2011, Beschta and Ripple 2012, Ripple et al 2015).

Another challenge involved with conducting studies that provide statistically-strong results involves the temporal scale of the study, which must be of sufficient duration to incorporate the generation times of the component species, especially plants. While predator impacts have been observed over weeks and months in lakes, streams, and nearshore marine systems, decades or even centuries may be required for terrestrial systems where the base autotrophs may be shrubs or trees (Duffy 2003, Schmitz et al. 2004, Briggs and Borer 2005, Ripple et al. 2016, Engeman et al. 2017).

Relevant Publications Outlining Challenges

Ecosystems are more complex than first thought: Pace (1999) suggested that cascades are more likely to be non-linear and food webs to be probabilistic due to highly variable conditions that promote and inhibit the transmission of the effects of predators on food webs (called trophic dynamics), including complicating and confounding factors such as differences in inherent primary productivity (the nutrition provided by the plant communities), adaptive predator-avoidance behavior, the potential for ecological compensation, and the availability of anti-predator refugia for prey. In other words, researchers began to understand that ecological interrelationships among biotic and abiotic components of ecosystems had blurred what had appeared to be clear boundaries and interconnections.

Top-down effects appear to dissipate faster on terrestrial ecosystems than in freshwater ecosystems: Polis et al. (2000) suggest that this may be the result of aquatic systems better fitting the simplifying assumptions of trophic cascade models (such as incorporating discrete homogeneous environments and short regeneration periods for predators, and simple and trophically-stratified systems with strong and clearly identifiable interactions among species). They also suggest that most terrestrial systems are more complex and heterogeneous, with fuzzy boundaries between trophic levels, having variable prey and predator dynamics, and weak and diffuse interactions between species (except in human-designed agricultural systems). Species that have greater defenses against predation or herbivory tend to become dominant, weakening the link between predators and prey. The authors argue that, even at the species level, support for the presence of trophic cascades is limited in terrestrial systems (also, Halaj and Wise 2001). Conclusions about the strength of top-down effects may be an artifact of the plant-response being measured, not a response that actually exists in the environment. Schmitz et al. (2004), based on a meta-analysis, reports that a conclusion that a cascading effect may be weak or non-existent or existent and strong may be an artifact of the was the species in a system are categorized and aggregated by the researcher (for example, whether a species is a mesopredator or an apex predator, or which predator species feeds on which prey species), and the conclusion may be dependent on the system topology as conceptualized for the specific web.

Certain ecological dynamics that occur in terrestrial ecosystems may not occur in aquatic ecosystems: The additions of the concepts of IGP and mesopredator release (MPR), in addition to non-consumptive factors such as adaptive anti-predator behavior and beneficial foraging behavior in the face of differing predation risk based on the type of predator hunting behavior ("coursing" compared to "sit-and-wait"), further complicate the concept of trophic cascades in heterogeneric terrestrial ecosystems with socially complex and wide-ranging predators and prey as discussed previously and in Ripple et al. (2016).

Some effects, though appearing in both ecosystems, may be weaker in terrestrial ecosystems: A meta-analysis of research papers conducted by Halaj and Wise (2001) related to terrestrial arthropod-dominated food webs found extensive support for the presence of trophic cascades in terrestrial communities, but that the effects on biomass of primary producers are weaker in terrestrial communities than in aquatic food webs. A meta-analysis of 102 scientific publications across different types of ecosystems (lakes/ponds, marine, stream, lentic and marine plankton, and terrestrial agricultural and old fields) conducted by Shurin et al. (2002) reported high variability among ecological systems, and that predator effects were apparently strongest in benthic communities in lakes, ponds and marine ecosystems, and weakest in marine plankton and terrestrial food webs (also Borer et al. 2005). The complexity of terrestrial food webs within which large wide-ranging and adaptable carnivores are at the top of the web may further weaken the statistically observable presence of predator-driven effects (Halaj and Wise 2001).

Tradeoff behavior may be specific to the type of ecosystem and may contribute to the variability in the nature and strength of cascading effects: Schmitz et al. (2004) conducted a meta-analysis of 41 studies conducted in aquatic and terrestrial ecosystems that indicated that one mechanism addressing the uncertainty about the ultimate mechanisms driving trophic cascades may be the trade-off behavior associated with prey avoiding the risk of predation while also attempting to forage optimally. Knowing the habitat and resource use by prey with regard to the presence of one or more predators, and the hunting mode of the predator ("coursing/patrolling" compared to "sit-and-wait") may help explain the considerable variability on the nature and strength of cascading effects among systems. Different hunting modes force prey to balance the energetic effects of reacting through vigilance, ceasing foraging and moving away, or exhibiting aggression. Prey responding to active, coursing predators may be the least risk averse, determining that foraging is more important than maintaining constant vigilance, especially later in the winter, when fitness is inherently reduced. Different predators apply different rules of engagement based on hunting mode and habitat use, which then drive adaptive behavioral responses and associated trophic effects (Schmitz et al. 2004, Peckarsky et al. 2008).

Studies may study small subsets of communities for short periods of time, making interpreting results difficult. Borer et al. (2005) conducted a meta-analysis of 114 studies in terrestrial agricultural and grassland/shrub ecosystems mainly involving arthropods, lake, marine, and stream benthic communities. Of all the studies reviewed, only the marine benthic and grassland studies involved warm-blooded predators, and only one included a warm-blooded herbivore. The authors found evidence that the strongest cascades involved warm-blooded vertebrates (otters and humans), but these communities were primarily in marine environments. However, the authors reported that most studies only evaluate interactions within a small subset of a community, potentially resulting in too little variability in the species manipulated to detect relationships between diversity and the strength of cascades. Most studies were also of insufficient duration and study area size to actually detect ecological impacts that could be suggested to be different from inherent natural variability.

Challenges to Conducting and Interpreting Research and Modeling on Complex and Dynamic Ecological Systems

Many researchers and theoretical ecologists have identified the challenges associated with attempting to study and reach conclusions about very complex and interrelated systems. Ray et al. (2005) finds that determining the ecological effects of large carnivores on the biodiversity, structure, function, and dynamics of ecological systems and any associated ecosystem services may be highly challenging or even impossible to discern. Reasons provided by various researchers include:

- It is difficult to design suitable experiments with spatial and temporal dimensions that are appropriate for the species, populations, communities, and systems involved. This is especially difficult for large carnivore species that are wide-ranging and socially and behaviorally complex, and that use large heterogeneous integrated habitats that may change seasonally (for example, Ray et al. 2005, Ripple and Beschta 2006, Vance-Chalcraft et al. 2007, Engeman et al. 2017)
- Determining change in systems requires that perturbations be created and the results tested, with replications, which may be socially, morally, ethically, and politically impossible with systems involving large carnivores (Ray et al. 2005, Estes et al. 2011)
- Baselines on which to compare changes to determine causal relationships are often already damaged or eliminated, with no remaining or known natural benchmarks against which to measure effects, restricting the ability to discern short-term and long-term equilibrium states with and without predators (Ray et al. 2005, Kozlowski et al. 2008, Estes et al. 2011)
- Finding matched comparison study areas that are sufficiently similar over large spatial areas and over a sufficiently large temporal duration may be difficult and costly at best, and realistically impossible (Ray et al. 2005)
- The existence of many confounding factors can make strong predictions about effects and causation impossible, including abiotic factors such as climate change; weather; differences in site and area productivity; naturally occurring environmental oscillations and "noise"; soil mineralization; and surface and subsurface hydrological dynamics (Ray et al. 2005, Ripple and Beschta 2006, Kauffman et al. 2010, Orrock et al. 2010, Miller et al. 2012, Ripple et al. 2013, Allen et al. 2014, Engeman et al. 2017)
- Human impacts are often discounted or are considered tangentially, despite their often dominant and pervasive influence (Vitousek et al. 1997, Estes et al. 2011), and can confound the ability to experimentally discern functional

roles of predators, such as: human actions that have historical caused extirpations or extinctions; habitat fragmentation, especially by development and agriculture; introduction of livestock and/or exotic and invasive species into systems; hunting, poaching, persecution, and roadkill; human intolerance, especially of larger predators; human competition for prey of predators; depletion of prey needed by predators; providing food and structural subsidies; creating predator guilds made up of free-ranging carnivorous pets (cats and dogs) that are subsidized, are recreational killers, and often live in developments bordering large fragmented habitats with already stressed prey populations; and large-scale resource exploitation (for example, Ray et al. 2005, Livaitis and Villafuerte 1996, Palomares et al. 1996, Fedriani et al. 2001, Estes et al. 2011, Fischer et al. 2012, Allen et al. 2017, Haswell et al. 2017)

- Some potentially strong and important correlations related to non-consumptive factors that are in the same statistical direction as commonly recognized correlations may be masked and not considered in interpretation of study results (Peckarsky et al. 2008)
- Valid comparisons of studies evaluated in meta-analyses of multiple studies (where researchers review and reconsider the results of many studies to look for patterns and problems) have been difficult to make because of differences in spatial and/or temporal scale, differences in factors measured, differences in statistical methods and assumptions, and differences in study methodologies, among other reasons (Briggs and Borer 2005, Hooper et al. 2005, Vance-Chalcraft et al. 2007, Brashares et al. 2010)
- Most models are oversimplifications of natural systems, and do not include complexities such as anti-predator behavior, more multi-trophic community models, and richer webs of interacting species across heterogeneous landscapes (for example, Holt and Huxel 2007)
- Much of the research related to trophic cascades is often conducted at a small scale and is of short duration in relation to the inherent biological characteristics of the species, communities, and populations (such as reproduction, immigration, generational turnover, or developing ecologically meaningful changes in abundance), and on species that are small, sessile, or localized and easily manipulated (adding or removing individual predator species or guilds), such as invertebrates, arthropods, localized fish populations, and plankton, and are typically in high productivity systems such as streams, lakes, and marine intertidal ecosystems (for example, Duffy 2003, Schmitz et al. 2004, Ray et al. 2005, Briggs and Borer 2005, Beschta and Ripple 2006, Brashares et al. 2010, Estes et al. 2011, Ritchie et al. 2012)
- Research conducted in small temporal and/or geographic scales is difficult or inappropriate to scale up or apply generally to large marine or terrestrial systems, especially for guilds involving wide-ranging, often socially complex predators (for example, bluefin tuna (*Thunnus thunnus*), sharks, wolves,

dingoes, or coyotes) (for example, Schmitz et al. 2004, Ripple and Beschta 2006, Brashares et al. 2010, Engeman et al. 2017)

- Research in various systems is being published so rapidly in the last 20 years that it is difficult for researchers to be aware, let alone familiar with, that level of new research results ("information avalanche"), especially if the research is conducted on systems outside of their own disciplinary area (Sergio et al. 2014)
- Statistical analyses, assumptions, and interpretations of results are often appropriately re-evaluated and challenged by other researchers, yet the original papers are cited by other researchers without recognizing these challenges (for example, Ripple and Beschta 2006, Ripple and Beschta 2007, Kauffman et al. 2010, Painter et al. 2015, Litvaitis and Villafuerte 1996, Palomares et al. 1996, Hooper et al. 2005, Balvanera et al. 2006, Wielgus and Peebles 2014, Poudyal et al. 2016)
- The role of outbreaks of parasites and pathogens in ecosystem function is often ignored, although they may be strong mediators of trophic competition and, in some systems, keystone species for driving ecological structure and/or function through acting as a small biomass predator on other larger predatory species within the food web (for example, canine parvovirus in wolves on Isle Royale) (for example, Ray et al. 2005)
- Several studies identify that predator population must reach a certain threshold level at which they become ecologically effective at creating trophic and ecosystem changes, but no one is attempting to determine the threshold level and its effect on humans and livestock (Ray et al. 2005, Letnic et al. 2011, Estes et al. 2011, Ripple et al. 2013)
- Researchers even disagree on the appropriate definitions of and factors involved in ecological functions, trophic cascades, and intraguild predation causing miscommunication among researchers, sampling of inappropriate factors, and misinterpretation of and challenges to cited correlations (Ray et al. 2005, Ripple et al. 2016)
- Poor population sampling to reflect true presence/absence and abundance, resulting in misinterpretations of results, and differences in sampling protocols among studies, making comparisons difficult (for example, Vance-Chalcraft et al. 2007, Wallach et al. 2009a, Allen et al. 2014)
- Publication bias, where only positive results are published, may result in important information being withheld that could provide insight into the findings of other studies (Polis et al. 2000, Brashares et al. 2010)
- Not considering adaptive behavior for predator avoidance (for example, changing circadian patterns of activity or habitats used or climbing trees) or increasing predator efficiencies (for example, scavenging), and morphological and biological traits (such as toxic chemicals used by brightly

patterned skunks) (for example, Schmitz et al. 2004, Peckarsky et al. 2008, Berger-Tal et al. 2011)

- Many papers repeatedly use the same few examples of trophic cascades, such as studies conducted in Yellowstone NP, Isle Royale, orca-otters-urchins-kelp (for example, Ray et al. 2005, Peckarsky et al. 2008, Estes et al, 2011, Allen et al. 2014, Allen et al. 2017)
- Confusing the roles of, failing to consider, or making inappropriate interpretations of immigration and emigration to account for changes in consumer, competitor or prey abundance; the levels and rates of immigration is very difficult to measure (for example, Duffy 2003, Ray et al. 2005, Briggs and Borer 2005)
- Few studies have attempted to evaluate or quantify the short term and long terms costs of loss of apex predators and mesopredator release (Brashares et al. 2010)
- Confusing and misinterpreting the trophic level and functions that a particular predator plays in a specific food web that may poorly reflect on actual roles in nature (Polis et al. 1989, Ray et al. 2005, Ripple et al. 2016)
- The differences in studying large carnivore-driven system structure and function in relatively unchanging and protected areas in which they were previously extirpated and rapidly reintroduced for management purposes (for example, wolves in Yellowstone National Park), areas in which large carnivores gradually immigrated that are dynamic and largely impacted by humans (for example, wolves in Wisconsin and Minnesota immigrating into areas with high levels of habitat fragmentation and human and livestock densities), urban areas with high levels of human-provided subsidies and habitats, human persecution, intense levels of habitat fragmentation, and/or high levels of subsidized carnivorous pets exist, and neotropical islands (e.g., Ripple and Beschta 2007, Berger et al. 2008, Beschta and Ripple 2012, Fischer et al. 2012, Newsome et al. 2015)
- The repeated citation of a few studies as examples throughout the literature, some of which have been challenged regarding validity of interpretations of results or factors considered (Peckarsky et al. 2008, Prugh et al. 2009, Allen et al. 2017)
- Consideration of whether ecological change to system structure and function occur in a smooth dynamic way or reach thresholds at which major, and possibly irreversible, shifts and perturbations occur (for example Ray et al. 2005, Estes et al. 2011, Ripple et al. 2016).

What Relevant Commonly Cited Articles Are Not Included in Summary Because of Study Discrepancies?

Several commonly cited papers in support of the occurrence of trophic cascades in terrestrial systems have serious discrepancies that create problems with the use of their results.

- **Clark (1972):** This early study collected field data on coyote densities, food habits, fecundity, and population growth in relation to prey densities. Documented limitations of the study included inconsistent time spent looking for dens between year, and small sample sizes for the size of the breeding female cohort and litter sizes. Despite these methodology weaknesses, this paper is often cited for its conclusion that long term coyote densities in the Great Basin of Utah appeared to be partly a function of food base, in this case jackrabbits. The study suggests that coyotes did not control jackrabbit populations.
- **Henke and Bryant (1999):** This study conducted in Texas involved heavy removal of coyotes with between 26 and 55 coyotes removed every third month between 1990 and 1992, reducing coyote density from approximately 0.12 coyotes/km^2 to 0.001 coyotes/km^2 (coyote density on untreated control area was 0.14 coyotes/km^2). In addition to such heavy and chronic removals, the authors suggest caution should be used in interpreting the results reported of a substantial decrease in rodent prey richness within nine months of coyote removals. A drought occurred in 1989 through 1990, which decreased forage and may have facilitated dominance of the highly competitive Ord's kangaroo rat over other species present before treatment began. Also, the authors state that logistical and financial constraints limited the number of replications performed, resulting in a low statistical power associated with the results. However, they state that the "weight of evidence" suggested that coyotes exerted top-down influence on the prey community with only weak empirical evidence. The authors also stated that, to consistently lower coyote densities, an annual removal rate of at least 75% is needed.
- **Mezquida et al. (2006):** This paper discusses a potential negative effect of coyote control on greater sage grouse conservation through release of mesopredators (foxes, badgers, and common ravens) that prey on greater sage-grouse and eggs, depending heavily on Henke and Bryant (1999) and an internal unpublished report prepared by the wildlife biologist at a large private ranch in Utah (Danvir 2000). Rather than coyote predation being either directly or indirectly involved in adversely or positively affecting greater sage-grouse, Danvir (2000) actually places the primary concern with heavy jackrabbit browsing in sagebrush habitat. Golden eagles, another predator of greater sage-grouse, and coyote abundance seemingly increased in response to variability of jackrabbits and ground squirrels. His final conclusion is that he did not consider predator-prey interactions to be the cause of the increase in greater sage-grouse, instead emphasizing the habitat

manipulations that had been performed on the ranch to benefit greater sage-grouse was the primary factor. Danvir (2000) suggests that weather drives greater sage-grouse population dynamics relating to vulnerability to predators, especially in winters with deep snow and during spring nesting season, and that the way sagebrush steppe ecosystems are managed related to the quality of greater sage-grouse habitat can magnify or reduce the effects of severe droughts, severe winters, and predation.

- **Atwood and Gese (2008):** In Yellowstone NP after wolf reintroduction, socially dominant coyotes (alpha and beta) responded to wolf presence by increasing the proportion of time spent vigilant while scavenging, with alphas more diligent than betas. Alphas fed first on carcasses, then betas, then others. Increased vigilance, reduced foraging time, changes in group size and configuration, pre-emptive aggression, and retreat to refugia are crucial behaviors to mediating interspecific interactions. Coyotes would aggressively confront wolves, with numerical advantage by coyotes and the stage of carcass consumption influencing whether coyotes were able to displace wolves. In confrontation bouts that coyotes won, both alpha coyotes were present, there were more coyotes than wolves, and wolves were not very invested in winning. These observations are on one wolf pack and should not be generalized to coyote-wolf interactions at a broader scale without further study.
- **Miller et al. (2012):** This paper suggested that coyotes avoided a wolf den, and that coyote predation on rodents away from the wolf den indicated a top-down effect by wolves on coyotes and subsequently on rodents, claiming that restoration of wolves could be a powerful tool for regulating predation at lower trophic levels. The authors argue that making comparisons over time as wolf numbers increase, especially when coupled with spatial comparisons in the study area, can provide evidence that the changes are due to the treatment, and not another confounding factor. These conclusions are based on studying coyote interactions with one wolf den in Grand Teton NP, which is not a sufficient sample size for making conclusions with any correlational strength.
- **Allen et al. (2014):** In Australia, 3 particular published case studies are commonly cited in support of the mesopredator release theory. Problems exist in each study, including use of circumstantial evidence for MPR of introduced red fox or feral cat coinciding with dingo control. The authors conclude that an absence of reliable evidence that top predator control induced MPR. In the last 10 years, 22 literature reviews and extended opinion pieces were published. Only 3 of the 22 discussed caveats or methodological limitations of these three case studies, while other call them anecdotal or circumstantial. Pettigrew (1993) concluded that shooting dingoes increased abundance of feral cats. Abundance sampling was imprecise (800 cats removed from trees, but only 229 observed in sampling surveys), and large bursts of cat abundance occurred in years following

rainfall-induced increases in prey availability. Cats shot were prime adults, indicating a large-scale immigration of nonresident cats rather than increased rapid reproduction. Lundie-Jenkins et al. (1993) stated that dingo control resulted in fox detection and extinction of a protected species after dingo control. The study was small scale and the experimental design insufficient for inferring changes in predator population abundance. To suggest that lethal dingo control caused a MPR of foxes from a single opportunistic observation of fox tracks is to extend inferences far beyond the limitations of the data. To infer from the data that dingo control caused the local extinction of the protected species does not recognize the persistence of a nearby colony that did not go extinct in response to baiting but was destroyed by wildfire. Christensen and Burrows (1995) stated that dingo and fox poisoning resulting in an increase in feral cat abundance. The experimental design (imprecise sampling of predator populations) precludes reliable inference because increases in cat abundance coincided with the beginning of 1080 baiting (which does not target cats) after cessation of cyanide baiting (which targets cats, dingoes, and foxes), substantial rainfall events increasing prey densities, and a change in the physical location of the unbaited treatment area, all confounding the results. The three case studies provide no reliable evidence of MPR because of little reliable evidence that dingo populations were affected by the control to any substantial degree, limitations to the experimental designs and predator sampling methods meant that the studies were incapable of reliably evaluating predator responses to dingo control, and MPR remains only one of several plausible explanations for the observations. Although broad patterns among top predator, mesopredators, and their prey have been demonstrated in some contexts and there are good reasons to suspect that these processes also occur for dingoes, MPR cannot be reliably separated from other equally plausible alternative explanations for the suggested interrelationships among dingoes, foxes, and cats. The authors advocate for evidence-based wildlife management approaches that do not unduly risk valuable environmental and economic resources, such as threatened species and livestock.

Literature Cited

ABS (Austrailian Bureau of Statistics). 2013. Statistical language- Correlation and causation. http://www.abs.gov.au/websitedbs/a3121120.nsf/home/statistical+language+-+correlation+and+causation.

Allen, B.L., G. Lundie-Jenkins, N.D. Burrows, R.M. Engeman, and P.J.S. Fleming. 2014. Does lethal control of top-predators release mesopredators? A re-evaluation of three Australian Case Studies. University of Nebraska-Lincoln http://digitalcommons.unl.edu/icwdm_usdanwrc/1438

Arim, M. and P.A. Marquet. 2004. Intraguild predation: A widespread interaction related to species biology. Ecology Letters 7:557-564.

Arjo, W. M., D. H. Pletscher, and R. R. Ream. 2002. Dietary overlap between wolves and coyotes in northwestern Montana. Journal of Mammalogy 83:754–766.

Atwood, T.C., E.M. Gese, and K.E. Kunkel. 2007. Comparative patterns of predation by cougars and recolonizing wolves in Montana's Madison Range. Journal of Wildlife Management 71:1098–1106.

Atwood, T.C. and E. Gese. 2008. Coyotes and recolonizing wolves: Social rank mediates risk-conditional behavior at ungulate carcasses. Animal Behavior 75:75762.

Ballard, W. B., L. A. Ayres, P. R. Krausman, D. J. Reed, and S. G. Fancy. 1997. Ecology of wolves in relation to a migratory caribou herd in northwest Alaska. Wildlife Monographs 135. 47 pp.

Balvanera, P., A.B. Pfisterer, N. Buchmann, J. He, T. Nakashizuka, D. Raffaelli, and B. Schmid. 2006. Quantifying the evidence for biodiversity effects on ecosystem functioning and services. Ecology Letters http://onlinelibrary.wiley.com/doi/10.1111/j.1461-0248.2006.00963.x/full

Benson, J.F., K.M. Loveless, L.Y. Rutledge, and B.R. Patterson. 2017. Ungulate predation and ecological roles of wolves and coyotes in eastern North America. Ecological Applications 27:718-733.

Berger, K.M., and E.M. Gese. 2007. Does interference competition with wolves limit the distribution and abundance of coyotes? Journal of Animal Ecology, 76:1075-1085.

Berger, K.M. E.M. Gese, and J. Berger. 2008. Indirect effects and traditional trophic cascades: A test involving wolves, coyotes, and pronghorn. Ecology 89:818-828.

Berger-Tal, O., T. Polak, A. Oron, Y. Lubin, B.P. Kotler, and D. Saltz. 2011. Integrating animal behavior and conservation biology: A conceptual framework. Behavioral Ecology 22:236-239.

Bergstrom, D.M., A. Lucieer, K. Kiefer, J. Wasley, L. Belbin, T.K. Pedersen, and S.L. Chown. 2009. Indirect effects of invasive species removal devastate World Heritage island. 2009. Journal of Applied Ecology 46:73-81.

Beschta, R.L. and W.J. Ripple. 2012. The role of large predators in maintaining riparian plant communities and river morphology. Geomorphology 157-158:88-98.

Bino, G., A. Dolev, D. Yosha, A. Guter, R. King, D. Saltz, and S. Kark. 2010. Abrupt spatial and numerical responses of overabundant foxes to a reduction in anthropogenic resources. Journal of Applied Ecology 47:1262-1271.

Blejwas, K.M., B.N. Sacks, M.M. Jaeger, and D.R. McCullogh. 2002. The effectiveness of selective removal of breeding coyotes in reducing sheep predation. Journal of Wildlife Management 66:451-462.

Boertje, R.D. and R.O. Stephenson. 1992. Effects of ungulate availability on wolf reproduction potential in Alaska. Canadian Journal of Zoology 70:2441-2443.

Borer, E.T. E.W. Seabloom, J.B. Shurin, K.E. Anderson, C.A. Blanchette, B. Broitman, S.D. Cooper, and B.S. Halpern. 2005. What determines the strength of a trophic cascade? Ecology 86:528-537.

Brainerd, S.M., H. Andren, E.E. Bangs, E.H. Bradley, J.A. Fontaine, W. Hall, Y. Iliopoulos, M.D. Jimenez, E.A. Jozwiak, O. Liberg, C.M. Mack, T.J. Meier, C.C. Niemeyer, H.C. Pedersen, H. Sand, R.N. Schultz, D.W. Smith, P. Wabakken, and A.P. Wydeven. 2008. The effects of breeder loss on wolves. Journal of Wildlife Management 72:89-98.

Brashares, J.S., L.R. Prugh, C.J. Stoner, and C.W. Epps. 2010. Ecological and Conservation Implications of mesopredator release. In: Terborgh, J., and J.A. Estes, Eds. Trophic Cascades: Predators, Prey, and the Changing Dynamics of Nature. Island Press. P. 221-240.

Briggs, C.J. and E.T. Borer. 2005. Why short-term experiments may not allow long-term predictions about intraguild predation. 15:1111-1117. DOI: 10.1111/j.1365-2664.2012.02207.x

Brook, L.A., C.N. Johnson, and E.G. Ritchie. 2012. Effects of predator control on behavior of an apex predator and indirect consequences of mesopredator suppression. Journal of Applied Ecology 49:1278-1286.

Brooks, J.L., and S.I. Dodson. 1965. Predation, body size, and composition of plankton. Science 150(3692): 28-35.

Brown, D.E. and M.R. Conover. 2011. Effects of large-scale removal of coyotes on pronghorn and mule deer productivity and abundance. Journal of Wildlife Management 75:876-882.

Bulte, E.H. and D. Rondeau. 2005. Research and management viewpoint: Why compensating wildliife damages may be bad for conservation. Journal of Wildlife Manaagement 75:14-19.

Callan, R, N.P. Nibbelink, T,P, Rooney, J.E. Weidenhoeft, and A.P, Wydeven. 2013. Recolonizing wolves trigger a trophic cascade in Wisconsin (USA). Journal of Ecology 101:837-845.

Casanovas, J.G., J. Barrull, I. Mate, J.M. Zorrilla, J.Ruiz-Olmo, J. Gosàlbez, and M. Salicrú. 2012. Shaping carnivore communities by predator control: Competitor release revisited. Ecological Research. 27:603-614. DOI 10.1007/s11284-012-0931-y.

Casula, P., A. Wilby, and M.B. Thomas. 2006. Understanding biodiversity effects on prey in multi-enemy systems. Ecology Letters 9:995-1004. doi: 10.1111/j.1461-0248.2006.00945.x

Christensen, P., and N. Burrows. 1995. Project desert dreaming: experimental reintrodution (sic) of mammals to the Gibson desert, western Australia. Reintroduction Biology of Australian and New Zealand Fauna (M. Serena Ed.) Ch 32: 199-207. Surrey Beatty and Sons. Sydney, Australia.

Clark, F.W. 1972. Influence of jackrabbit density on coyote population change. Journal of Wildlife Management 36:343-356.

Cleland, E. 2011. Biodiversity and ecosystem stability. Nature Education Knowledge 3:14. http://www.nature.com/scitable/knowledge/library/biodiversity-and-ecosystem-stability-17059965.

Connolly, G. E., and W. M. Longhurst. 1975. The effects of control on coyote populations. University of California, Division of Agricultural Science, Davis, California, USA.

Coté, I.M. and W.J. Sutherland. 1997. The effectiveness of removing predators to protect bird populations. Conservation Biology 11:395-405.

Courchamp, M.F., M. Langlais, and G. Sugihara, G. 1999. Cats protecting birds: modeling the mesopredator release effect. Journal of Animal Ecology. 68:282–292.

Creel, S., and J. A. Winnie. 2005. Responses of elk herd size to fine-scale spatial and temporal variation in the risk of predation by wolves. Animal Behavior 69:1181-1189.

Crooks, K.R., and M.E. Soulé. 1999. Mesopredator release and avifaunal extinctions in a fragmented system. Nature 400:563-566.

Danvir, R.E. 2002. Sage Grouse Ecology and Management in Northern Utah Sagebrush-Steppe. Deseret Land and Livestock Wildlife Research Report. 40 pp.

Darwin, C. 1859. On the origin of species by means of natural selection; or, the preservation of favoured races in the truggle for life. John Murray 6th Ed. 277 Pps. London, UK.

Daugherty, M.P., J.P. Harmon, and C.P. Briggs. 2007. Trophic supplements to intraguild predation. Ecological Applications 15:1111-1117.

Dobson, A., Lodge, D., Alder, J., Cumming, G.S., Keymer, J., McGlade, J. 2006. Habitat loss, trophic collapse, and the decline of ecosystem services. Ecology, 87, 1915–1924.

Duffy, J.E. 2003. Biodiversity loss, trophic skew, and ecosystem functioning. Ecology Letters 6:680-687.

Duffy, E., B.J. Cardinale, K.E. France, P.B. McIntyre, E. Thébault, and M. Loreau. 2007. The functional role of biodiversity in ecosystems: Incorporating trophic complexity. Ecology Letters 10:522-538.

Elbroch, L.M., P.E. Lendrum, J. Newby, H. Quigley, D.J. Thompson. 2015. Recolonizing wolves influence the realized niche of resident cougars. Zoological Studies 54:41-52.

Elmhagen, B., G. Ludwig, S.P. Rushton, P. Helle, and H. Linden. 2010. Top predators, mesopredators and their prey: Interference ecosystems along bioclimatic productivity gradients. Journal of Animal Ecology 79:785-794.

Estes, J. A., M. T. Tinker, and Palmisano. 1974. Sea Otters: Their role in structuring nearshore communities. Science 185:1058-1060.

Estes, J. A., M. T. Tinker, and D. F. Doak. 1998. Killer whale predation on sea otters linking oceanic and nearshore ecosystems. Science 282:473-475.

Estes, J.A., J. Terborgh, J.S. Brashares, M.E. Power, J. Berger, W.J. Bond, S.R. Carpenter, T.E. Essington, R.D. Holt, J.B.C. Jackson, R.J. Marquis, L. Oksanen, T. Oksanen, R.T Paine, E.K. Pikitch, W.J. Ripple, S.A. Sandin, M. Scheffer, T.W. Schoener, HB. Shurin, A.R.E. Sinclair, ME, Soulé, R. Virtanen, and D.A. Wardle. 2011. Trophic downgrading of planet earth. Science 3333:301-306.

Fedriani, J.M., T.K. Fuller, and R.M. Sauvajot. 2001. Does availability of anthropogenic food enhance densities of omnivorous mammals? An example with coyotes in southern California. Ecography 24:325-331.

Feldman, J.W. 2007. Public opinion, the Leopold Report, and the reform of federal predator control policy. Human-Wildl Conflicts, 1:112-124.

Finke, D.L. and R.F. Denno. 2005. Predator diversity and the functioning of ecosystems: The role of intraguild predation in dampening trophic cascades. 2005. Ecology Letters 8:1299-1306.

Fischer, J.D., S.H. Cleetin, T.P. Lyons, and J.R. Miller. 2012. Urbanization and the predation paradox: The role of trophic dynamics in structuring vertebrate communities. BioScience 62:809-818.

France, K.E. & Duffy, J.E. 2006. Diversity and dispersal interactively affect predictability of ecosystem function. Nature 441:1139–1143.

Fuller, T.K., D.L. Mech, and J.F. Cochrane. 2003. Wolf population dynamics. In: Mech, D.L., and L. Boitaini, Eds. Wolves: Behavior, Ecology, and Conservation. University of Chicago Free Press. Pp. 161-191.

Gehrt, S.D., C. Anchor, and L.A. White. 2009. Home range and landscape use of coyotes in a metropolitan landscape: conflict or coexistence. Journal of Mammalogy 90:1045-1057.

Gehrt, S.D. and S. Prange. 2006. Interference competition between coyotes and raccoons: A test of the mesopredator release hypothesis. Behavioral Ecology 18:204-214.

Gese, E.M. 1998. Response of neighboring coyote (*Canis latrans*) to social disruption in an adjacent pack. Canadian Journal of Zoology 76:1960-1963.

Gese, E. M. 1999. Threat of predation: Do ungulates behave aggressively towards different members of a coyote pack? Canadian Journal of Zoology 77:499-503.

Gese, E.M. 2005. Demographic and spatial responses of coyotes to changes in food and exploitation. Proc. 11th Wildlife Damage Management Conference, D.L. Nolte, K.A. Fagerstone, Eds.

Gese, E. M., R. L. Ruff, and R. L. Crabtree. 1996a. Social and nutritional factors influencing the dispersal of resident coyotes. Animal Behaviour 52:1025-1043.

Gese, E. M., R. L. Ruff, and R. L. Crabtree. 1996b. Foraging ecology of coyotes (*Canis latrans*): The influence of extrinsic factors and a dominance hierarchy. Canadian Journal of Zoology 74:769-783.

Gese E.M. and P.A. Terletzky. 2009. Estimating coyote numbers across Wyoming: A geospatian and demographic approach. Final report to Wyoming Department of Agriculture Animal Damage Management Board, Utah State University.

Goodrich, J.M. and S.W. Buskirk. 1995. Control of abundant native vertebrates for conservation of endangered species. Conservation Biology 9:1357-1364.

Halaj, J., and D. H. Wise. 2001. Terrestrial trophic cascades: how much do they trickle? American Naturalist 157:262– 281.

Harper, E., W. J. Paul, L. D. Mech, and S. Weisberg. 2008. Effectiveness of lethal, directed wolf-depredation control. Journal of Wildlife Management 72:778-784.

Haswell, P.M., J. Kusak, and M.W. Hayward. 2017. Large carnivore impacts are context-dependent. Food Webs 12:3-13.

Hebblewhite, M., and D.H. Pletscher. 2002. Effects of elk group size on predation by wolves. Canadian Journal of Zoology 80:800-809.

Hebblewhite, M., C. A. White, C. G. Nietvelt, J. A. McKenzie, T. E. Hurd, J. M. Fryxell, S. E. Bayley, and P. C. Paquet. 2005. Human activity mediates a trophic cascade caused by wolves. Ecology 86:2135–2144.

Henke, S.E. and F.C. Bryant. 1999. Effects of coyote removal on the faunal community in western Texas. Journal of Wildlife Management 63:1066-1081.

Holt, R.S. and G.R. Huxel. 2007. Alternative prey and the dynamics of intraguild predation: Theoretical perspectives. Ecology 88:2706-2712.

Hooper, D.U., F.S. Chapin III, J.J. Ewel, A. Hector, P. Inchausti, S. Lavorel, J.H. Lawton, D.M. Lodge, M. Loreau, S. Naeem, B. Schmid, H. Setala, A.J. Symstad, J. Vandermeer, and D.A. Wardle. 2005. Effects of biodiversity on ecosystem functioning: A consensus of current knowledge and needs for future research. Ecological Monographs 75:3-35. http://onlinelibrary.wiley.com/doi/10.1890/04-0922/full.

Hrbáček, J., and M. Straškraba. 1966. Horizontal and vertical distribution of temperature, oxygen, pH and water movements in Slapy Reservoir (1958-1960). Pages 7-40. Hydrobiological Studies 1. Academia Publishing House of the Czechoslovak Academy of Sciences. Prague, Czechoslovakia.

Hunter, J. and T. Caro. 2008. Interspecific competition and predation in American carnivore families. Ethology Ecology and Evolution 20:295–324.

Ives, A.R., B.J. Cardinale, and W.E. Snyder. 2005. A synthesis of subdisciplines: Predator–prey interactions, and biodiversity and ecosystem functioning. Ecological Letters 8:102–116.

Jaeger. M.M. 2004. Selective targeting of alpha coyotes to stop sheep depredation. Sheep and Goat Research Journal 19:80-84.

Kamler, J.F., W.B. Ballard, R.R. Gilliland, P.R. Lemons, and K. Mote. 2003. Impacts of coyotes on swift foxes in northwestern Texas. Journal of Wildlife Management 67:317-323.

Kauffman, M. J., J. F. Brodie, and E. S. Jules. 2010. Are wolves saving Yellowstone's aspen? A landscape-level test of a behaviorally mediated trophic cascade. Ecol. 91: 2742–2755.

Kitchen, A.M., Gese, E.M. and Schauster, E.R. 2000. Changes in coyote activity patterns due to reduced exposure to human persecution. Canadian Journal of Zoology, 78, 853–857.

Knowlton, F.F., E.M. Gese, and M.M. Jaeger. 1999. Coyote depredation control: An interface between biology and management. Journal of Range Management 52:398-412.

Kozlowski, A.J. E.M. Gese, and W.M. Arjo. 2008. Niche overlap and resource partitioning between sympatric kit foxes and coyotes in the Great Basin Desert of Western Utah. American Midland Naturalist 160:191-208.

Kremen, C. 2005. Managing ecosystem services: What do we need to know about their ecology? Ecological Letters, 8:468–479.

Lendrum, P.E., L.M. Elbroch, H. Quigley, M. Jimenez, and D. Craighead. 2014. Home range characteristics of a subordinate predator: Section for refugia or prey availability? Journal of Zoology 294:58-66.

Letnic, M., A. Greenville, E. Denny, C.R. Dickman, M. Tischler, C. Gordon, and F. Koch. 2011. Does a top predator suppress the abundance of an invasive mesopredator at a continental scale? Global Ecology and Biogeography 20:343-353.

Levi, T. and C.C. Wilmers, 2012. Wolves-coyote-foxes: A cascade among carnivores. Ecology 93:921-929.

Lindzey, F., 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.

Linnell, J.D.C., Odden, J., Smith, M.E., Aanes, R. and Swenson, J.E. 1999. Large carnivores that kill livestock: Do "problem individuals" really exist? Wildlife Society Bulletin 27:698-705.

Litvaitis, J.A. and R. Villafuerte. 1996. Intraguild predation, mesopredator, and prey stability. Conservation Biology 10:676-677.

Loreau, M., S. Naeem, P. Inchausti, J. Bengtsson, J.P. Grime, and A. Hector. 2001. Ecology–biodiversity and ecosystem functioning: Current knowledge and future challenges. Science, 294:804–808.

Lundie-Jenkins, G., Corbett, L.K. and Phillips, C.M. (1993). Ecology of the rufous hare -wallaby, Lagorchestes hirsutus Gould (Marsupialia : Macropodidae) in the Tanami Desert, N.T .. III. Interactions with introduced Mammal Species. Wildlife Research 20, 495-511

Lute, M.L. and S.Z. Attari. 2016. Public preferences for species conservation: Choosing between lethal control, habitat protection and no action. Environmental Conservation doi:10.1017/S037689291600045X.

Mack, C., J. Rachael, J. Holyan, J. Husseman, M. Lucid and B. Thomas. 2010. Wolf conservation and management in Idaho: Progress Report 2009. Nez Perce Tribe Wolf Recovery Project; Idaho Department of Fish and Game. Boise, Idaho, USA.

Marshall, K.N., N. T. Hobbs, and D.J. Cooper. 2013. Stream hydrology limits recovery of riparian ecosystems after wolf reintroduction. Proc. The Royal Society B Vol. 280. DOI: 10.1098/rspb.2012.2977. http://rspb.royalsocietypublishing.org/content/280/1756/20122977.

McShane, T.O., P.D. Hirsch, T.C. Trung, A.N. Songorwa, A. Kinzig, B. Monteferri, D. Mutekanga, H.A. Thang, J.L. Dammert, M. Pulgar-Vidal, M. Welch-Devine, J. P. Brosius, P. Coppolillo, and S. O'Connor. 2011. Hard choices: Making Trade-offs between biodiversity conservation and human well-being. Biological Conservation 144:966-972.

Mech, L.D. and L. Boitani. 2003. Wolf Social Ecology. In: Mech, L.D. and L. Boitani, Eds. Wolves: Behavior, Ecology, and Conservation. University of Chicago Free Press.

Mezquida, E.T., S.J. Slater, and C.W. Benkman. 2006. Sage-Grouse and indirect interactions: Potential implications of coyote control on sage-grouse populations. Condor 108:747- 759.

Miller, B.J., H.J. Harlow, T.S. Harlow, D. Biggins and W.J. Ripple. 2012. Trophic cascades linking wolves (*Canis lupus),* coyotes (*Canis latrans*) and small mammals. Canadian Journal of Zoology 90:70-78.

Mitchell, B.R., M.M. Jaeger, and R.H. Barrett. 2004. Coyote depredation management: Current methods and research needs. Wildlife Society Bulletin 32:1209-1218.

Moehrenschlager, A., R. List, and D. W. Macdonald. 2007. Escaping intraguild predation: Mexican kit foxes survive while coyotes and golden eagles kill Canadian swift foxes. Journal of Mammalogy 88:1029–1039.

Mosnier, A., D. Boisioly, R. Courtois, and J. Ouellet, 2008. Extensive predator space use can limit the efficacy of a control program. Journal of Wildlife Management 72:483-491.

Nadeau, M.S., C. Mack, J. Holyan, J. Husseman, M. Lucid, D. Spicer, and B. Thomas. 2008. Wolf conservation and management in Idaho. Progress Report 2007. Idaho Department of Fish and Game, Nez Perce Tribe, Lapwai, Idaho.

_____. 2009. Wolf conservation and management in Idaho. Progress Report 2008. Idaho Department of Fish and Game, Nez Perce Tribe, Lapwai, Idaho.

Newsome, T.M., J.A. Dellinger, C.R. Pavey, W.J. Ripple, C.R. Shores, A.J. Wirsing, and C.R. Dickman. 2015. The ecological effects of providing resources subsidies to predators. Global Ecology and Biogeography 24:1-11. doi: 10.1111/geb.12236 (http://wileyonlinelibrary.com/journal/geb)

Newsome, T.M., A.C. Greenville, D. Ćirović, C.R. Dickman, C.N. Johnson, M. Krofel, M. Letnic, W.J. Ripple, E.G. Ritchie, S. Stoyanov, and A.J. Wirsing. 2017. Top predators constrain mesopredator distributions. Nature Communications. Volume 23, Issue 8.

Orrock, J.L., L.M. Dill, A. Sih, J.H. Grabowski, S.D. Peacor, B.L. Peckarsky, E.L. Preisser, J.R. Vonesh, and E.E. Werner. 2010. Predator effects in predator-free space: The remote effects of predators on prey. The Open Ecology Journal 3:22-30.

Pace, M.L., Cole, J.J., Carpenter, S.R., Kitchell, J.F., 1999. Trophic cascades revealed in diverse ecosystems. Trends in Ecology and Evolution 14, 483–488.

Painter, L.E., R.L. Beschta, E.J. Larsen, and W.J. Ripple. 2015. Recovering aspen follow changing elk dynamics in Yellowstone: Evidence of a trophic cascade? Ecology 96:252-263.

Palomares, F., P. Goana, P. Ferreras, and M. Delibes. 1995. Positive effects on game species of top predators by controlling smaller predator populations: An example with lynx, mongooses, and rabbits. Conservation Biology 9:295-305.

Palomeres, F., M. Delibes, P. Ferreras, and Pilar Gaona. 1996. Mesopredator release and prey abundance: Reply to Litvaitis and Villafuerte. Conservation Biology 10:678-679.

Paquet, P.C. 1992. Prey use strategies of sympatric wolves and coyotes in Riding Mountain National Park, Manitoba. Journal Mammalogy 73: 337-343.

Peckarsky, B.A. P.a. Abrams, D.I. Bolnick, L.M. Dill, J.H. Grabowski, B. Luttbeg, J.L. Orrock, S.D. Peacor, E.L. Preisser, O.J. Schmitz, and G.C. Turssell. 2008. Revisiting the classics: Considering nonconsumptive effects in textbook examples of predator-prey interactions. Ecology 89:2416-2425.

Peterson, R.O., J.D. Woolington, and T.N. Bailey. 1984. Wolves of the Kenai Peninsula, Alaska. Wildlife Monographs 88.

Pettigrew, J.D. 1993. A burst of feral cats in the Diamantina-A lesson for the management of pest species? Cat Management Workshop:24-33.

Polis, G.A., C.A. Myers, and R.D. Holt. 1989. The ecology and evolution of intraguild predation: Potential competitors that eat each other. Annual Review of Ecological Systematics, 20:297–330.

Polis, G. A., A. L. Sears, G. R. Huxel, D. R. Strong, and J. Maron. 2000. When is a trophic cascade a trophic cascade? Trends in Ecology and Evolution 15:473–475.

Poudyal, N., N. Baral, and S.T. Asah. 2016. Wolf lethal control and livestock depredations: Counter-evidence from specified models. PLoSOne 11(2):e0148743 doi:10.1371/journal.pone.0148743.

Prugh, L.R., C.J. Stoner, C.W. Epps, W.T. Bean, W. J. Ripple, A.S. Laliberte, and J.S. Brashares. 2009. The rise of the mesopredator. Bioscience, 59:779-791.

Ray, J.C., K.H. Redford, J. Berger, and R. Steneck. 2005. Conclusion: Is large carnivore conservation equivalent to biodiversity conservation and how can we achieve both? In: Large Carnivores and the Conservation of Biodiversity, Ray, J.C., K.H. Redford, J. Berger, and R. Steneck, Eds. Island Press, Washington. Pp. 400-426.

Ripple, W.J. and R.L. Beschta. 2006. Linking a cougar decline, trophic cascade and catastrophic regime shift in Zion National Park. Biological Conservation 133:297-408.

_____. 2007. Restoring Yellowstone's aspen with wolves. Biological Conservation 138:514-519.

_____. 2012. Trophic cascades in Yellowstone: The first 15 years after wolf reintroduction. Biological Conservation 145:205-213.

Ripple, W.J., A.J. Wirsing, C.C. Wilmers, and M. Letnic. 2013. Widespread mesopredator effects after wolf extirpation. Biological Conservation 160:70-79.

Ripple, W.J., A.J. Wirsing, R.L. Beschta, and S.W. Buskirk. 2011. Can restoring wolves aid in lynx recovery? Wildlife Society Bulletin 35:514-518.

Ripple, W.J., J.A. Estes, O.J. Schmitz, V. Constant, M.J. Kaylor, A. Lenz, J.L. Motley, K.E. Self, D.S. Taylor, and C. Wolf. 2016. What is a trophic cascade? Trends in Ecology and Evolution 31:842-849.

Ripple, W.J., L.A. Estes, R.L. Beschta, C.C. Wilmers, E.G. Ritchie, M. Hebblewhite, J. Berger, B. Elmhagen, M. Letnic, M.P. Nelson, O.J. Schmitz, D.W. Smith, A.D. Wallach, and A.I. Wirsing. 2014. Status and ecological effects of the world's largest carnivores. Science, 343:151–163.

Ripple, W.J., R.L. Beschta, I.K. Fortin, and C.T. Robbins. 2013. Trophic cascades from wolves to grizzly bears in Yellowstone. Journal of Animal Ecology 83:223-233. Doi: 10.1111/1365-2656.12123

_____. 2015. Wolves trigger a trophic cascade to berries as alternative food for grizzly bears. Journal of Animal Ecology 84:652-654.

Ritchie, E.G. and C.N. Johnson. 2009. Predator interactions, mesopredator release, and biodiversity conservation. Ecology Letters 12 982-998.

Ritchie, E.G., B. Elmhagen, A.S. Glen, M. Letnic, G. Ludwig, and R.A. McDonald. 2012. Ecosystem restoration with teeth: What role for predators? Trends in Ecology and Evolution 27:265-271.

Roemer, G.W., M.E. Gompper, and B. Van Valkenburgh. 2009. The ecological role of the mammalian mesocarnivore. BioScience 59:165-173.

Russell, J.C., V. Lecomte, Y. Dumont, and M. Le Corre. 2009. Intraguild predation and mesopredator release effect on long-lived prey. Ecological Modeling 220: 1098-1104.

Schmitz, O.J., V. Krivan, and O. Ovadia. 2004. Trophic cascades: The primary of trait-mediated indirect interactions. Ecology Letters 7:153-163.

Schwartz, C.C., Swenson, J.E. & Miller, S.D. 2003. Large carnivores, moose and humans: a changing paradigm of predator management in the 21st century. Alces, 39, 41-63.

Sergio, F., C.J. Krebs, R.D. Holt, M.R. Heithaus, A.J. Wirsing, W.J. Ripple, E. Ritchie, D. Ainley, D.Oro, Y. Jhala, F. Hiraldo, and E Korpimaki. 2014. Towards a cohesive, holistic view of top predation: a definition, synthesis and perspective. Oikos Journal 123: 1234-1243. doi: 10.1111/oik.01468.

Shivik, J. A. 2006. Tools for the edge: What's new for conserving carnivores. BioScience 56:253-259.

Shurin, J.B., W.T. Borer, E.W. Seabloom, K. Anderson, C.A. Blanchette, B. Broitman, S.D. Cooper, and S. Halpern. 2002. A cross-ecosystem comparison of the strength of trophic cascades. Ecological Letters 5:785–791.

Silva-Rodrigues, E.A. and K.E. Sieving. 2012. Domestic dogs shape the landscape-scale distribution of a threatened forest ungulate. Biological Conservation 150:103-110.

Squires, J.R., N.J. DeCesare, M. Hebblewhite, and J. Berger. 2012. Missing lynx and trophic cascades in food webs: A reply to Ripple et al. Wildlife Society Bulletin 36:567-571.

Srivasta, D.S. and M. Vellend. 2005. Biodiversity-ecosystem function research: Is it relevant to conservation? Annual Review Ecological Evolution Systems 36:267-294.

Stenseth, N.C., Hannson, L., Myllymäki, A., Andersson, M. and Katila, J. 1977. General models for the population dynamics of the field vole Microtus agrestis in Central Scandinavia. Oikos 29: 616-642.

Stenseth, N.C., W. Falck, O.N. Bjornstad, and C.J. Krebs. 1997. Population regulation in snowshoe hare and Canadian lynx: Asymmetric food web configurations between hare and lynx. 94:5147-5152.

Stoddart, L.C., Griffiths, R.E. & Knowlton, F.E. 2001. Coyote responses to changing jackrabbit abundance affect sheep predation. Journal of Range Management 54:15-20.

Terbourgh, J., L. Lopez, P. Nuñez, M. Rao, G. Shahabuddin, G. Orihuela, M. Riveros, R. Ascanio, G. H. Adler, T. D. Lambert, and L. Balbas. 2001. Ecological meltdown in predator-free forest fragments. Science 294:1923–1926.

Thompson, C. M., and E. M. Gese. 2007. Food webs and intraguild predation: Community interactions of a native mesocarnivore. Ecology 88:334-346.

Till, J.A. 1992. Behavioral effects of removal of coyote pups from dens. Proc. 15th Vertebrate Pest Conference Paper 80.

Treves, A., L. Naughton-Treves, E.K. Harper, R.A. Rose, T.A., T.A. Sickley, and A.P Wydeven. 2004. Predicting human-carnivore conflict: A spatial model derived from 25 years of data on wolf predation on livestock. Conservation Biology 18:114-125.

Vance-Chalcraft, H.D., J.A. Rosenheim, J.R, Vonesh, C.W. Osenberg, and A. Sih. 2007. The influence of intraguild predation on prey suppression and prey release: A meta-analysis. Ecology 88:2689-2696.

Vitousek, P.M., H.A. Mooney, J. Lubchenco, and J.M. Melillo. 1997. Human domination of Earth's ecosystems. Science, 277:494–499.

Wallach, A.D., Murray, B.R., O'Neill, A.J., 2009a. Can threatened species survive where the top predator is absent? Biological Conservation 142:43–52.

Wallach, A.D., E.G. Ritchie, J. Read, and A.J. O'Neill. 2009b. More than mere numbers: the impact of lethal control on the social stability of a top-order predator. PLoS One 4:1–8.

Wielgus, R.B. and K.A. Peebles. 2014. Effects of wolf mortality on livestock depredations. PLoS ONE 9(12):e113505. Doi:10.1371/journal.pone. 0113505.

Williams, C.L., K.M. Blejwas, J.J. Johnson, and M.M. Jaeger. 2003. Temporal genetic variation in a coyote (*Canis latrans*) population experiencing high turnover. Journal of Mammalogy 84:177-184.

Wilmers, C.C., R.L. Crabtree, D.W. Smith, K.M. Murphy, and W.M. Getz. 2003. Trophic facilitation by introduced top predators: Grey wolf subsidies to scavengers in Yellowstone National Park. Journal of Animal Ecology, Vol. 72: 909.

Wilson, R.R., T.L. Blankenship, M.B. Hooten, and J. Shivik. 2010. Prey-mediated avoidance of an intraguild predator by its intraguild prey. Oecologia 153:921-929.

Appendix G. Wilderness and Wilderness Study Areas in Nevada

Table G-1. Likelihood and Duration of WS-Nevada Working in WAs and WSAs in the Next 10 Years.

Duration of Work Legend		Average % of the year with some level of activity or equipment present:
5	Nearly year-round	81-100%
4	Long	61-80%
3	Medium	41-60%
2	Short	21-40%
1	Extremely Short	0-20%
0	**No Work**	**0%**

Chance of Work Legend		Likelihood that some level of work may occur in the next 10 years based on current or potential requests:	
EH	Extremely High	95 - 100%	Historical depredation - expect it to continue
H	High	66 - 95%	Historical depredation - may not continue
M	Medium	33 - 66%	Historical depredation nearby - may not continue
L	Low	2 - 33%	Historical depredation nearby - expect none
EL	Extremely Low	0 - 2%	No historical depredation - expect none to start
Z	**Will Not Work**	**0%**	**Outside geographic scope of EA**

Property Type	Property Name	Federal Agency	Acres	County	Chance of Work	Duration of Work
WAs[1]	Alta Toquima	FS	35,581	Nye	EL	1
	Arc Dome	FS	120,555	Nye	EL	1
	Arrow Canyon	BLM	27,502	Clark	EL	1
	Bald Mountain	FS	22,374	White Pine	EL	1
	Becky Peak	BLM	18,119	White Pine	EH	3
	Big Rocks	BLM	12,930	Lincoln	EL	1
	Black Canyon	**NPS**	**17,220**	**Clark**	**Z**	**0**
	Black Rock Desert	BLM	314,835	Humboldt	EL	1
				Pershing	EL	1
	Boundary Peak	FS	10,521	Esmeralda	EL	1
	Bridge Canyon	**NPS**	**7,761**	**Clark**	**Z**	**0**

Bristlecone	BLM	14,095	White Pine	EH	5
Calico Mountains	BLM	64,968	Humboldt	EL	1
			Pershing	EL	1
Clover Mountains	BLM	85,668	Lincoln	L	1
Currant Mountain	FS	47,311	Nye	L	1
			White Pine	L	1
Death Valley	**NPS**	**45,350**	**Esmeralda**	**Z**	**0**
			Nye	**Z**	**0**
Delamar Mountains	BLM	111,066	Lincoln	EL	1
East Fork High Rock Canyon	BLM	52,618	Humboldt	EL	1
			Washoe	EL	1
East Humboldts	FS	32,364	Elko	EL	3
Eldorado	BLM	5,766	Clark	EL	1
Eldorado	**NPS**	**26,250**	**Clark**	**Z**	**0**
Far South Egans	BLM	36,299	Lincoln	L	3
			Nye	L	3
Fortification Range	BLM	30,539	Lincoln	L	1
Goshute Canyon	BLM	42,544	White Pine	EH	3
Government Peak	BLM	6,313	White Pine	M	3
Grant Range	FS	52,451	Nye	EH	5
High Rock Canyon	BLM	46,465	Washoe	EL	1
High Rock Lake	BLM	59,107	Humboldt	EL	1
High Schells	FS	121,467	White Pine	EH	3
Highland Ridge	BLM	68,623	White Pine	EH	5
Ireteba Peaks	BLM	10,332	Clark	EL	1
Ireteba Peaks	**NPS**	**29,299**	**Clark**	**Z**	**0**
Jarbidge	FS	110,471	Elko	M	3

	Jimbilnan	**NPS**	**18,879**	**Clark**	**Z**	**0**
	Jumbo Springs	BLM	4,760	Clark	EL	1
	La Madre Mountain	BLM	27,896	Clark	EL	1
	La Madre Mountain	FS	19,047	Clark	EL	1
	Lime Canyon	BLM	23,710	Clark	EL	1
				Humboldt	EL	1
	Little High Rock Canyon	BLM	48,355	Washoe	EL	1
				Clark	L	1
	Meadow Valley Range	BLM	123,508	Lincoln	L	1
				Clark	L	1
	Mormon Mountains	BLM	157,716	Lincoln	L	1
				Lincoln	L	1
	Mount Grafton	BLM	78,754	White Pine	L	1
	Mt. Charleston	FS	54,641	Clark	EL	1
	Mt. Charleston	BLM	2,178	Clark	EL	1
	Mt. Irish	BLM	28,274	Lincoln	EL	5
	Mt. Moriah	FS	79,963	White Pine	EH	5
	Mt. Moriah	BLM	8,708	White Pine	EH	5
	Mt. Rose	FS	31,197	Washoe	L	3
	Muddy Mountains	BLM	44,633	Clark	EL	1
	Muddy Mountains	**NPS**	**3,521**	**Clark**	**Z**	**0**
	Nellis Wash	**NPS**	**16,423**	**Clark**	**Z**	**0**
	North Black Rock Range	BLM	30,648	Humboldt	EL	1
	North Jackson Mountains	BLM	23,439	Humboldt	EL	1
	North McCullough	BLM	14,779	Clark	EL	1
	Paiute Peak	BLM	56,890	Humboldt	EL	1
	Parsnip Peak	BLM	43,512	Lincoln	EL	1

	Pine Forest Range	BLM	24,015	Humboldt	EL	1
	Pinto Valley	NPS	39,173	Clark	Z	0
	Quinn Canyon	FS	26,310	Nye	EL	1
	Rainbow Mountain	BLM	20,184	Clark	EL	1
	Rainbow Mountain	FS	4,599	Clark	EL	1
				Nye	EL	1
	Red Mountain	FS	20,520	White Pine	EL	1
	Ruby Mountains	FS	92,652	Elko	L	3
	Santa Rosa-Paradise Peak	FS	32,072	Humboldt	EL	1
	Shellback	FS	36,151	White Pine	EL	1
				Lincoln	EH	3
				Nye	EH	3
	South Egan Range	BLM	67,214	White Pine	EH	3
	South Jackson Mountains	BLM	54,536	Humboldt	EL	1
	South McCullough	BLM	43,996	Clark	EL	1
	South Pahroc Range	BLM	25,671	Lincoln	L	1
	Spirit Mountain	BLM	553	Clark	EL	1
	Spirit Mountain	**NPS**	**32,913**	**Clark**	**Z**	**0**
	Table Mountain	FS	92,627	Nye	EL	1
	Tunnel Spring	BLM	5,341	Lincoln	EL	1
	Wee Thump Joshua Tree	BLM	6,489	Clark	EL	1
				Lincoln	EL	1
	Weepah Spring	BLM	51,305	Nye	EL	1
	White Pine Range	FS	40,041	White Pine	EL	1
	White Rock Range	BLM	24,249	Lincoln	EL	1
	Worthington Mountains	BLM	30,594	Lincoln	L	3
	Wovoka	FS	49,018	Lyon	EL	1

WSAs[2]	Antelope Range	FS	43,700	Nye	L	5
	Antelope Range	BLM	43,700*	Nye	L	5
	Augusta Mountains	BLM	89,732	Churchill	L	5
				Lander	L	5
				Pershing	L	5
	Bad Lands	BLM	9,426	Elko	EL	1
	Blue Eagle	BLM	59,560	Nye	L	1
	Bluebell	BLM	54,413	Elko	EL	4
	Buffalo Hills	BLM	45,287	Washoe	EL	1
	Burbank Canyons	BLM	13,395	Douglas	L	3
	Cedar Ridge	BLM	10,009	Elko	EL	5
	China Mountain	BLM	10,358	Pershing	EL	1
	Clan Alpine Mountains	BLM	196,128	Churchill	EL	1
	Desatoya Mountains	BLM	51,402	Churchill	EL	1
				Lander	EL	1
	Disaster Peak	BLM	13,200	Humboldt	EL	1
	Dry Valley Rim	BLM	76,177	Washoe	EH	5
	Fandango	BLM	530	Nye	EL	1
	Fandango	FS	40,410*	Nye	EL	1
	Five Springs	BLM	1,383	Washoe	EL	1
	Fox Range	BLM	75,404	Washoe	EL	5
	Gabbs Valley Range	BLM	79,600	Mineral	EL	3
	Goshute Canyon	BLM	362	Elko	EH	3
	Goshute Peak	BLM	69,770	Elko	EH	4
	Grapevine Mountains	BLM	66,800	Esmeralda	EL	1
				Nye	EL	1
	Job Peak	BLM	90,209	Churchill	EL	1

Kawich	BLM	54,320	Nye	EL	1
Lahontan Cutthroat Trout Instant Study Area	BLM	12,316	Humboldt	EL	1
Little Humboldt River	BLM	42,213	Elko	EL	1
Massacre Rim	BLM	10,290	Washoe	EL	1
Million Hills	BLM	21,296	Clark	EL	1
Morey Peak	BLM	5,070	Nye	L	1
Morey Peak	FS	15,050*	Nye	L	1
Mount Limbo	BLM	23,752	Pershing	EL	3
Mount Stirling	BLM	5,600	Clark	EL	1
			Nye	EL	1
Mount Stirling	FS	64,050*	Clark	EL	1
			Nye	EL	1
Mountain Meadow Instant Study Area	BLM	22	Nye	EL	1
North Fork of the Little Humboldt River	BLM	69,683	Humboldt	L	2
Owyhee Canyon	BLM	21,875	Elko	L	1
Palisade Mesa	BLM	99,550	Nye	L	1
Park Range	BLM	47,268	Nye	L	5
Pigeon Spring	BLM	3,575	Esmeralda	EL	1
Pinyon Joshua Instant Study Area	BLM	560	Esmeralda	EL	1
Pole Creek	BLM	12,969	Washoe	EL	1
Poodle Mountain	BLM	142,050	Washoe	EH	5
Pueblo Mountains	BLM	600	Humboldt	EL	1
Queer Mountain	BLM	81,550	Esmeralda	EL	1
			Nye	EL	1

	Rawhide Mountain	BLM	64,360	Nye	EL	1
	Red Springs	BLM	7,847	Elko	EL	5
	Resting Springs	BLM	3,850	Nye	EL	1
	Riordan's Well	BLM	57,002	Nye	EL	1
	Roberts Mountain	BLM	15,090	Eureka	EL	1
	Rough Hills	BLM	6,685	Elko	EL	1
	Selenite Mountains	BLM	32,041	Pershing	L	3
	Sheldon Contiguous	BLM	23,700	Washoe	EL	1
	Silver Peak Range	BLM	33,900	Esmeralda	EL	1
	Simpson Park	BLM	490,670	Eureka	L	1
				Lander	L	1
	Skedaddle	BLM	589	Washoe	EL	1
	South Fork Owyhee River	BLM	7,842	Elko	EL	1
	South Pequop	BLM	41,090	Elko	EL	1
	South Reveille	BLM	106,200	Nye	EL	1
	Stillwater Range	BLM	94,607	Churchill	EL	1
	The Wall	BLM	38,000	Nye	EL	1
	Tobin Range	BLM	13,107	Pershing	EL	1
	Twin Peaks	BLM	65,114	Washoe	EH	5
	Virgin Mountain Instant Study Area	BLM	6,560	Clark	EL	1
	Wall Canyon	BLM	46,305	Washoe	EL	1

[1] (BLM 2018b, Wilderness Connect 2018a, 2018b) Some areas Jointly managed, Total WAs 70 (Wilderness Connect 2018a)
[2] (BLM 2018c, BLM 2018)
*Management agency (Friends of Nevada Wilderness https://www.nevadawilderness.org/wilderness_study_areas).

Table G-2. WA and WSAs WS-Nevada Considers Likely to Receive PDM.

Duration of Work Legend:		Average % of the year with some level of activity or equipment present:
5	Nearly year-round	81-100%
4	Long	61-80%
3	Medium	41-60%
2	Short	21-40%
1	Extremely Short	0-20%

Chance of Work Legend		Likelihood that some level of work may occur in the next 10 years based on current or potential requests:	
EH	Extremely High	95 - 100%	Historical depredation - expect it to continue
H	High	66 - 95%	Historical depredation - may not continue
M	Medium	33 - 66%	Historical depredation nearby - may not continue
L	Low	2 - 33%	Historical depredation nearby - expect none
EL	Extremely Low	0 - 2%	No historical depredation - expect none to start

Property Type	Property Name	Federal Agency	Acres	County	Chance of Work	Duration of Work	Reasoning
WAs[1]	Becky Peak	BLM	18,119	White Pine	EH	3	Duration: April-September; resource: sheep (adults-lambs); damage agents: coyote, mountain lion and bobcat.
	Bristlecone	BLM	14,095	White Pine	EH	5	Duration: throughout year (with gaps as per grazing permit); resource: sheep (adults-lambs); damage agent: mountain lion.
	East Humboldts	FS	32,364	Elko	EL	3	Duration: April-September; resource: sheep (adults-lambs); damage agents: coyote, mountain lion and bobcat.
	Far South Egans	BLM	36,299	Lincoln	L	3	Duration: April-September; resource: sheep (adults-lambs); damage agent: mountain lion.
				Nye	L	3	
	Goshute Canyon	BLM	42,544	White Pine	EH	3	Duration: April-September; resource: sheep (adults-lambs); damage agents: coyote, mountain lion and bobcat.

	Government Peak	BLM	6,313	White Pine	M	3	Duration: April-September; resource: sheep (adults-lambs); damage agents: coyote, mountain lion and bobcat.
	Grant Range	FS	52,451	Nye	EH	5	Duration: throughout year (with gaps as per grazing permit); resource: sheep (adults-lambs) and cattle (calves); damage agents: coyote, mountain lion and bobcat.
	High Schells	FS	121,467	White Pine	EH	3	Duration: April-October; resource: sheep (adults-lambs); damage agent: coyote, mountain lion and bobcat.
	Highland Ridge	BLM	68,623	White Pine	EH	5	Duration: throughout year (with gaps as per grazing permit); resource: sheep (adults-lambs); damage agents: coyote, mountain lion and bobcat.
	Jarbidge	FS	110,471	Elko	M	3	Duration: April-September; resource: sheep (adults-lambs); damage agents: coyote, mountain lion and bobcat.
	Mt. Irish	BLM	28,274	Lincoln	EL	5	Duration: throughout year (with gaps as per grazing permit); resource sheep (adults-lambs); damage agents: coyote, mountain lion and bobcat.
	Mt. Moriah	FS	79,963	White Pine	EH	5	Duration: throughout year (with gaps as per grazing permit); resource: sheep (adult-lambs) and cattle (calves); damage agents: coyote, mountain lion and bobcat.
	Mt. Moriah	BLM	8,708	White Pine	EH	5	
	Mt. Rose	FS	31,197	Washoe	L	3	Livestock present April-September; Sheep (adults-lambs) Damage Agents: Coyote, mountain lion, black bear, coyote.
	Ruby Mountains	FS	92,652	Elko	L	3	Duration: April-September; resource: sheep (adults-lambs); damage agent: coyote, mountain lion and bobcat.
	South Egan Range	BLM	67,214	Lincoln	EH	3	Duration: throughout year (with gaps as per grazing permit); resource: sheep (adults-lambs) and cattle (calves); damage agent: coyote and mountain lion.
				Nye	EH	3	
				White Pine	EH	3	
	Worthington Mountains	BLM	30,594	Lincoln	L	3	Duration: April-September; resource: sheep (adults-lambs); damage agent: coyote, mountain lion and bobcat.

WSAs[2]	Antelope Range	FS	43,700	Nye	L	5	Duration: throughout year (with gaps as per grazing permit); resource: sheep (adults-lambs) and cattle (calves); damage agents: coyotes and mountain lions
	Antelope Range	BLM	43,700*	Nye	L	5	
	Augusta Mountains	BLM	89,732	Churchill	L	5	Duration: throughout year (with gaps as per grazing permit); resource: sheep and cattle (calves); damage agent: coyote, mountain lion, raven, bobcat.
				Lander	L	5	
				Pershing	L	5	
	Bluebell	BLM	54,413	Elko	EL	4	Duration: April-September; resource: sheep (adults-lambs); damage agents: coyote, mountain lion and bobcat.
	Burbank Canyons	BLM	13,395	Douglas	L	3	Duration: February-August; resource: sheep (adults and lambs); damage agent: coyote, mountain lion, raven, black bear and bobcat.
	Cedar Ridge	BLM	10,009	Elko	EL	5	Duration: throughout year; resource: sheep (adults-lambs) and cattle (calves); damage agents: coyote, mountain lion, raven and bobcat.
	Dry Valley Rim	BLM	76,177	Washoe	EH	5	Duration: throughout year (with gaps as per grazing permit); resource: sheep, cattle (calves); damage agents: coyote, mountain lion, raven and bobcat.
	Fox Range	BLM	75,404	Washoe	EL	5	Duration: throughout year (with gaps as per grazing permit); resource: cattle (calves); damage agents: coyote, mountain lion, and raven.
	Gabbs Valley Range	BLM	79,600	Mineral	EL	3	Duration: November-May; resource: cattle (calves); damage agent: coyote and mountain lion.
	Goshute Canyon	BLM	362	Elko	EH	3	Duration: April-September; resource: sheep (adults-lambs); damage agents: coyote, mountain lion and bobcat.
	Goshute Peak	BLM	69,770	Elko	EH	4	Duration: April-September; resource: sheep (adults-lambs); damage agents: coyote, mountain lion and bobcat.
	Mount Limbo	BLM	23,752	Pershing	EL	3	Duration: Winter and spring; Sheep (adults/lambs) on rare occation; Damage agents: coyote, mountain lion, raven and bobcat.

	Park Range	BLM	47,268	Nye	L	5	Duration: throughout year (with gaps as per grazing permit); resource: sheep (adults-lambs) and cattle (calves); damage agents: coyote and mountain lion.
	Poodle Mountain	BLM	142,050	Washoe	EH	5	Duration-throughout year with gaps per grazing permit; resource-adult sheep, cattle (calves); Damage agents: Coyote, mountain lion, raven, bobcat.
	Red Springs	BLM	7,847	Elko	EL	5	Duration: throughout year (with gaps as per grazing permit); resource: sheep (adults-lambs) and cattle (calves); damage agents: coyote and mountain lion.
	Selenite Mountains	BLM	32,041	Pershing	L	3	Duration: Winter and Spring; resource-sheep (adult/lambs) on rare occasion; damage agent: coyote, lion, raven and bobcat.
	Twin Peaks	BLM	65,114	Washoe	EH	5	Duration: throughout year (with gaps as per grazing permit); resource: sheep and cattle (calves); damage agents: coyote, mountain lion, raven and bobcat.

[1] (BLM 2018b, Wilderness Connect 2018a, 2018b) Some areas Jointly managed, Total WAs 70 (Wilderness Connect 2018a)[2] (BLM 2018c, BLM 2018)
*Management agency (Friends of Nevada Wilderness https://www.nevadawilderness.org/wilderness_study_areas).

Table G-3. WAs and WSA WS-Nevada Considers Unlikely to Receive PDM.

Duration of Work Legend:		Average % of the year with some level of activity or equipment present:
5	Nearly year-round	81-100%
4	Long	61-80%
3	Medium	41-60%
2	Short	21-40%
1	Extremely Short	0-20%

Chance of Work Legend		Likelihood that some level of work may occur in the next 10 years based on current or potential requests:	
EH	Extremely High	95 - 100%	Historical depredation - expect it to continue
H	High	66 - 95%	Historical depredation - may not continue
M	Medium	33 - 66%	Historical depredation nearby - may not continue
L	Low	2 - 33%	Historical depredation nearby - expect none
EL	Extremely Low	0 - 2%	No historical depredation - expect none to start

Property Type	Property Name	Federal Agency	Acres	County	Chance of Work	Duration of Work
WAs[1]	Alta Toquima	FS	35,581	Nye	EL	1
	Arc Dome	FS	120,555	Nye	EL	1
	Arrow Canyon	BLM	27,502	Clark	EL	1
	Bald Mountain	FS	22,374	White Pine	EL	1
	Big Rocks	BLM	12,930	Lincoln	EL	1
	Black Rock Desert	BLM	314,835	Humboldt	EL	1
				Pershing	EL	1
	Boundary Peak	FS	10,521	Esmeralda	EL	1
	Calico Mountains	BLM	64,968	Humboldt	EL	1
				Pershing	EL	1
	Clover Mountains	BLM	85,668	Lincoln	L	1
	Currant Mountain	FS	47,311	Nye	L	1
				White Pine	L	1
	Delamar Mountains	BLM	111,066	Lincoln	EL	1

	East Fork High Rock Canyon	BLM	52,618	Humboldt	EL	1
				Washoe	EL	1
	Eldorado	BLM	5,766	Clark	EL	1
	Fortification Range	BLM	30,539	Lincoln	L	1
	High Rock Canyon	BLM	46,465	Washoe	EL	1
	High Rock Lake	BLM	59,107	Humboldt	EL	1
	Ireteba Peaks	BLM	10,332	Clark	EL	1
	Jumbo Springs	BLM	4,760	Clark	EL	1
	La Madre Mountain	BLM	27,896	Clark	EL	1
	La Madre Mountain	FS	19,047	Clark	EL	1
	Lime Canyon	BLM	23,710	Clark	EL	1
	Little High Rock Canyon	BLM	48,355	Humboldt	EL	1
				Washoe	EL	1
	Meadow Valley Range	BLM	123,508	Clark	L	1
				Lincoln	L	1
	Mormon Mountains	BLM	157,716	Clark	L	1
				Lincoln	L	1
	Mount Grafton	BLM	78,754	Lincoln	L	1
				White Pine	L	1
	Mt. Charleston	FS	54,641	Clark	EL	1
	Mt. Charleston	BLM	2,178	Clark	EL	1
	Muddy Mountains	BLM	44,633	Clark	EL	1
	North Black Rock Range	BLM	30,648	Humboldt	EL	1
	North Jackson Mountains	BLM	23,439	Humboldt	EL	1
	North McCullough	BLM	14,779	Clark	EL	1
	Paiute Peak	BLM	56,890	Humboldt	EL	1
	Parsnip Peak	BLM	43,512	Lincoln	EL	1

	Pine Forest Range	BLM	24,015	Humboldt	EL	1
	Pinto Valley	NPS	39,173	Clark	Z	0
	Quinn Canyon	FS	26,310	Nye	EL	1
	Rainbow Mountain	BLM	20,184	Clark	EL	1
	Rainbow Mountain	FS	4,599	Clark	EL	1
	Red Mountain	FS	20,520	Nye	EL	1
				White Pine	EL	1
	Santa Rosa-Paradise Peak	FS	32,072	Humboldt	EL	1
	Shellback	FS	36,151	White Pine	EL	1
	South Jackson Mountains	BLM	54,536	Humboldt	EL	1
	South McCullough	BLM	43,996	Clark	EL	1
	South Pahroc Range	BLM	25,671	Lincoln	L	1
	Spirit Mountain	BLM	553	Clark	EL	1
	Table Mountain	FS	92,627	Nye	EL	1
	Tunnel Spring	BLM	5,341	Lincoln	EL	1
	Wee Thump Joshua Tree	BLM	6,489	Clark	EL	1
	Weepah Spring	BLM	51,305	Lincoln	EL	1
				Nye	EL	1
	White Pine Range	FS	40,041	White Pine	EL	1
	White Rock Range	BLM	24,249	Lincoln	EL	1
	Wovoka	FS	49,018	Lyon	EL	1
WSAs[2]						
	Bad Lands	BLM	9,426	Elko	EL	1
	Blue Eagle	BLM	59,560	Nye	L	1
	Buffalo Hills	BLM	45,287	Washoe	EL	1
	China Mountain	BLM	10,358	Pershing	EL	1
	Clan Alpine Mountains	BLM	196,128	Churchill	EL	1

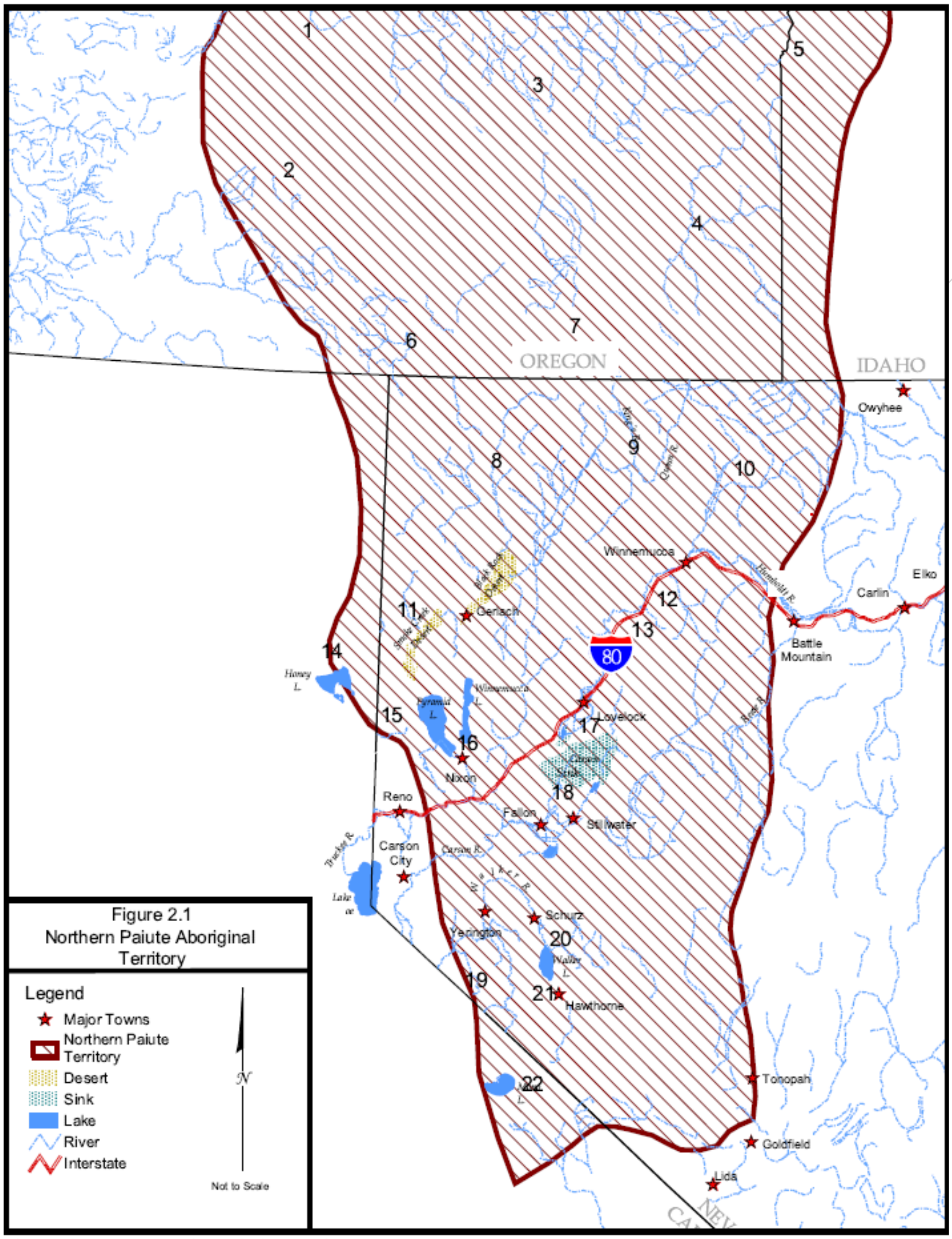
	Desatoya Mountains	BLM	51,402	Churchill	EL	1
				Lander	EL	1
	Disaster Peak	BLM	13,200	Humboldt	EL	1
	Fandango	BLM	530	Nye	EL	1
	Fandango	FS	40,410*	Nye	EL	1
	Five Springs	BLM	1,383	Washoe	EL	1
	Grapevine Mountains	BLM	66,800	Esmeralda	EL	1
				Nye	EL	1
	Job Peak	BLM	90,209	Churchill	EL	1
	Kawich	BLM	54,320	Nye	EL	1
	Lahontan Cutthroat Trout Instant Study Area	BLM	12,316	Humboldt	EL	1
	Little Humboldt River	BLM	42,213	Elko	EL	1
	Massacre Rim	BLM	10,290	Washoe	EL	1
	Million Hills	BLM	21,296	Clark	EL	1
	Morey Peak	BLM	5,070	Nye	L	1
	Morey Peak	FS	15,050*	Nye	L	1
	Mount Stirling	BLM	5,600	Clark	EL	1
				Nye	EL	1
	Mount Stirling	FS	64,050*	Clark	EL	1
				Nye	EL	1
	Mountain Meadow Instant Study Area	BLM	22	Nye	EL	1
	North Fork of the Little Humboldt River	BLM	69,683	Humboldt	L	2
	Owyhee Canyon	BLM	21,875	Elko	L	1
	Palisade Mesa	BLM	99,550	Nye	L	1
	Pigeon Spring	BLM	3,575	Esmeralda	EL	1

	Pinyon Joshua Instant Study Area	BLM	560	Esmeralda	EL	1
	Pole Creek	BLM	12,969	Washoe	EL	1
	Pueblo Mountains	BLM	600	Humboldt	EL	1
	Queer Mountain	BLM	81,550	Esmeralda	EL	1
				Nye	EL	1
	Rawhide Mountain	BLM	64,360	Nye	EL	1
	Resting Springs	BLM	3,850	Nye	EL	1
	Riordan's Well	BLM	57,002	Nye	EL	1
	Roberts Mountain	BLM	15,090	Eureka	EL	1
	Rough Hills	BLM	6,685	Elko	EL	1
	Sheldon Contiguous	BLM	23,700	Washoe	EL	1
	Silver Peak Range	BLM	33,900	Esmeralda	EL	1
	Simpson Park	BLM	490,670	Eureka	L	1
				Lander	L	1
	Skedaddle	BLM	589	Washoe	EL	1
	South Fork Owyhee River	BLM	7,842	Elko	EL	1
	South Pequop	BLM	41,090	Elko	EL	1
	South Reveille	BLM	106,200	Nye	EL	1
	Stillwater Range	BLM	94,607	Churchill	EL	1
	The Wall	BLM	38,000	Nye	EL	1
	Tobin Range	BLM	13,107	Pershing	EL	1
	Virgin Mountain Instant Study Area	BLM	6,560	Clark	EL	1
	Wall Canyon	BLM	46,305	Washoe	EL	1

[1] (BLM 2018b, Wilderness Connect 2018a, 2018b) Some areas Jointly managed, Total WAs 70 (Wilderness Connect 2018a)[2] (BLM 2018c, BLM 2018) *Management agency (Friends of Nevada Wilderness https://www.nevadawilderness.org/wilderness_study_areas).

Appendix H. Aboriginal Territory of Northern Paiute Tribes

Map of Aboriginal Territory of the Northern Paiute Tribes (Bengston 2002).



P:\5000-5999\5199-068-093 BLM Northern Nevada Ethno Overview\GIS Figure 3.1

Bengston, G. 2002. NORTHERN PAIUTE AND WESTERN SHOSHONE LAND USE IN NORTHERN NEVADA: A CLASS I ETHNOGRAPHIC/ETHNOHISTORIC OVERVIEW. Online. https://www.blm.gov/documents/national-office/blm-library/cultural-resource-series/northern-paiute-and-western-shoshone.