Final Environmental Assessment
Mammal Damage Management in Washington
USDA APHIS Wildlife Services-Washington

Prepared by the

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

In consultation with:

Washington Department of Fish and Wildlife

U.S. Department of the Interior
Bureau of Land Management

United States Army Corps of Engineers

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List of Acronyms

AFWA	Association of Fish and Wildlife Agencies
APHIS	US Department of Agriculture Animal and Plant Health Inspection Service
APHIS-WS	Animal and Plant Health Inspection Service - Wildlife Services
ATOC	APHIS-WS Aviation Training and Operations Center in Cedar City, Utah
ATSDR	Agency for Toxic Substances and Disease Registry
AVMA	American Veterinary Medical Association
AWP	Annual Work Plan
BA	Biological Assessment (Endangered Species Act)
BLM	US Dept. of Interior Bureau of Land Management
BMP	Best Management Practice
BO	Biological Opinion
CDC	Center for Disease Control
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CWTD	Columbia white-tailed deer
dB or dBA	Decibels of sound pressure (metric for sound)
DEA	United States Drug Enforcement Agency
EA	Environmental Assessment
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
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FLPMA	Federal Land Policy and Management Act
FONSI	Finding of No Significant Impact
FSA	Farm Services Agency
FY	Fiscal Year
GAO	US Government Accountability Office
GHG	Greenhouse gas
IARC	International Agency for Research on Cancer
IGP	Intraguild predation
IWDM	Integrated wildlife damage management
LD_{50}	Lethal dose – the level at which 50% of the study animals die
MBTA	Migratory Bird Treaty Act
MDM	Mammal Damage Management
MIS	Management Information System
MOU	Memorandum of Understanding
MPR	Mesopredator release
NASAO	National Association of State Aviation Officials
NASS	National Agriculture Statistics Service
NEPA	National Environmental Policy Act

NMFS	National Marine Fisheries Service
NPS	National Park Service
NRA	National Rifle Association
NWRC	USDA APHIS-WS National Wildlife Research Center
WDFW	Washington Department of Fish and Wildlife
OIG	USDA Office of Inspector General
WAC	Washington Advisory Code
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
RCW	Revised Code of Washington
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
WCO	Wildlife control operator
WID	Work Initiation Document
WDM	Wildlife Damage Management
WSA	Wilderness Study Area
WS-Washington	Wildlife Services Program in Washington

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1 Purpose and Need

1.1 Introduction

This chapter provides the foundation for:

- Understanding why wildlife damage occurs and the practice of wildlife damage management;

- Knowing the statutory authorities and roles of federal and state agencies in managing damage caused by mammals in Washington;

- Understanding how the United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) Wildlife Services (WS) -Washington cooperates with and assists private and commercial resource owners and federal, tribal, state, and local government agencies in managing mammal 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-Washington;

- Understanding the reasons why private and commercial entities, tribes, and federal, state, and local government agencies request assistance from WS-Washington;

- Understanding the effectiveness and cost-effectiveness associated with mammal damage management in the United States; and

- The public involvement and notification processes used by WS-Washington for this EA.

Chapter 2 identifies the issues analyzed in detail in this Environmental Assessment (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, a program within the USDA's APHIS, provides federal professional leadership and expertise to resolve wildlife conflicts to help create a balance that allows people and wildlife to coexist.

Animal and Plant Health Inspection Service Wildlife Services (APHIS-WS) recommends and/or implements a cohesive integrated wildlife damage management (IWDM) 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 are initially considered, 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 mammal species are involved, and expertly implementing or recommending the most effective strategy using sustainable methods that balance those considerations.

This EA evaluates the impacts of four approaches to managing mammal damage (mammal damage management; MDM) in Washington. The purpose of the EA is to assist APHIS-WS in analyzing the options and the associated comparative impacts of each and make an informed decision regarding managing the WS-Washington approach to responding to requests for assistance.

This EA focuses on mammal species. It refers to the overall strategies and approaches used by WS-Washington as MDM. Where the EA discusses wildlife damage management in general, it will be called wildlife damage management (WDM). There are other sections dealing specifically with predator damage management (PDM). The assistance provided to requesters for managing mammal damage evaluated in this EA is simply a component of the total WS-Washington WDM program. NEPA analysis of other components of the WS-Washington activities that do not involve the mammal species included in this EA are evaluated in separate documents.

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-Washington involvement in MDM, the degree of technical assistance (advice, information, education, and/or demonstrations) and of operational damage management (actions of MDM to control the damage caused by offending mammals), and the degree of lethal and non-lethal methods available for use. For this EA, the following species are included as mammals: badger, bats, beaver, black bear, bobcat, cougar, coyote, deer, elk, feral dogs, feral cats, feral rabbits, feral swine, fox, gophers, ground squirrels, marmots, mink, mountain beaver, moles, muskrat, nutria, old world mice, rats, voles, opossum, porcupine, rabbits, raccoon, river otter, sea lions, squirrels, skunks, and weasels.

The goal of WS-Washington MDM, as currently conducted in Washington, is to reduce mammal damage, threats of damage, and risks to human/pet health and/or safety by responding to requests for assistance, including technical assistance and operational damage management, regardless of whether the source of the request is private or public (Section 1.5.2).

WS-Washington proposes to continue responding to people requesting assistance with MDM for the protection of livestock and agriculture, 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 WS-Washington's MDM assistance on all land classes (e.g., federal, tribal, state, county, municipal, and private properties in rural, urban and suburban areas) where WS-Washington personnel have been and may be requested to assist, based on agreements between WS-Washington and the requesting entity. It also includes analysis of impacts of three other levels of MDM activities in Washington, including those that do not involve WS-Washington.

The proposed action (Alternative 1; Section 2.3.1 and Appendix A), involves WS-Washington continuing to use appropriate methods, singly or in combination, to resolve damage caused by mammals identified in this EA. WS-Washington is proposing to implement the current integrated and adaptive MDM program, using proven non-lethal and lethal methods, as well as providing technical assistance and education.

All WS-Washington 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-Washington and the various federal and state resource management agencies. WS-Washington cooperates with Washington Department of Fish and Wildlife (WDFW), the Washington State Department of Agriculture (WSDA), United States Fish and Wildlife Service (USFWS), and National Marine Fisheries Service (NMFS) as appropriate, for actions involving MDM.

Mammal damage management is conducted by WS-Washington 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 2.3.4, and Appendix A for details on the four alternatives evaluated in this EA, and Chapter 3 for their associated impacts.

1.3 What Species are Included in this EA?

This EA includes the following mammal species (in alphabetical order; Table 1) and the primary management authority. Most species are managed under state law by the WDFW but some are managed entirely by local authorities and others are regionally co-managed with tribal entities to meet state and tribal management goals. WS-Washington coordinates with the appropriate management entities for all managed species impacted by WS-Washington's damage management activities.

Table 1. Mammal Species Included in Scope of this EA and the Agency with Management Authority

Common Name	Scientific Name	Managed By[1]
BADGER	*Taxidea taxus*	WDFW
BATS (ALL)	*Family Pteropodidae*	WDFW
BEARS, BLACK	*Ursus americanus*	WDFW
BEAVER	*Castor canadensis*	WDFW
BEAVER, MOUNTAIN	*Aplodontia rufa*	WDFW
BOBCATS	*Lynx rufus*	WDFW
CATS, FERAL/FREE RANGING	*Felis catus*	Local authorities
COYOTES	*Canis latrans*	WDFW
DEER, BLACK-TAILED	*Odocoileus hemionus columbianus*	WDFW
DEER, MULE	*O. hemionus*	WDFW
DEER, WHITE-TAILED	*O. virginianus idahoensis*	WDFW
DOGS, FERAL/FREE-RANGING	*Canis lupus*	Local authorities
ELK, WAPITI (WILD)	*Cervus canadensis*	WDFW
FOX, RED	*Vulpes vulpes*	WDFW
GOPHER, NORTHERN POCKET	*Thyomomys talpoides*	WDFW
LION, MOUNTAIN (COUGAR)	*Puma concolor*	WDFW
MARMOTS, YELLOW-BELLIED	*Marmota flaviventris*	WDFW
MICE, DEER (ALL)	*Peromyscus spp*	WDFW
MOUSE, HOUSE	*Mus musculus*	Local authorities
MINK	*Neovison vison*	WDFW
MOLES (ALL)	*Scapanus spp.*	WDFW
MUSKRAT	*Ondantra zibethicus*	WDFW
NUTRIA	*Myocastor coypus*	WDFW
OPOSSUM, VIRGINIA	*Didelphis virginianus*	WDFW
OTTER, RIVER	*Lontra canadensis*	WDFW
PORCUPINE	*Erethizon dorsatum*	WDFW
SQUIRRELS, GROUND, CALIFORNIAN	*Spermophilus beecheyi*	WDFW
RABBITS, FERAL	*Oryctolagus cuniculus*	Local authorities
RABBITS, COTTONTAILS, EASTERN	*Sylvilagus floridanus*	WDFW
RABBITS, COTTONTAILS, NUTTALL’S	*Sylvilagus nuttallii*	WDFW
RACCOON	*Procyon lotor*	WDFW
RAT, NORWAY	*Rattus norvegicus*	Local authorities
RAT, BLACK (ROOF)	*Rattus rattus*	Local authorities
SEA LION, CALIFORNIA	*Zalophus californianus*	NMFS
SEA LION, STELLER	*Eumetopias jubatas*	NMFS
SHREWS	*Sorex spp.*	WDFW
SKUNK, STRIPED	*Mephitis mephitis*	WDFW
SQUIRREL, DOUGLAS	*Tamiasciurus douglasii*	WDFW
SQUIRREL, EASTERN GRAY	*Sciurus carolinensis*	WDFW
SQUIRREL, FOX	*Sciurus niger*	WDFW
SQUIRREL, GROUND, COLUMBIAN	*Urocitellus washingtoni*	WDFW
SQUIRREL, WESTERN GRAY	*Sciurus griseus*	WDFW
SWINE, FERAL	*Sus scrofa*	WDFW
VOLES (ALL)	*Microtus spp.*	WDFW
WEASEL, LONG-TAILED	*Mustela frenata*	WDFW

1.4 What is Wildlife Damage Management?

Wildlife management agencies endeavor to affect the overall or regional population of a wildlife species, such as managing for an increase in the population of an endangered species or a popular game species. This generally referred to as "wildlife management". Wildlife Damage Management (WDM), on the other hand, focuses on addressing a specific situation's damage, damage threat, or risk to health and safety, not broad-scale population management. In general, the goal of WDM is to alleviate the damage or risk, without affecting overall or regional populations. The Wildlife Society, a non-profit scientific and educational organization that represents wildlife professionals, recognizes WDM as a specialized field within the wildlife profession, and espouses adherence to professional standards for responsible WDM. Their official position on WDM is as follows (The Wildlife Society 2016):

> *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 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. 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 Wildlife Society further "recognize[s] that wildlife damage management is an important part of modern wildlife management" (The Wildlife Society 2016).

1.4.1 What is Integrated Wildlife Damage Management?

Per APHIS-WS Directive 2.105, WS-Washington applies an integrated approach to WDM by integrating and applying all approved methods of prevention and management to reduce damage. 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.

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 minimizes economic, health, and environmental risks. This integrated approach improves efficacy 2 ways:

(1) Different techniques may be more or less effective, depending on the specific circumstances,
(2) Combinations of techniques often have a synergistic effect; the combination works better than the sum of the individual techniques.

1.4.2 Why Do Wildlife Damage and Risks to Human Health and Safety Occur?

Wildlife habitat has been substantially changed as human populations expand and land is used for human needs. This continued and increasingly 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 has caused substantial changes in the ways that humans and wildlife interact. These human uses and needs often compete with the needs of wildlife, which increases the potential for conflict between humans and wildlife.

While some species are displaced or removed by habitat change, others habituate and adapt to use resources supplied by humans, especially food. 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.

Human development and growth continue to pressure wildlife populations to adapt to changing circumstances. Some species are more adaptable than others, resulting in these species reaching unnaturally large population sizes, while less adaptable species decline in number and distribution. Because humans tend to concentrate livestock, food crops, buildings, their pets, and even themselves in localized areas of intensive use, some wildlife species find it easier to meet their life needs using human-subsidized assets. Species better adapted to exploiting human development can negatively impact natural resources in surrounding areas (e.g. predation, resource competition, displacement). This can lead to overabundance of the species and conflicts with humans and natural resources.

Many people moving from urbanized areas into the rural areas or newly developed areas are often not familiar with wild animals and their habits. Some individual animals become habituated to people to the point that they lose their natural fear of humans, choosing to live near residences, prey on pets and livestock, and/or attack or intimidate people.

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.

Wildlife use and adapt to the available habitats, including opportunities where humans provide easy food and living space. Wildlife's ability to adapt to changes in their environment for meeting their own needs for food, water, and shelter sometimes creates tension and conflict where human needs for social and economic security and health and safety overlap.

1.4.3 How Do People Feel About Wildlife?

Wildlife is a valuable natural resource, long enjoyed by the American public for aesthetic, recreational, emotional, psychological, and economic reasons. Human perceptions, attitudes, and emotions differ depending on how they desire to "use" different wildlife and how they interact with individual or groups of animals. For example, seeing a group of deer in a field at dusk may be 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 killing your pets or farm animals on your property is typically highly undesirable and can even be frightening. Raccoons in the neighboring forest patch may be enjoyable to watch, while the same raccoons in your garbage, henhouse, or attic is intolerable.

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.

People also have cultural perceptions based on 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 be managed, which may require lethal removal or translocation.

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. People who live in rural areas that depend on land and natural resources tend to consider wildlife from a more utilitarian viewpoint, such as a renewable resource like hunting. Many urban people are not fully educated on where their food products come from or the issues revolving around their food production. 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 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

People have strong opinions about killing wildlife, dependent on a myriad of factors, such as social identity, 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 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 mutually exclusive ones. The public often looks at animals on an individual or herd/pack level, whereas professional wildlife management is generally focused on population-level concerns. (Lute and Attari 2016)

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 and increased distribution and population growth.

Three public opinion surveys of the general public and hunters in Washington have been conducted by Responsive Management in partnership with WDFW (Duda et al. 2002, Duda et al. 2008, Duda 2014). Duda et al. (2014) found that 29% of the Washington public experienced negative situations or problems associated with wildlife in the previous 2 years). The previous 2 surveys, in 2002 and 2008, showed similar percentages, 26% and 29%, respectively. In the 2014 survey, deer (35%) and raccoons (25%) were the most frequently cited species, followed by bear (14%), geese (13%), and coyotes (10%).

Duda et al. (2014) looked at public opinion of predator management specifically and reported that 70% of the population supports managing predators and 68% support reducing predator populations to protect threatened or endangered species, though this statistic has fluctuated across the 3 surveys. Seventy one percent of the respondents expressed support for reducing predators to increase deer or elk herds that are below the management objectives. However, respondents were less supportive (48%) of reducing predators to protect domestic animals. These statistics reflect the attitudes of the state residents, and WDFW considers them when setting management objectives.

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 Washington, 28.9% 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 Washington, 31.7% 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 Washington, 37.9% 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 Washington, 37.9% were Mutualists, 28% were Traditionalists, 19.9% were Pluralists and 14.3% 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 Washington from 2004 to 2018 was as follows: Mutualists increased by 1.5%, Traditionalists decreased by 2.5%, Pluralists increases by 1.5% and decreased by 0.5%.

Lute and Attari (2016) recognized that conflicts with wildlife are ongoing, especially through the substantial environmental modifications and land use changes conducted by humans, and that lethal control may be more cost-effective than sweeping habitat protection strategies. They suggest 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 in decision-making regarding specific situations. (Lute and Attari 2016)

Trade-offs can and do occur between different conservation objectives and human livelihoods (McShane et al. 2011). The authors argued 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 that, for at least some of those effected, may seem personally significant.

1.4.4 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 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."

When wildlife 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, people, government agencies, or commercial interests request private companies or federal or state governments to address the damage; whether by excluding, removing, killing, or dispersing the wildlife causing the problems. When damage or losses have previously occurred and can be expected to occur again, people or agencies may request that wildlife be proactively removed or dispersed to avoid further/future losses, before the damage or losses recur. Often, without outside help, people or entities try to resolve the problems themselves, sometimes by attempting to prevent the damage from recurring, such as by building fences and other infrastructure, or by killing animals that they perceive are causing the problem (whether true or not), using traps, firearms, or toxic chemicals.

Nearly every cooperator WS-Washington assists accepts some level of damage before attempting to rectify the problem themselves or contacting WS-Washington for assistance. So, the term "damage", in the case of WDM, is used to describe situations where the damage threshold is exceeded, and people/entities request assistance or attempt to take care of the problem themselves.

The threshold triggering a request for assistance with wildlife damage is often unique to the person, entity, or agency requesting assistance. What constitutes damage to one person or entity, and considered intolerable, may not be considered a problem to another individual or entity. Addressing wildlife damage problems requires consideration of 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 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 largest number of animals that can sustainably survive under the most restricting ecological conditions, such as during severe winters or droughts; (The Wildlife Society 1980)). The "wildlife acceptance capacity" (Decker and Purdy 1988) , or "cultural carrying capacity," is the limit of human tolerance for wildlife or its behavior and the number of a given species that can coexist compatibly with local human populations. It is not a static number and is expected to be different based on people's attitudes towards wildlife. 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.

People's damage thresholds help determine 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 exceeded in any particular circumstance, people take, or request help for taking, action to alleviate the damage or address threats.

1.5 What Is the Role of USDA APHIS Wildlife Services in WDM?

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' operational activities at the state level provide wildlife damage control assistance in four major areas: (1) agriculture resources, which includes protecting livestock from predators, reducing damage to crops from damaging species, alleviating bird damage at aquaculture facilities; (2) natural resources, which includes protecting threatened and endangered species, managing invasive species; (3) property, which includes protecting homes, landscaping, and industrial facilities from damage by mammals and birds; and (4) health and human safety, which includes reducing the risk of aircraft strikes of wildlife around airport runways , reducing and monitoring the spread of wildlife diseases to livestock, pets, or humans, protecting infrastructure to ensure public safety during use or operation. 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 on its paired programs of fieldwork (operations) and research. Its National Wildlife Research Center (NWRC), internationally recognized as a leader in wildlife damage management science, conducts research and develops tools to address dynamic WDM 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. The 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. The 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 and the exchange of technical information, the NWRC provides valuable data and expertise to the public and the scientific community, as well as to APHIS-WS' operational program. Vast amounts of technical and peer-reviewed science used in the development of WDM best management practices used by other agencies and in commercially developed non-lethal tools is a direct result of the efforts of APHIS-WS personnel and NWRC activities.

1.5.1 What Are APHIS-WS Mission, Goals, and Objectives?

APHIS-WS' mission is to provide federal leadership in managing conflicts with wildlife. APHIS stated mission, is to safeguard health, welfare, and value of American agriculture and natural resources (APHIS-WS Directive 1.201) and to provide Federal leadership in managing conflicts with wildlife.

APHIS-WS responds to requests for assistance from private and public entities, tribes and other federal, state, and local governmental agencies in accordance with APHIS-WS Directive 1.201 and 3.101. The goal of WS-Washington is to 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 (APHIS-WS Decision Model, APHIS-WS Directive 2.201, Section 2.2.1.2) to evaluate, formulate, and implement or recommend the most effective strategy. The recommended strategy is designed to reduce or eliminate damage and risks caused by the offending animal(s) and to resolve conflicts with humans and their valued resources, health, and safety.

The WS-Washington objectives are to:

- Professionally and proficiently respond to all requests for assistance using WDM and the APHIS-WS decision model (APHIS-WS Directive 2.201; Section 2.2.1.2). IWDM must be consistent with all APHIS-WS policies and directives, cooperative agreements, MOUs, and other requirements as provided in any decision resulting from this EA.

- Implement IWDM so that cumulative effects do not negatively affect the viability of any native wildlife populations.

- Ensure that actions conducted within the IWDM 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.

- Minimize non-target effects by using the APHIS-WS Decision Model (APHIS-WS Directive 2.201; Section 2.2.1.2) to select the most effective, target-specific, and humane remedies available, given legal, environmental, and other constraints.

- Incorporate the use of appropriate and effective new and existing lethal and non-lethal technologies, where appropriate, into technical and direct assistance strategies.

APHIS-WS' activities are also conducted in accordance with the directives found in the WS Program Policy Manual located at https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/sa_ws_program_directives/ct_ws_dir_ch2.

1.5.2 What is the Federal Regulation Authorizing Wildlife Services' 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."

1.5.3 How Does APHIS-WS Operate?

In addition to performing specific wildlife damage tasks directed by Congress and providing technical assistance to the general public, APHIS-WS enters into cooperative service agreements (CSAs) to resolve specific wildlife conflicts at the request of non-federal cooperators, such as state, county, or city agencies, commercial entities, or private entities. CSAs establish a cooperative framework with the cooperator and recover the partial or entire cost of its services. For each CSA, the APHIS-WS State office develops an annual work plan and a financial plan. The work plan describes the actions to be taken and the types of damage to be managed. The financial plan describes the amount of funds to be spent on the project. The cooperators must review and approve both plans. In order to follow laws unique to state and local governments, cooperative arrangements with APHIS-WS may vary considerably. In most cases, cooperators pay all/most of the costs associated with wildlife damage management.

After a CSA is signed, APHIS-WS field specialists can work directly with cooperators or landowners to address wildlife damage problems. After a landowner makes initial contact with APHIS-WS, the field specialist will conduct a site visit to assess wildlife damage, examine the property, and discuss options for reducing losses. If the landowner requests that APHIS-WS conduct operational damage management activities, both parties discuss and sign a Work Initiation Document called a Form 12. A Form 12 gives the field specialist access to the cooperator's property; it also specifies APHIS-WS' methods, tools, and species to be managed.

APHIS-WS enters memoranda of understanding (MOU) with other federal and state agencies to establish the framework governing its activities and coordinate efforts in reducing wildlife damage. The MOUs define and clarify the respective roles and responsibilities of each agency for resolving wildlife conflicts. An MOU between APHIS-WS and a federal/state agency requires both parties to conduct wildlife damage management activities in accordance with applicable federal, state, and local laws and regulations. While APHIS-WS assumes primary responsibility for resolving wildlife conflicts involving migratory birds, federally protected species, and airport hazards, state agencies are responsible for providing wildlife damage assistance with state-regulated species. State agencies also cooperate with APHIS-WS to ensure that proper permits are secured for wildlife damage management activities.

Trained and experienced field personnel determine the appropriate MDM methodologies to recommend and/or implement using the APHIS-WS Decision Model (Slate et al. 1992). This includes selecting methodologies with a preference given to non-lethal methods when practical and effective. After the field employee receives a request for assistance; they assess the problem; evaluate the effectiveness of the various methods available using IWDM; recommend 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. They then provide 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 2.2.1.2.

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, and then recommending to the requester one or more courses of actions they can take to minimize 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, removal of attractions, 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 "operational damage management" activities. Operational damage management can include non-lethal techniques such as recommendations and 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 WDM of any type is conducted, a Work Initiation Document WID must be signed by a representative of WS-Washington and the land owner or manager, or, for work on federal lands, an Work Plan is discussed and agreed upon by the land management administrator or agency representative and WS-Washington (per MOUs with the USFS and BLM, Section 1.9).

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 mammal damage and threats to human/pet health or safety, using an integrated approach often entailing multiple strategies. For example, these strategies may include:

- 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 the WDFW, USFWS, USFS, Department of Defense (DOD), U. S. Army Corps of Engineers (USACE), 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 applicable state statutes discussed in this EA (Section 1.11.3 and 2.4) and in Appendix B.

When requested to assist with MDM 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 when and if one is proposed by the requester (e.g. by WDFW or USFWS). WDFW is authorized to control the threat of mammal-related damage to wildlife populations under their authority using hunting seasons and administrative removals of mammals. The USFWS is authorized to manage ESA-listed species, migratory birds, and eagles (Section 1.11.3 and Appendix B). Therefore, when requested by WDFW or the USFWS to conduct MDM for protection or management of resources under their jurisdiction, WS-Washington evaluates the potential effectiveness and appropriateness of WS-Washington's involvement before making a final decision to assist. WS-Washington considers whether such actions would be strategically planned (e.g. timing) to accomplish management goals, WS-Washington activities are described in detail in Section 2.3.1.

1.5.4 How Does APHIS-WS Ensure the Implementation of Ethical and Professional WDM Practices?

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, specialists, technicians, and others.

APHIS-WS field personnel must be experienced in wildlife management and ecological principles and practices, and highly competent in identifying mammal sign and developing and implementing effective strategies within a wide diversity of challenging conditions and circumstances. They are highly trained in the use of firearms, capture techniques, pyrotechnics, field chemicals, and other methods described in detail in Appendix A per APHIS-WS Directives. 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 2.2.1.2).

Directive 1.301 states: "WS is the Federal leader in providing wildlife damage management solutions that are safe, effective, selective, economically feasible, and environmentally responsible…Our individual and collective adherence to this Code of Ethics will promote public service and will uphold the standards of the WS program."

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.

All field personnel, as needed and appropriate, 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 humane use of immobilizing and euthanizing drugs (WS Direct 2.430).

1.5.5 How does WS-Washington Work with Conservation and Restoration Entities?

WS-Washington may conduct MDM activities to support conservation or habitat restoration efforts when requested. Mammals, specifically invasive, deleterious species such as nutria and feral swine, cause extensive damage to habitats and resources that native species need. WS-Washington also partners with conservation groups to increase the use of non-lethal MDM and reduce the need for lethal removal of mammals. These partnerships utilize the skills and resources of APHIS-WS to further conservation goals of individual entities.

1.5.5.1 Stream Restoration and Beaver Relocation

Numerous studies have demonstrated the important contributions of beaver to ecosystems, which will be discussed further in Section 3.7.2. Thompson et al (2021) stated that from an ecological perspective, beaver do not negatively influence their surroundings, but their actions can do a disservice to some stakeholders while benefitting society at large. The flooding of a crop or home is an example of a disservice to a stakeholder. Thompson et al (2021) also found that expanding beaver populations bring both benefits and disadvantages and encouraged managers to maximize the use of beavers while minimizing the damage. WS-Washington works with natural resource management agencies and conservation groups to find solutions to these conflicts that resolve damage and increase the wildlife acceptance capacity for beaver (discussed in Section 1.4.4).

WS-Washington is an active participant on the Washington Beaver Working Group, a consortium of State, Federal, county agencies, Native American tribes, and beaver conservation groups in Washington. This working group was established and chaired by WDFW with the intent to develop beaver relocation guidelines and outreach efforts. In the last two years, WS-Washington has worked directly with members of this working group to live trap and relocate more than 100 beavers from areas where they are causing damage. Additionally, WS-Washington has partnered with beaver conservation groups to implement instream beaver damage mitigation using methods such as pond-leveling devices and outreach.

1.5.5.2 Non-lethal Predator Damage Management

WS-Washington works with livestock producers to mitigate depredation by predators. WS-Washington has partnered with WDFW for the last four years to procure and install fladry for the purpose of deterring depredation by wolves. WS-Washington is currently working with counties, WDFW, livestock producers, and private timber companies to explore the use of additional nonlethal methods such as range riders, rag boxes, electronic guards, and supplemental feeding.

1.5.5.3 Invasive Species Management

Executive Order 13112 (Appendix B) directs federal agencies to use resources to prevent int introduction and spread of invasive species, and work to restore habitats affected by those species. WS-Washington's goal is to provide assistance to any landowner or resource manager requesting assistance with invasive species, such as nutria and feral swine.

Feral swine have the potential to damage numerous resources in any area of the state (cite feral swine EIS). APHIS-WS operates a National Feral Swine Damage Management Program that facilitates local responses to feral swine damage. Washington state is in the "detection phase", meaning feral swine are thought to be eliminated, but resources remain to respond if they are detected again.

Nutria are an invasive aquatic rodent that damage sensitive wetland habitats by destroying vegetation and burrowing, while competing with native species for resources. Their feeding habits exploit marsh vegetation and can directly conflict with efforts to restore valuable wetland habitats and riparian corridors. Removal of nutria from established habitats or other undergoing restoration is a benefit to native species.

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

APHIS-WS policy is to respond to requests for assistance with reducing wildlife damage under the authority provided by Congress. Managing wildlife populations is under the legal jurisdiction of WDFW, the USFWS/NMFS for ESA-listed species, the USFWS for migratory birds and eagles, and tribal governments on tribal lands.

APHIS-WS has no authority to determine state or 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 or timber growth and harvest, nor use of private land, such as for livestock feedlots, or government, commercial, or residential development.

APHIS-WS cannot 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 (FLPMA) 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-Washington only addresses mammal damage management upon request (Section 1.5 and WS Directive 2.201).

WS-Washington cannot use toxicants unless they are approved by the U.S. Environmental Protection Agency (EPA) per FIFRA and are registered for use in Washington by the WSDA. WS-Washington must ensure that all storage, use, and disposal by WS-Washington personnel is consistent with FIFRA label requirements and WS Directive 2.401. WS-Washington does not use M-44s.

In Washington, most wildlife species are managed by WDFW per Revised Code of Washington (RCW) 77.04.012. WS-Washington has no authority to regulate hunting seasons, bag limits, or hunting methods; nor can WS-Washington issue policy on local or state-wide bounty systems.

Washington Administrative Code (WAC) 220-610-110 classifies endangered, threatened, and species of concern in WA, with criteria identified in WAC 220-200-100.

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

It is APHIS-WS' policy to comply with applicable state laws (APHIS-WS Directive 2.210) and APHIS-WS' practice to cooperate with states in managing mammal damage.

Under RCW 77.12.240, WDFW has the authority to "authorize the removal or killing of wildlife that is destroying or injuring property, or when it is necessary for wildlife management or research." WAC 220-440 codifies how WDFW exercises that authority and defines how Washington State handles human wildlife conflict. WAC 220-440-020 defines damage as "economic losses caused by wildlife interactions" and livestock as "horses, cattle, sheep, goats, swine, donkeys, mules, llamas, and alpacas".

WAC 220-440-040 and WAC 220-440-050 outlines wildlife interaction regulations and defines stipulations around RCW 77.36.030 which states

> *the owner, the owner's immediate family member, the owner's documented employee, or a tenant of real property may trap, consistent with RCW 77.15.194, or kill wildlife that is threatening human safety or causing property damage on that property, without the licenses required under RCW 77.32.010 or authorization from the director under RCW 77.12.240.*

Under WAC 220-440-060, without a permit or license required under 77.32.010, landowners may, at any time, take one big game animal if found in the act of attacking livestock/pets or multiple big game animals if they are posing immediate risk to health/human safety on private land. If in possession of a damage prevention agreement or kill permit from WDFW, multiple big game animals may be taken to protect commercial livestock or commercial crops (RCW 77.36.030, WAC 220-440-040, WAC 220-440-060). Take from situations not requiring a permit must be reported to WDFW within 24 hours and the animal/all parts must be provided to WDFW or its designees (WAC 220-440-090). With a damage prevention agreement or kill permit issued by WDFW (WAC 220-440-060) must be disposed of consistent with the conditions identified under the permit (WAC 220-440-090). There are some restrictions to protect human safety and sensitive species, and WDFW advises homeowners to check with local authorities to determine additional restrictions. Also, an additional permit is required if using any body-gripping trap (RCW 77.15.192).

Generally, either WDFW or WS-Washington receives requests directly to handle damage to livestock and/or threats to human/pet health or safety caused by black bear or cougar. WDFW is the primary respondent, but often defers requestors directly to WS-Washington or may directly request WS-Washington to respond to requests for assistance. WS-Washington may respond independently to livestock or property damage caused by black bears and cougar. In Washington, private landowners, or their authorized agents, that experience cougar or bear damage to crops or domestic animals are authorized to kill the cougar or bear but must report it to WDFW immediately. Also, the body or remains of any cougar taken under these circumstances becomes property of the state and will be turned over to WDFW where practical.

WDFW has legal wildlife damage management authority and a staff of Wildlife Conflict Specialists. WDFW can also certify volunteers, and trappers for mammal damage management for cougar and bears and certify commercial mammal damage management companies; typically for addressing human conflicts with smaller mammals (WAC 220-440-110). WDFW provides links to state licensed private wildlife control operators (WCO) on its Living with Wildlife website. WCOs must complete state provided training and have obtained one or more levels of certification from WDFW. WCOs are not WDFW employees and charge their own fees for service. More information is available at (Washington Department of Fish and Wildlife 2018b)

Wildlife conflict is also addressed in the Game Management Plan for June 2015 – June 2021 (Washington Department of Fish and Wildlife 2015b). The document set out goals for managing conflict along with managing game species populations. Portions of this plan are integrated into this EA to support needs and analyses within the context of appropriate state policies.

WAC 220-413-070 prohibits the use of aircraft to spot or shoot wildlife except as authorized by the director of WDFW. WDFW is responsible for administering Section 13 of the Fish and Wildlife Act of 1956 (commonly referred to the Airborne Hunting Act or Shooting from Aircraft Act, 16 U.S. Code § 742j-1), with the authority to approve permits for commercial and private aerial shooting of wildlife. While WDFW may provide permits for aerial hunting, they opted to limit that activity solely to WDFW and WS-Washington personnel/agents.

1.7.1 *Classification of Species Under Washington State Law*

In Washington, "furbearers" is a classification of mammals indicating that their hides have a commercial value. Furbearers can be trapped but not hunted, unless there is an established hunting season for them (i.e. those cross-classified as game animals). "Furbearers" categorized in WAC 220-400-020 include beaver, muskrat, fox, raccoon, marten, short-tailed weasel or ermine, long-tailed weasel, mink, badger, river otter, bobcat.

"Game animals" categorized in WAC 220-400-020 can be hunted and include eastern cottontail, Nuttall's cottontail, snowshoe hare, fox, black bear, raccoon, cougar, bobcat, Roosevelt and Rocky Mountain elk, mule deer and black-tailed deer, white-tailed deer, moose, pronghorn, mountain goat, California and Rocky Mountain bighorn sheep. Two exceptions to this being white-tailed jackrabbits and black-tailed jackrabbits that are also categorized under WAC 220-400-020 but seasons are closed year round so they cannot be hunted.

Coyote, European rabbit, gophers, gray and fox squirrels, ground squirrels, mice, moles, mountain beaver, nutria, Virginia opossum, porcupine, rats, shrews, striped skunk, voles, and yellow-bellied marmots are "unclassified" but still managed by WDFW. Exceptions to this are species classified as protected under WAC 220-200-100 (e.g. western gray squirrels (*Sciurus griseus*). Deer, elk, bear, or turkey are subject to mandatory reporting of hunting activity under WAC 220-413-100 and furbearer trapping activity is subject to mandatory reporting under 220-417-020 and RCW 77.15.160 (3)(b).

1.7.2 *How Does WS-Washington Work with Washington Department of Fish and Wildlife?*

WDFW has authority to manage wildlife conflicts within the State of Washington and delegate its authority to agents or a landowner/manager, depending on the entity requesting assistance. WS-Washington is developing an updated MOU with WDFW and maintains cooperate service agreements to conduct MDM at the request of WDFW. This document establishes a cooperative relationship between WS-Washington and WDFW and outlines roles and responsibilities and agreements for responding to wildlife damage conflicts in Washington.

Under the Cooperative Service Agreements, WS-Washington provides professional assistance upon request to resolve wildlife and human conflicts related to certain wildlife damage to agriculture, horticulture, animal husbandry, forest and range resources, natural resources, threatened and endangered species, and public health and safety. WDFW may request assistance from WS-Washington for any species under their responsibility, with WS-Washington acting as their agent for WDM work. While WS-Washington may act as an agent for WDFW, WDFW remains the regulatory agency for wildlife management decisions. WDFW is responsible for issuing any required permits for management actions and can specify the methods to be used.

Any state agencies not currently under an intergovernmental agreement with WS-Washington may enter into one consistent with the analyses and impacts in this EA and APHIS-WS policies and directives, and thereby the activities would be covered by this EA.

1.8 How Does WS-Washington Work with Federal Agencies?

WS-Washington has numerous federal agency cooperators that manage federal lands and facilities. Federally-managed lands/facilities in Washington total 28.6% of the total acreage in the state[1]. This includes, but is not limited to, military bases, hydroelectric facilities, national forests, recreation areas. WS-Washington may be requested by a federal agency to provide MDM assistance on any of these lands or facilities. WS-Washington coordinates these activities carefully with the federal agency using a MOU, Interagency Agreement, and/or Annual Work Plan. In some cases, WS-Washington may be asked to conduct MDM by entities that have a lease (such as grazing allotments) on the land. WS-Washington coordinates all activities related to livestock protection with the land management agency prior to conducting work, in accordance with existing MOUs.

From FY2015-2015, approximately 90% of MDM conducted by WS-Washington on federally-managed lands/facilities was for the protection of human health and safety (e.g. aviation safety, roads, dykes, and levies) or T&E species protection (e.g., protection of salmonids at hydroelectric facilities.

1.8.1 How Does WS-Washington Work with the U.S. Forest Service and the BLM?

The USFS and the BLM manage federal lands for multiple uses, including wildlife habitat, livestock grazing, timber, wilderness, cultural resources, and recreation. BLM has one district in Washington, the Spokane District. As of FY15, BLM manages 0.4 million acres in Washington State, which is less than 1% of the land in Washington (Vincent et al. 2017).

USFS manages 9.2 million acres in Washington, totaling 22% of the land area of the state (Vincent et al. 2017). There are 31 designated Wilderness Areas in Washington State. This land is set aside by Congress to be protected and preserved in their natural condition, without permanent improvements or habitation (U.S. Forest Service). WS-Washington is not proposing any MDM in Wilderness Areas or Wilderness Study Areas.

WS-Washington coordinates with these land management agencies before performing MDM activities on lands under their jurisdiction. Current agreements with USFS are related to feral swine eradication. All national forests and BLM Districts may request WS-Washington assistance with emergency work at any time.

Over the last five years, 0.064% of WS-Washington's responses for assistance were conducted on BLM land, which accounts for 0.03% of Washington State's total land area. 0.128% of responses for assistance were conducted on Forest Service land, which accounts for 0.00004% of Washington's total land area (MIS 2020). WS-Washington has not conducted any in Wilderness Areas or Wilderness Study Areas.

[1] According to a 2017 Congressional Research Service Report Vincent, C. H., L. A. Hanson, and C. N. Argueta. 2017. Federal land ownership: Overview and data. Congressional Research Service. , ibid., there are 12.2 million acres of federally owned land in Washington, amounting to 28.6% of the total acreage in the state. Federal landowners in Washington include BLM (0.4 million acres), USFS (9.2 million acres), USFWS (0.2 million acres), NPS (1.8 million acres), and DOD (0.4 million acres).

1.8.2 What MOUs Does APHIS-WS Have with the USFS and BLM?

APHIS-WS has memoranda of understanding (MOUs) with the USFS (2017) and the BLM (2020) for MDM work on federal lands and resources under their jurisdiction.

A. MOU with the USFS (USDA Wildlife Services and U.S. Forest Service 2017)

- Documents the cooperation between the USFS and APHIS-WS for managing indigenous and feral vertebrates causing resource damage on USFS lands, minimizing livestock losses due to predation by coyotes, mountain lions, and other mammals, 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.

- APHIS-WS evaluates needs for MDM in cooperation with the USFS, develops and may annually update 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 MDM 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 USFS lands and may report on MDM 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 may provide technical assistance and training to the USFS on MDM methodologies when requested.

B. MOU with the BLM (USDA Wildlife Services 2020):

- Documents cooperation with BLM, APHIS-WS, and state governments, provides guidelines for field operations, and identifies responsibility for NEPA compliance for MDM 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 MDM 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 mammal damage management in 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 mammal 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.

1.8.3 How Does WS-Washington Work with the USFWS?

When MDM activities may affect federally listed threatened or endangered species, WS-Washington consults with the USFWS to ensure its program will not jeopardize the continued existence of the listed species. 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. Effects of WS-Washington activities on federally listed species in Washington were evaluated by the USFWS in a Biological Opinion and informal consultation on 20 June 2014. WS-Washington follows operational measures outlined in its ESA consultation documents to minimize the risk of take of listed species (Section 2.4).

Minimization measures, reasonable and prudent measures, and terms and conditions included in the consultation and Biological Opinion are identified in Section 2.4 and analyses of the potential impacts of WS-Washington activities on federally-threatened and endangered species are located in Section 3.7.

WS-Washington directly assists the USFWS in protecting ESA-listed species (e.g. western snowy plover). Additionally, WS-Washington notifies USFWS of ESA-listed species presence if individuals of the listed species are observed outside of known areas.

APHIS-WS has a national Memorandum of Understanding with the FWS (USDA Animal and Plant Health Inspection Service and U.S. Fish and Wildlife Service n.d.), 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 minimize 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 minimize 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.

USFWS has historically requested MDM assistance for the protection of habitat from invasive species on USFWS managed lands. In these agreements, coordination between WS-Washington with the USFWS ensure that MDM actions are consistent with land management objectives.

1.8.4 How Does WS-Washington Work with the National Marine Fisheries Service?

The National Marine Fisheries Services (NFMS) administers the Marine Mammal Protection Act (MMPA) for cetaceans (e.g. whales) and pinnipeds (e.g. seals) and manages most ESA-listed marine species. When MDM activities may affect mammals protected or ESA, WS-Washington consults with the National Marine Fisheries Service NMFS to ensure it will not jeopardize the continued existence of ESA listed species. For actions covered under Section 7 of the ESA, for species under NMFS jurisdiction, federal agencies must consult with the NMFS when any action the agency carries out, funds, or authorizes may affect a specially protected species. Effects of WS-Washington activities on protected marine species in Washington were evaluated by the NMFS in a Biological Opinion and informal consultation on 30 November 2018 and completed on April 30th, 2018. WS-Washington follows operational measures outlined in its ESA consultation documents to minimize the risk of take of listed species (Section 2.4). Additionally, WS-Washington directly assists in the protection ESA-listed species under NMFS jurisdiction (e.g. salmonids).

Minimization measures, reasonable and prudent measures, and terms and conditions included in the consultation and Biological Opinion are identified in Biological Opinion and analyses of the potential impacts of WS-Washington activities on federally-threatened and endangered species are located in Section 3.6.

1.8.5 How Does WS-Washington Work with the Department of Defense?

WS-Washington works with DOD facilities primarily for necessary resolution of wildlife damage at military airfields to support aviation safety. WS-Washington may also conduct on other DOD facilities to protect other resources such as natural resources, housing, and military assets. WS-Washington implements MDM through close coordination with installation management agencies to ensure MDM actions are consistent with installation natural resource management plans and to comply with security restrictions.

1.8.6 How Does WS-Washington Work with the Army Corps of Engineers?

WS-Washington conducts MDM for the USACE, when requested, to reduce predators' (e.g. California sea lions) impacts on ESA-listed species. USACE consults and coordinates with NMFS, who administers the MMPA and ESA, to ensure MDM actions comply with ESA and MMPA.

1.8.7 How Does WS-Washington Work with the Federal Aviation Administration and National Association of State Aviation Officials?

- WS-Washington works with the Federal Aviation Administration (FAA) and National Association of State Aviation Officials (NASAO), when requested, for necessary resolution of wildlife damage at airports to support aviation safety. 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, technical and operational damage management assistance, and necessary training to the aviation community to ultimately reduce the risk of wildlife hazards and ensure safer operations at airports.

1.9 How Does WS-Washington Comply with NEPA?

1.9.1 How Does NEPA Apply to WS-Washington's MDM Activities?

WS-Washington MDM 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 prepared this analysis in compliance with the 1978 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. This EA was prepared in accordance with the 1978 CEQ regulations. 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 regarding WS-Washington's implementation of MDM in Washington have prompted WS-Washington to initiate this new analysis. The analyses contained in this EA are based on information and data derived from APHIS-WS' Management Information System (MIS) database; data from WDFW regarding species under their jurisdiction; published and, when available, peer-reviewed scientific documents referenced cited and those reviewed but not cited (a list of literature reviewed included in Chapter 4); interagency consultations; public involvement; and other relevant sources.

This EA describes the needs for resolving mammal damage problems for which WS-Washington 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-Washington involvement in MDM.

To assist with understanding applicable issues and reasonable alternatives to managing mammal damage in Washington and to ensure that the analysis is complete for informed decision-making, WS-Washington 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]).

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 1.12), WS-Washington is coordinating the preparation of this EA with cooperating and consulting partner agencies, including BLM, USFWS, USFS, WDFW, WSDA, WSCC, WDOT, and WDNR. WS-Washington also recognizes the sovereign rights of Native American tribes to manage wildlife on tribal properties, and has invited all federally recognized tribes in Washington to cooperate or participate in the development of this EA. The WS-Washington program is committed to coordinating with all applicable land and resource management agencies, including tribes.

1.9.2 How will this EA Be Used to Inform WS-Washington's Decisions?

WS-Washington will use the analyses in this EA, including input from consulting and cooperating agencies, to help inform it's decision-making, including whether to prepare an EIS or a FONSI; and whether or not to continue WS-Washington MDM activities and, if so, to determine how and to what degree such activities would be implemented.

The purpose of the proposed action (Alternative 1-No Action alternative) is to respond to requests to manage damages and threats associated with mammals that prey on, harass, or damage livestock, wildlife and other natural resources, and that threaten/damage agricultural resources, property, and human health and safety. The proposed action would continue most work described/analyzed in the 1997 Predator EA, the 2010 Predator EA Supplement, and the 2008 Aquatic Mammals EA. This EA incorporates new and relevant information and combines the former analyses to cover all MDM actions into one document. This will simplify WS-Washington's environmental processes and better facilitate agency and public involvement. This EA re-evaluates the actions from two existing documents and gives agencies and the public additional opportunity to comment on WS' mammal work and provide new, pertinent information for WS-Washington's review.

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-Washington can reasonably expect to be acting. Although WS-Washington can predict some of the locations or types of situations and sites where some kinds of mammal-related damage could occur, the program cannot predict each specific location or time when resource owners would determine that damage has become intolerable to the point that they request assistance from WS-Washington. Therefore, WS-Washington must be ready to provide assistance on short notice anywhere in Washington to protect any resource or human/pet health or safety upon request.

The APHIS-WS Decision Model (Section 2.2.1.2) is the site-specific procedure for individual actions conducted by WS-Washington 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 2.6), 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 Washington for which WS-Washington may be requested for assistance. Using the Decision Model (Section 2.2.1.2) 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-Washington objectives.

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

The geographic scope of the actions and analyses in this EA is statewide. WS-Washington decided that one EA analyzing potential operational impacts for the entire State of Washington provides a more comprehensive and less redundant analysis than multiple EAs covering smaller regions. 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-Washington MDM activities may occur encompasses rural and urban areas, including residential and commercial development, rangelands, pastures, ranches and farms, agricultural croplands, timber and forested areas, recreation areas and trails; airports, and other places where mammals may overlap with human occurrence, activities, and land uses and create conflicts.

WS-Washington anticipates requests for assistance to follow patterns observed in recent years. Routinely, operational damage management areas may include:

A. Private Property

Private property may be in urban, suburban, and rural areas, including agricultural lands, timberlands, pastures, residential complexes, subdivisions, and business developments.

B. Federally-Managed Lands

30.6% of the responses to damage or damage threats by the species in this EA occurred on federally-managed lands accounting for 0.12% of Washington State's acreage. The percentage of responses to damage or damage threats followed by the percentage of

Washington State's total acreage is given by federal entity; USACE (17.26% and 0.05%), military land (9.47% and 0.04%), USFWS land (3.71% and 0.04%), USFS land (0.1% and 0.00004%), and BLM land (0.06% and 0.03%). Per MOUs with the USFS and BLM, WS-Washington responds to permittee and agency requests for MDM for protection of livestock on federal grazing allotments, protection of T&E species, and eradication of feral swine. WS-Washington coordinates with the agencies prior to the grazing/recreation seasons to identify needs, types of operations, and restrictions (U.S. Forest Service 2017, USDA Wildlife Services 2020), and reports annually to the agencies on their activities (Section 1.9). WS-Washington may respond to requests for assistance with feral swine eradication, human health and safety incidents, and the protection of ESA-listed species on federal lands. WS-Washington is not proposing any MDM in special management areas (e.g. wilderness areas) and any analysis for IWDM actions in special management areas would be covered in a separate analysis.

WS-Washington has not and is not proposing to conduct any MDM in Wilderness Areas, Wilderness Study Areas, Wild and Scenic Rivers, Areas of Critical Environmental Concern, National Recreational Areas, National Conservation Areas, or National Monuments. A complete list of areas excluded from the analysis can be found in Appendix D.

C. State-Managed Lands and Municipal Property

27% of the responses to damage or damage threats by the species in this EA occurred on state and municipal property. Activities are conducted, when requested, on properties owned/managed by municipalities including ports/airports which are managed as municipal corporations in Washington. Such properties can include ports, airports, dikes and dams not managed by COE, parks, forestland, historical sites, natural areas, scenic areas, conservations areas, and campgrounds. 99.5% of responses accounting for 99.8% of lethal take occurred on port property, airport property, dams, and dikes. Sometimes private landowners that are being affected by mammals that reside in habitat located on adjacent public lands may request assistance. The adjacent property owner/manager may agree to allow MDM activities to occur to assist the affected private landowner. WS-Washington can also conduct MDM activities directly on state and city properties, as agents for WDFW when requested, or independently. Airports request MDM activities often due to small mammals, some of which are prey for and attract raptors and coyotes, found within fenced active airfields, these mammals can become hazards to aviation safety. Even with an appropriate wildlife deterrent fence, larger mammals such as coyotes and deer can gain access to the runways. WS-Washington receives requests for assistance and training from several airport authorities to address threats of wildlife strikes in Washington and predicts requests for assistance at airports in the future. WS-Washington currently provides technical assistance, operational damage management, and/or training to 27 airports in Washington.

D. Tribal Property

Tribal governments and landowners can request assistance from WS-Washington for MDM on lands under their authority/ownership. Many mammal species have an important role in tribal culture and religious beliefs. WS-Washington continues to work with tribes to address their needs through offers for consultation on this EA, with policy, and in the field, as requested. Work conducted at the request of tribal governments would be consistent with tribal decisions, values, and traditions of the requesting tribal entity.

Native American tribes may choose to work with relevant cooperating agencies for meeting MDM needs, use WS-Washington's services, hire commercial control companies, or conduct their own work. Any participating tribes would need to make their own decision regarding the management alternative they choose to implement. WS-Washington respects the rights of sovereign tribal governments, provides early opportunities for all federally-recognized tribes in Washington to participate in planning and developing MDM strategies affecting tribal interests and requests for assistance through consultations, cooperating agency status, and effective means of engagement through the government-to-government relationship consistent with USDA APHIS Directive 1040.3 and federal policy.

1.9.4.1 Summary of Geographic Scope of Past MDM actions

Table 3. Summary of Geographic Scope of Lands under MDM Agreement with WS-Washington and MDM Responses FY2015-2019

Landowner under Agreement with WS-Washington	MDM Responses by Land Class	Acres Under Agreement with WS-Washington	Percent of Lands Under MDM Agreement with WS-Washington	Percent of Washington States Total Land Area
BLM	0.06%	15,662	0.9%	0.03%
County or City	9.30%	666,925	39%	1.46%
US Fish and Wildlife Service	3.72%	20,230	1.2%	0.04%
US Forest Service	0.13%	20	<1%	<0.01%
Military	9.47%	17585	1%	0.04%
Other Federal	17.27%	1,614	<1%	<0.01%
Other Public	14.38%	22,858	1%	0.05%
State	3.37%	55,074	3%	0.12%
Private	42.31%	905,032	53%	1.98%
Total	-	**1,705,000**	**-**	**3.73%**
Washington State's Total Land Acreage		**45,671,680**		

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

WS-Washington 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. The section of the APHIS NEPA Implementing Regulations that addresses actions requiring EA can be found in 7 CFR 372 § 372.5(b)(5).

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-Washington can make an informed decision on whether or not an EIS is required for the WS-Washington MDM activities included in this EA. If WS-Washington makes the determination that, based on this EA, the selected alternative would have a significant impact on the quality of the human environment, then WS-Washington will 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)).

1.10.1 How will WS-Washington 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-Washington 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-Washington 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-Washington 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-Washington 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-Washington 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-Washington IMDM program. Determination of significance of the impacts predicted in this analysis does not occur in this EA but is made by the APHIS-WS decision maker documented in the appropriate decision document.

1.10.1.1 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 that are applicable to APHIS-WS informed decision-making.

1.10.1.2 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-Washington uses the best available data and information from wildlife agencies having jurisdiction by law (WDFW, WSDA, and USFWS; 40 CFR §1508.15), as well as the scientific literature to inform its decision-making. Data provided by those experiencing damage (e.g., livestock producers identifying the economic value of livestock lost to predation) 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 those damages in Section 1.12.

WS-Washington recognizes that estimating wildlife populations over large areas can be extremely difficult, labor intensive, and expensive. Any state wildlife management agency, including WDFW, has limited resources for estimating population levels and trends for mammal 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. Therefore, these state agencies do not always set population management objectives for these species. This EA uses the best available information from wildlife management agencies, including WDFW and WDNR when available, and peer-reviewed literature to assess potential impacts to mammal 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 WDFW 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 3.4 and 3.5 Provide information for WS-Washington to determine if WS-Washington's contribution to cumulative mortality from all sources would adversely affect population levels for each mammal species considered.

1.10.1.3 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 cultural and historic resources, and compliance with other environmental 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: Section 3.7
- Impacts to unique geographic areas: Section 3.12
- Impacts to cultural and historic resources: Section 3.10
- Compliance with other environmental laws: Sections 1.1 and 2.4

1.10.1.4 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:

- Impacts to target species' populations, as each population has many sources of mortality, loss of habitat, climate change, and/or other stressors, only one of which is take by WS-Washington;
- Impacts to non-target species' populations, as each population has many sources of mortality, loss of habitat, climate change, and/or other stressors, and only one source of mortality is take by WS-Washington;
- 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 certain mammal species (e.g. predators and beavers), as many ecological factors contribute to any resulting impacts; and
- 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.

1.10.1.5 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 Chapter 3 (Section 3.10):

- The risk of injury to WS-Washington employees during aerial shooting operations;
- The potential for humans to ingest lead sourced from ammunition through water and game meat;

- The potential for hazardous chemicals being spilled or leached into surface and groundwater, and being ingested by humans;

- The risk of injury to the Public from WS-Washington's use of traps, firearms, aerial operations, trained animals, and chemical IMDM methods;

- The risk of injury to WS-Washington employees while working with traps and captured animals, using firearms, during aerial operations, using trained animals, implementing chemical IMDM methods.

1.10.2 How Do Key Statutes and Executive Orders Apply to the WS-Washington Program?

Appendix B provides additional details on all the federal and state laws and executive orders relevant to WS-Washington activities. This section addresses Washington-specific application of highly relevant laws.

Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)

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

Endangered Species Act (ESA)

WS-Washington has consulted with the USFWS and NMFS regarding the impacts of the proposed action. See Section 3.6 for discussion of the effects on T&E species.

National Historic Preservation Act

WS-Washington has reviewed its program per this EA and concluded that the program is not an "undertaking" as defined by NHPA and that consultation with the SHPO is not necessary. WS-Washington works with the USFS and BLM on their lands to ensure there are no conflicts with cultural resources. WS-Washington has also reached out to tribes as discussed under "Consultation and Coordination with Indian Tribal Governments" in this section, and no issues were identified. Each method described in the EA that WS-Washington may use operationally 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-Washington under the proposed action are not generally the types of activities that would have the potential to affect historic properties.

If an activity with the potential to affect historic resources is planned under an alternative selected as a result of a decision based on the analysis in this EA, then site-specific consultation as required by Section 106 of the NHPA would be conducted as necessary.

Consultation and Coordination with Indian Tribal Governments (EO 13175).

WS-Washington 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. WS-Washington is committed to respecting tribal heritage and cultural values when planning and initiating wildlife damage management programs. Consultation and coordination with tribal governments is conducted consistent with EO 13175 and APHIS-WS' plan implementing the executive order. WS-Washington has offered opportunities for formal government-to-government consultation on its proposed program to federally-recognized tribes in Washington and has requested their involvement for this EA through direct invitations (September 13th, 2019) and draft EA review opportunities.

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

The USFWS has delegated permitting of aerial shooting to WDFW. WDFW has authority to permit aerial shooting in WA [16. U.S. Code §742j-1 (b)(2.)]. WDFW at the time of the EA has determined that only they and WS-Washington will be permitted to conduct aerial shooting (Section 1.8). Changes to WDFW's aerial shooting policies will be assessed and if appropriate, new NEPA analysis may be conducted.

Compliance with Executive Order 12898 "Environmental Justice"

This EO relates to the fair treatment of all races and income in regard to the potential for disproportionate adverse social, health, and environmental impacts to minority and low income populations. WS-Washington 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 mammals and economic impacts from depredation and damage.

WS-Washington personnel use damage management methods as selectively and environmentally conscientiously as possible. All chemicals used by APHIS-WS are regulated by the EPA through FIFRA, WSDA, and use is conducted in accordance with MOUs with federal land managing agencies and by APHIS-WS Directives. Based on a risk assessment conducted in Section 3.11.3 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-Washington program properly disposes of any excess solid or hazardous waste and has been found to manage its chemicals appropriately (OIG Report 2015). 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.

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 minimize them, and WS-Washington has considered the impacts that alternatives analyzed in this EA might have on children. All WS-Washington mammal 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 WS-Washington activities and Section 3.10 for an analysis of their impacts.

1.11 What are the Needs for the WS-Washington Mammal Damage Management Program?

1.11.1 What is the Need for WS-Washington MDM Activities?

WS-Washington's need for action is to respond to requests for assistance from any entity requesting assistance with mammal damage in Washington state. Most cooperators tolerate some damage and loss until the damage reaches a threshold where the damage becomes an economic, physical, or emotional burden. The point at which a particular entity reaches their tolerance threshold and requests assistance is affected by many variables specific to the affected entity. As a government entity, WS-Washington does not refuse services to anyone or any entity without cause, because that would not be consistent with the fairness standards of USDA, APHIS, or WS.

WS-Washington 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 large mammals. Therefore, WS-Washington 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 conflicts.

Whenever practical, WS-Washington recommends that cooperators take non-lethal action in lieu of or in addition to operational management lethal actions conducted by WS-Washington personnel. However, the appropriate strategy for any set of circumstances must be determined on a case-by-case basis, using the APHIS-WS Decision Model.

Two independent government audits, one conducted at the request of Congress (GAO 2001), the other based on complaints from the public and animal welfare groups to the USDA (OIG 2015, Section 1.13.2.1), found that, despite cooperator implementation of non-lethal actions (such as damaging wildlife exclusion, herding, and harassment) a need exists for APHIS-WS' MDM activities. These audits determined that APHIS-WS' management actions are necessary.

Frequently damage or damage threats impacts multiple types of resources (e.g. human health and safety and residential property). Protected resources are identified by land managers/owners during the initial request for assistance and additional resources can be identified by WS-WA if readily apparent. Management of one type of damage/damage threat can protect multiple resources. An example is management of beaver that are damaging road infrastructure and blocking fish passage of ESA listed salmonids. Table 1 below summarizes the damage reported to WS-Washington from FY14-FY18 by species and by category of damage. This list is intended to provide an outline of the damages caused by different species following sections. Each category of damage identified in the table is explained in detail (sections 1.12.2 through 1.12.6). Table 1 is not an exhaustive list of all types of damage caused by species covered under this EA that WS-Washington may provide assistance within the future.

Table 4. Need for Action Represented by Resources Damaged by Species for FY2015 through FY2019

	Health and Safety - General	Health and Safety - Infrastructure	Health and Safety - Aviation	Agriculture – Crops	Agriculture – Livestock	Residential – Property	Non-Residential Property	Timber	Natural Resources
BADGERS	X		X						
BATS	X		X			X	X		
BATS, BROWN, BIG	X		X			X	X		
BEARS, BLACK	X			X	X	X	X	X	
BEAVERS	X	X	X	X	X	X	X	X	X
BEAVERS, MOUNTAIN	X	X		X		X	X	X	X
BOBCATS	X				X		X		X
CATS, FERAL/FREE RANGING	X		X		X	X	X		X
CHIPMUNKS						X			
COYOTES	X	X	X	X	X	X	X	X	X
DEER, BLACK-TAILED	X		X	X			X		
DEER, MULE			X						
DEER, WHITE-TAILED (WILD)			X	X			X		
DOGS, FERAL, FREE-RANGING AND HYBRIDS	X		X						
ELK, WAPITI (WILD)	X			X	X		X	X	X
FOXES, RED	X				X				X
LIONS, MOUNTAIN (COUGAR)	X				X			X	
MARMOTS, YELLOW-BELLIED	X	X	X	X		X	X	X	
MICE	X					X			X
MINKS					X	X	X		
MOLES (ALL)		X		X		X	X		
MUSKRATS	X	X	X	X		X	X		X
NUTRIAS	X	X		X	X	X	X	X	X
OPOSSUMS, VIRGINIA	X		X	X	X	X	X		X
OTTERS, RIVER	X	X	X	X		X	X	X	X
POCKET GOPHERS, NORTHERN	X	X	X		X	X	X	X	
PORCUPINES		X	X					X	

	Health and Safety - General	Health and Safety - Infrastructure	Health and Safety - Aviation	Agriculture – Crops	Agriculture – Livestock	Residential – Property	Non-Residential Property	Timber	Natural Resources
RABBITS, COTTONTAILS, EASTERN	X		X	X			X	X	
RABBITS, COTTONTAILS, NUTTALL'S							X		
RABBITS, FERAL			X	X		X	X		
SHEEP, BIGHORN									X
RACCOONS	X	X	X	X	X	X	X		X
RATS, NORWAY (BROWN)	X			X	X	X	X		X
RATS, BLACK (ROOF)	X				X	X	X		
SEA LIONS, CALIFORNIA									X
SEA LIONS, STELLER									X
SKUNKS	X	X			X	X	X		X
SQUIRRELS, DOUGLAS	X					X	X		X
SQUIRRELS, EASTERN GRAY	X			X		X	X		
SQUIRRELS, FOX						X	X		
SQUIRRELS, WESTERN GRAY	X					X	X		
SQUIRRELS, GROUND CALIFORNIA	X						X		
SQUIRRELS, GROUND, COLUMBIAN		X	X				X		
SWINE, FERAL	X				X		X		X
VOLES (ALL)							X		X
WEASELS	X				X	X			X
WOODCHUCKS		X					X		

1.11.2 How Many Requests for WS' Assistance Occur in Washington?

Requests for assistance are an indication of the level of need for MDM work to be conducted by WS-Washington, but these requests represent only a portion of the actual need. For example, Connolly determined that only a fraction of the total predation attributable to coyotes was reported to or verified by APHIS-WS nationally (Connolly 1992). 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 killed by mammals.

WS-Washington does not currently capture the number of unique events or requests for service in the MIS database; however, in each work task entry, WS-Washington records 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-Washington to provide technical assistance, to conduct a wildlife damage field evaluation/assessment/investigation, or to continue work on an MDM activity/project in progress. The number of work tasks serves as an index of the intensity of effort needed by WS-Washington to address incidents involving the damage 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-Washington for those types of resource/species combinations. This information describes the frequency of responses to requests for assistance.

Table 5. Number of mammal-related operational damage management agreements WS-Washington responded to per year for FY2015 through FY2019

FY	Number of Agreements
15	178
16	184
17	158
18	166
19	149
Average	167

At the time of providing a response to an individual request for service, WS-Washington may provide a requester with information, demonstrations, recommendations for strategies that the landowner may implement (technical assistance), and/or operational damage management in which WS-Washington takes direct action to address the damage situation. Conflict data recorded for each field visit may cover multiple individuals damaging multiple resources and does not capture the number of requests for each damaging individual or quantities of threatened/damaged resources (e.g. number of livestock animals).

1.11.3 What is the Need for MDM in Washington for Protection of Public Safety, Health, and Pets?

Those species that people are likely to encounter are those most likely to adapt to and thrive in human-altered habitats due to the availability of food, water, and shelter inadvertently (and purposefully) provided by residents. These habitat alterations may include landscaping vegetation, artificial pools, pet food, bird feeders, presence of pets (leashed or unleashed), garbage, piles of waste debris, and woodpiles. Often the reason for damaging wildlife exploiting a human built resource is inherent in the design of recreational facilities (e.g. golf courses), waste treatment facilities (e.g. landfills), and other various structures. The form of these manmade facilities provides the landscape structures that artificially increase carrying capacity. Frequently wildlife's use of these areas/structures results in damage that either directly conflicts with or prohibits use (e.g. damage to residence from breeding raccoons, damage to waste containment areas by mammals digging, damage to recreational fields by burrowing mammals making them unsafe for use). Even situations in which begin with relatively minimal damages can escalate into conflicts with human health and safety that result from these damages.

Wildlife damage that affects property or agricultural, commercial, and industrial businesses results in financial losses that are often argued to be the "cost of doing business" or part of living with wildlife. With these types of damage some threshold of damage tolerance must be exceeded before a resolution to the damage is sought. However, when conflicts of human health and safety occur there is very little to no tolerance for wildlife damage that results directly or indirectly in injury or death. Therefore, MDM for the protection of human health and safety is necessarily proactive and involves greater cooperation with government agencies, private individuals, and the public. For the purposes of this EA risks to human health and safety have been broken into three categories of risk: aviation safety, damage to infrastructure, and general.

1.11.3.1 What is the extent of mammal damage threat to airports?

From FY2015-FY2019, 16% of WS-Washington MDM operational activities were in response to threats to aviation safety (MIS 2020). Mammal presence on airfields is an immediate threat to human health and safety. Wildlife-aircraft strikes involving mammals are generally more damaging that strikes with other kinds of wildlife. Strikes involving large mammals, specifically deer and elk, can be catastrophic, resulting in loss of life and property. 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.

Airports take wildlife presence on airfields very seriously and generally employ a wide range of deterrent measures to safeguard aviation., including fencing, wildlife patrols, and many types of harassment. However, airports provide large areas of land with limited human disturbance, making them ideal wildlife habitat

There were 53 mammal strikes in Washington reported to the FAA (reporting is voluntary) between 1990 and 2015. Coyotes, rabbits, and deer comprised over half of those reports. Airports, the FAA, and the Washington State Department of Transportation - Aviation have requested assistance with managing threats to aviation and human safety associated with mammals at airports.

1.11.3.2 What is the extent of mammal damage threat to other transit systems and infrastructure?

From FY2015-FY2019, 15% of WS-WA responses involving operational damage management are to protect infrastructure, such as roadways and bridges (MIS 2020). Beaver are the main species identified in these damage situations and are responsible for a variety of different kinds of damage (Loven 1985, Wade and Ramsey 1986, Willging and Sramek 1989, Miller and Yarrow 1994).

There are three primary means by which beaver damage occurs: damming, burrowing, and chewing. Damming causes damage to drainage areas, storm water retention ponds, and blockage of waterways, causing roads, railways, and areas adjacent to flood that results in erosion of road and railway beds (Hill and Carpenter 1982, Woodward 1983, Wade and Ramsey 1986, Miller and Yarrow 1994). In flat terrain, a relatively small beaver dam may cause hundreds of acres to be flooded. Beaver bank dens damage infrastructure by undermining walkways, roads, and railways, drain storm water retention ponds, and damage reservoir levees (Wade and Ramsey 1986). Beaver chewing can remove or girdle waterway side vegetation that can result in erosion and destabilization of the waterways bank. Beaver chewing the wooden pilings on piling docks can make the dock unsafe for use.

Beaver activity that degrades infrastructure can also threaten public health and safety. For example, a beaver blocking water flow with a dam can cause flooding of roadways, leading to serious vehicle accidents (Miller 1983, Woodward 1983). Increased water levels in urban areas resulting from beaver activity can lead to unsanitary conditions and potential health problems by flooding septic systems and sewage treatment facilities (de Almeida 1987a, Loeb Jr. 1994). Beaver can damage large trees either by girdling or, when near stream banks, undermined by bank dens. Those large trees present a hazard to safety by potentially falling onto nearby residences, roads, walkways, and businesses.

Nutrias, marmots, and muskrats are other burrowing mammals whose actions result in destabilizing levees/dams and undermining roads and railways with their burrows.

There is a low tolerance for damage to infrastructure and often wildlife conflict is resolved before any observable damage occurs. Though damage to infrastructure is not always immediately apparent as in cases like damage from the undermining of roads and railways. Damages may not become apparent for months or even a year after the damage is done thus are infrequently reported to wildlife services.

1.11.3.3 What is the Potential for Risk to General Human Health and Safety?

From FY2015-2019, 17% of WS-Washignton responses involving operational damage management were to protect human health and safety not associated with aviation or infrastructure (MIS 2020).

General human health and safety threats are those presented by animal attacks on humans and their pets, vehicle collisions, zoonotic diseases, and less directly by unsanitary conditions created by wildlife in certain places (e.g. hospitals, residences, schools, dining areas). Threats to general health and safety can prove difficult for members of the public to discern at times. This difficulty is compounded by limited knowledge of what constitutes abnormal animal behavior and indirect health risks presented by some species. For example, coyotes witnessed by the public during the day often raise concern over safety when no threat to human safety exists.

1.11.3.4 What is the Potential for Risk to Human and Pet Health and Safety from Mammals?

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. Many people enjoy wildlife to the point of purchasing food specifically for feeding wildlife despite laws prohibiting this.

RCW 77.15.790 prohibits negligently feeding, attempting to feed, or attracting large wild carnivores to land or a building. Even an intermittent presence of human-created refuse, water, or prey found in areas of human development often increases 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, removal through management actions, and unintentional 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 exhibit bold and even dominant behavior toward humans. Animal behavior may then either appear to be or 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 Washington, but attacks on pets are not.

1.11.3.5 What is the Extent of Conflict between Humans and Coyotes in Washington?

Although wildlife attacking people rarely occurs, the number of attacks appears to be on the increase, especially near human residential areas. Timm and Baker 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 (Timm and Baker 2007). Their database found 111 incidents (except for one) in California, occurring since the early 1970s, 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.

WDFW and Timm and Baker (2007) found 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 or even intentionally feeding it. After emboldened coyotes become accustomed to a being provided with food, the abrupt removal 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 Washington, WDFW receives many complaints from the public related to urban coyotes.

The first report of a coyote attack on humans in WA was in 2006. Another confirmed coyote attack occurred in Washington in December 2012 and involved 3 coyotes attacking an adult man in his backyard (adjacent to an elementary school) in Kent, WA, biting him on his leg, and requiring a series of 26 post-exposure rabies shots (Drew 2012). WS-Washington received damage reports from coyotes in excess of $1M during the reporting period (MIS 2020).

There are many preventative, 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. 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.

When non-lethal methods are not effective or human health and safety is at imminent risk, lethal methods may be needed. WDFW considers coyotes as unclassified wildlife and they may be hunted throughout the year, but a state license is required to hunt or trap them (RCW 77.32.010). If coyotes are damaging crops or domestic animals the owner, owner's immediate family members, owner's documented employees, or tenants of the real property on which the damage is occurring may kill or trap coyotes on that property (WAC 220-440-050, WAC 220-440-060). A hunting license is not required in such cases (RCW 77.36.030, WAC 220-440-060), but a special permit is required for body-gripping traps. In order to reduce damage, it is not necessary or possible to eliminate all coyotes. Removal of specific problem individuals can resolve many coyote problems and cause other coyotes to once again be fearful of humans (Washington Department of Fish and Wildlife)

Timm et al. (1998) 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 (Baker and Timm 1998). Previously, traps were also shown to be effective at removing coyotes from Glendale, California, shortly after a child was killed in his yard. City and 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).

During FY2015-FY2019, WS-Washington responded to 224 conflicts (work tasks) with pets, 37% of which were related to coyotes, 39% to raccoons, 11% to river otters, 5% to striped skunks, and 5% to Virginia opossums (MIS 2020).

Table 6. Coyote Complaints Received by WS-Washington from FY 2015 through FY 2019

Resource Protected	2015	2016	2017	2018	2019
Pets	47	18	9	9	4
Human Health/ Safety General	112	48	40	43	55

1.11.3.6 What is the Extent of Conflict between Humans and Beaver in Washington?

As discussed in section 1.12.4.2 beaver activity in certain situations can threaten public health and safety (e.g., burrowing into or flooding of roadways and railroad beds can result in serious vehicle accidents) (Miller 1983, Woodward 1983). Though conflict with infrastructure is the largest threat to human health and safety caused by beaver in Washington, beaver activity conflicts with human health and safety in other ways as well. Increased water levels in urban areas resulting from beaver activity can lead to unsanitary conditions and potential health problems by flooding septic systems and sewage treatment facilities (De Almeida 1987b, Loeb Jr. 1994). Beaver damming activity also creates conditions favorable to mosquitoes (Aedes spp.) and can hinder mosquito control efforts or result in undesirable population increases of these insects (Wade and Ramsey 1986).

Beaver have been linked to other human diseases. They are known carriers of tularemia, a bacterial disease that is transmittable to humans through bites by insect vectors or infected animals or by handling animals or carcasses which are infected (Wade and Ramsey 1986) tularemia is also responsible for large-scale beaver die-offs (Addison et al. 1998). On rare occasions, beaver may contract the rabies virus and attack humans. In February 1999, a beaver attacked and wounded a dog and chased children that were playing near a stream in Vienna, Virginia; approximately a week later, a beaver was found dead at the site and tested positive for rabies. In 2012 two incidents involving beaver confirmed rabid through testing occurred within 3 days of one another; one in which the beaver bit a 83 year old woman swimming in Lake Barcroft in Fairfax County resulting in the woman's hospitalization and the other incident which a beaver chased kids fishing on a dock which resulted in no injuries (ABC News 7 2012).

Beaver are also known carriers of the intestinal parasite Giardia lamblia, which can contaminate water supplies used for human consumption and recreation (Beach and McCullough 1985). Giardiasis is an intestinal protozoal disease associated with ingesting fecal material in contaminated water. In a 1982 study of Giardia in Washington State, the Department of Social and Health Services, Washington State (DSHS) found that of 656 beaver stools tested, 10.9% were positive for Giardia. Of 172 muskrat stools tested, 51.2% were positive for Giardia (Frost et al. 1982).

Beaver damming activity can create conditions favorable for mosquitoes and can result in increased abundance of these insects (Wade and Ramsey 1986). West Nile Virus (WNV), a disease that is carried by birds, but is spread by mosquitoes, was first identified in the United States in 1999 in New York; beaver ponds create habitat for mosquitoes.

1.11.3.7 What is the Extent of Interactions between Humans and Black Bears, and Humans and Cougars in Washington?

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. Most threatening conflicts with bears in Washington occur in rural and urban residential areas and recreational areas such as campgrounds involving the presence of easy access human-provided food, typically garbage cans, bird feeders, feed storage sheds, or food kept in automobiles (Herrero and Fleck 1990). Access to readily available and nutrient dense human foods may almost double the reproductive potential of black bears (Rogers 1987). Potentially dangerous cougar 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. Cougar 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 mountain lion habitats, and habituation to people (Beier 1991;1992). Although rare, cougar attacks on humans in the western United States and British Columbia have increased in the last two decades (Beier 1992, Cougar Management Guidelines Working Group 2005), primarily due to increased cougar populations, reduced hunting, and increased human use of cougar habitats (Beier 1992). Fitzhugh et al. 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 (Fitzhugh et al. 2003).

In Washington state eight human-bear interactions not involving hunting in which a human received injuries have been documented in Washington; one human mortality in 1979 of a 4-year old girl was recorded (Bush 2016).

The first fatal cougar attack was reported in WDFW in 1924 recently Washington State experienced its second fatal attack on May 19th, 2018. The second attack occurred when two mountain bikers were stalked, scared the cougar away, and then attacked killing one and injuring the second. From 1924-2018 nineteen non-fatal attacks on humans were recorded by WDFW in Washington (Washington Department of Fish and Wildlife 2019g).

Additionally, in September of 2018 a hiker in Mt. Hood National Forest in Oregon was attacked and killed by a cougar (Elise Herron 2018). WDFW remains the primary entity for resolving cougar conflicts though WS-WA can respond to requests for assistance directly from requestors or at the behest of WDFW.

WDFW's Enforcement Program is responsible for responding and assisting the public regarding solutions to complaints about dangerous wildlife. Response to hazardous wildlife is within 24 hours by WDFW enforcement officers who have the authority to euthanize the offending animal. In situations not involving attacks on humans the officers can immobilize, mark, and relocate the offending animal one time only (Washington Department of Fish and Wildlife). In the event of an attack a tissue sample is sent to the State Health Department for rabies testing.

1.11.3.8 What is WDFW's Policy Regarding Relocation of Bears and Cougars?

When technical assistance does not resolve the problem or an eminent threat is likely, WDFW may attempt to live-trap and relocate the offending bear or request WS-Washington to do so for them. Generally, the WDFW will euthanize bears/cougars that are in poor physical condition, have been habituated to food sources associated with humans, or that cannot be live-captured safely. WDFW also has the authority to lengthen hunting seasons and increase the number of hunting permits in areas experiencing bear and cougar problems. However, most human-bear conflicts in Washington are resolved using advice or non-lethal solutions.

The success of relocating problem animals is often dependent on the age and sex of the relocated animal, as relocated bears may return to their original location or create similar problems in their new location (Rogers 1986).

WDFW's Enforcement Program is responsible for responding and assisting the public regarding solutions to complaints about dangerous wildlife. Response to hazardous wildlife is within 24 hours by WDFW enforcement officers who have the authority to euthanize the offending animal. In situations not involving attacks on humans the officers can immobilize, mark, and relocate the offending animal one time only (Washington Department of Fish and Wildlife 2019g).

1.11.3.9 What is the Potential for Disease Threat to Humans and Pets?

Zoonosis (i.e., wildlife diseases transmissible to people) are a major concern of cooperators when requesting assistance with managing threats from mammals. Pathogen transmission occurs through direct contact between infected and uninfected hosts, including host contact with a pathogen-contaminated environment or food product. Indirect transmission of pathogens, such as through an intermediate host or vector species such as mosquitos and biting flies, is another possible transmission pathway. Once a pathogen transmits to a new host species, such as livestock or pets, secondary cases of infection to the rest of the herd or humans can occur. Pets and livestock often encounter and interact with wild mammals, which can increase the opportunity of transmission of pathogens to humans. Diseases of wildlife, livestock, pets, and humans can be caused by viral, bacterial, or parasitic pathogen species.

Wildlife diseases are often poorly understood, and many members of the public have misconceptions about wildlife diseases. For example, MDM concerning bat species in Washington State is likely related to zoonotic disease concerns from bats inside of dwellings, schools, or hospitals. If a bite has occurred or if the bat is exhibiting disease symptoms taking the bat is taken to the appropriate laboratory for testing. However, most bats trapped inside of structures were merely looking for a day roost site (a place to rest for the day before returning to a primary roost site) and are not a significant threat of zoonotic disease transmission. In those instances, the bat is relocated outside the structure unharmed.

WS-Washington uses technical assistance to actively attempt to educate the public about the risks associated with pathogen transmission from wildlife to humans and pets. The transmission of pathogens from wildlife to humans is neither well documented nor well understood for most infectious zoonosis and can be complicated by the potential for multiple sources of infection. WS-Washington currently conducts minimal sampling for diseases that can be transmitted to humans and pets in Washington, as part of the WS-National Wildlife Disease Program. However, WS-Washington remains available to assist WDFW or the Department of Public Health with active or passive sampling, as requested and as funding allows.

1.11.3.9.1 What Diseases Threaten Humans and Pets exist in Washington?

Distemper which can be fatal to domestic dogs but is not a threat to human health. Raccoons, coyotes, red fox, skunks, and feral dogs have been implicated in outbreaks of distemper. Clinical signs of distemper include abnormal behavior, such as aggressive behavior and not showing fear of humans, which are similar to clinical signs of rabies. This can cause people that feel threatened by the possibility of disease transmission to request assistance after observing sick animals. The disease can be spread through direct contact with the aerosolized droplets of a coughing or sneezing host but also environmentally through shared food bowls and animal handling equipment. Additionally, the virus can be transmitted vertically from mother to fetus during pregnancy.

Parvovirus is highly infectious virus carried by coyotes, foxes, raccoons, feral cats and dogs, and other wildlife after coming in contact with infected animals or contaminated feces. Parvovirus is a common infectious domestic canine disease in the U.S. It has a high morbidity and mortality rate in unvaccinated and untreated dogs. Puppies and incompletely vaccinated dogs are the most at risk of infection, and affected puppies have the highest mortality rate (Martin et al. 2002, Nandi and Kumar 2010, Decaro and Buonavoglia 2011, Mitchell 2016). Wildlife can serve as a reservoir for the disease. When shed in feces, the virus is environmentally stable and extremely difficult to destroy.

Leptospirosis bacteria, carried by striped skunks, raccoons, red fox, and opossums can infect humans and pets. Transmission usually occurs by direct contact with urine-contaminated water or food. Pets are commonly infected when wildlife have access to water bowls or when they drink from streams. People living or working closely with animals, wild or domestic, have a higher risk of developing leptospirosis. Currently, WS-Washington is collecting blood samples as part of a nationwide research program conducted by the National Wildlife Research Center to determine the distribution and prevalence of *Leptospira* infection in canines and raccoons.

The raccoon roundworm, *Baylisascaris procyonis*, and skunk roundworm (*B. columnaris*) are common parasites of raccoons and skunks. While the parasite causes little or no clinical disease in those natural host species, it can cause serious or fatal disease in humans and domestic animals. Raccoon roundworm is transmitted through eggs shed in feces. When raccoons use human structures for shelter, feces can build up in attics, roofs, and yards, increasing the odds that human will come in contact with infected soil or feces. Children and adults with compromised immune systems are at increased risk of contracting the parasites when they are exposed to raccoon feces; human fatalities have been confirmed in the U.S. when the mature roundworm migrates to the brain. The roundworm can also migrate to the central nervous system and eyes. There is no test for roundworm infection, and medical professionals believe it may be an underrepresented cause of death among those suffering from encephalitis.

Mange, caused by a sarcoptic mite, infects foxes and coyotes, causing fur loss and thickened crusting on the skin. Mange is transmitted to other animals and to humans by direct contact or contact with blankets and other bedding, giving humans a red, itchy rash.

Echinococcosis infections (Hydatid disease) involve the larval stage of tapeworm that depends on wild ungulates and fox, coyote, and wolves for transmission, but can infect any animal. Tapeworm cysts can be found in the liver, other organs, nervous tissue, or bone. People become infected by accidentally ingesting the eggs when handling infected animals or by eating contaminated food, water, or soil. If not treated, it is potentially fatal.

Diseases and parasites affecting feral cats and dogs can have particularly serious implications to human health, given the close association of those animals with humans and pets. Feral cats and dogs are considered by most professional wildlife groups to be a non-native species that can have detrimental effects to the native ecosystems, especially in the presence of a human-altered landscape. However, some people view feral cats to be an extension of companion animals and pets that should be cared for and for which affection bonds are often developed, especially through feeding. Of special concern are those cats and dogs considered companion animals living part-time in a residence that are allowed to range freely outside the home for extended periods with no oversight or care by their owners during that time. If interactions occur between pets and feral animals of the same species, pets can become exposed to a wide-range of pathogens that are brought back into the home, where direct contact between the pet and their caretakers increases the likelihood of pathogen transmission. These animals are also likely to expose family members to a pathogen before diagnosis of infection in the animal.

Several known pathogens that are infectious to people have been found in feral cats and dogs, including ringworm (*Tinea* spp.,) a contagious fungal disease contracted through direct interactions with an infected person, animal, or soil; pasteurella; salmonella; cat scratch disease; and numerous parasitic diseases, including roundworms; tapeworms; and toxoplasma. These may not be life-threatening if treated early but are transmissible. Pregnant women, children, and people with weakened immune systems are at increased risk of clinical disease if exposed to toxoplasma (American Veterinary Medical Association 2004). In 1994, five Florida children were hospitalized with encephalitis that was associated with cat scratch fever (American Veterinary Medical Association 2004). The daycare center at the University of Hawaii at Manoa was closed for two weeks in 2002 because of concerns about potential transmission of murine typhus (*Rickettsia typhi)* and flea (*Ctenocephalides felis*) infestations. The fleas at the facility originated from a feral cat colony that had grown from 100 cats to over 1,000 cats, despite a trap, neuter, and release effort (American Veterinary Medical Association 2004).

Domestic and feral cats are also vectors of toxoplasmosis, through birds, and rodents and other mammals, which can infect humans and other wildlife through contact with cat feces and oocysts in the soil (Torrey and Yolken 2013). The oocysts can also enter water supplies and persist in soil for up to 18 months (Dumetre and Darde 2003). Toxoplasmosis can be transmitted to humans and cause miscarriages, still-births, microcephaly, mental retardation, and blindness. Although cats are only infected once before gaining immunity, the huge number of outdoor cats in the US is sufficient to maintain a large volume of oocysts in the environment. Cats are also a vector for rabies and plague as well as another 27 diseases (Minshall 2016).

Plague (*Yersinia pestis*) and tularemia (*Franciscella tularensis*) are zoonotic diseases that also have been identified as potential bio-terrorism agents. Plague and tularemia may cause severe disease in human populations. Despite the dangers these pathogens pose to people, there is still limited understanding about their transmission and persistence in the environment. Information on geographic distribution of the pathogens, habitat associations, and occurrence in different hosts and vectors is needed to better understand these diseases and the risk they pose to humans, domestic animals, and species of conservation concern (APHIS-WS 2016). WS-Washington is participating in the National Surveillance Plan by collecting blood samples from mammals.

Beaver have been linked to other human diseases. They are known carriers of tularemia, a bacterial disease that is transmittable to humans through bites by insect vectors or infected animals or by handling animals or carcasses which are infected (Wade and Ramsey 1986) tularemia is also responsible for large-scale beaver die-offs (Addison et al. 1998). On rare occasions, beaver may contract the rabies virus and attack humans. In February 1999, a beaver attacked and wounded a dog and chased children that were playing near a stream in Vienna, Virginia; approximately a week later, a beaver was found dead at the site and tested positive for rabies. In 2012 two incidents involving beaver confirmed rabid through testing occurred within 3 days of one another; one in which the beaver bit a 83 year old woman swimming in Lake Barcroft in Fairfax County resulting in the woman's hospitalization and the other incident which a beaver chased kids fishing on a dock which resulted in no injuries (ABC News 7 2012).

Beaver are also known carriers of the intestinal parasite Giardia lamblia, which can contaminate water supplies used for human consumption and recreation (Beach and McCullough 1985). Giardiasis is an intestinal protozoal disease associated with ingesting fecal material in contaminated water. In a 1982 study of Giardia in Washington State, the Department of Social and Health Services, Washington State (DSHS) found that of 656 beaver stools tested, 10.9% were positive for Giardia. Of 172 muskrat stools tested, 51.2% were positive for Giardia (Frost et al. 1982).

Indirect disease threats come from altering habitat or creating conditions conducive to other diseases becoming present in close proximity to humans and their pets. For example, beaver damming activity can create conditions favorable for mosquitoes and can result in increased abundance of these insects (Wade and Ramsey 1986). West Nile Virus (WNV), a disease that is carried by birds, but is spread by mosquitoes, was first identified in the United States in 1999 in New York; beaver ponds create habitat for mosquitoes.

1.11.3.9.2 What is the Need for WS-Washington 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 mortality and morbidity, which can manifest in reduced individual growth rate, reduced fecundity, or reduced product yield. An active wildlife disease program provides WS-Washington, WDFW, WSDA, USFWS, 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-Washington's disease program allows for better communication and collaboration with our partners and quicker response time to potential disease outbreaks due to trained personnel solely dedicated to wildlife disease issues. This information is crucial to making disease mitigation and response decisions.

Because WS-Washington has access to many mammals, either while still alive or shortly after death, it is sometimes requested to opportunistically collect blood and tissue samples for research and management entities, as an additional part of its field operations. These samples are used to test for diseases such as plague, tularemia, and leptospirosis. Requests for samples have increased substantially, especially because of the new APHIS-WS program. WS-Washington does not kill animals for this purpose; all samples are collected as a by-product of normal operations. Use of existing MDM activities reduces cost by eliminating a redundancy of effort in capturing mammals to obtain samples and eliminating the additive wildlife mortality that would be incurred if the MDM and wildlife disease programs were separate.

Emergency responses to disease outbreaks are also a duty of some WS-Washington personnel, this entails aiding management agencies in assessing and managing the spread of highly virulent wildlife diseases. Without WS-Washington's cooperation, it would be more difficult for agencies to collect fresh samples from around the state.

1.11.4 What is the Need for MDM in Washington for Protecting Natural Resources?

Normally, species interactions are part of the function of a healthy ecosystem, and the health of wildlife populations are integrally linked to the occurrence of those interspecific (between species) and intraspecific (within the same species) interactions. Disruptions in the balance of species interactions from non-native wildlife, invasive wildlife, and overabundant native wildlife can degrade ecosystem function and result in decline of native species. This is especially true on populations with few individuals and/or under resource constraints that are cumulatively impacted by human-induced environmental changes (habitat loss, recovery from extirpation, disease caused by concentration, etc.), can reduce the size and sustainability of populations, especially if they have low reproductive rates.

Beyond healthy ecosystem function natural resources are also important to Washington State's economy. Revenue derived from recreation and hunting, especially recreation related to wildlife and the outdoors, is increasingly important to the economy of Washington. In 2011, over 1 million people participated in wildlife related outdoor recreation (Washington

Department of Fish and Wildlife 2010). WDFW also reported; hunting generated $313 million annually and was associated with 5,595 jobs; wildlife watching $1.5 billion annually and was associated with 26,000 jobs indicating that both consumptive and non-consumptive use and enjoyment of wildlife are important in Washington. These activities generate economic activity throughout the state from expenditures related to travel, local recreation, and equipment purchases (Washington Department of Fish and Wildlife 2010).

Introduction of new diseases or enhanced disease transference in wildlife populations can reduce population viability or threaten species survival range wide if not carefully managed. WDFW's has requested assistance from WS-Washington in protection of game species. In 2009, 2010, and 2013 bighorn sheep in the Umtanum and Yakima River Valley were found to be infected with pneumonia, which often leads to individual and even herd-level die offs. In order to limit the spread of this deadly disease, WDFW decided to euthanize animals showing signs of the disease and requested WS-Washington to assist. The herds were located on WDNR, USFWS, and BLM lands in Yakima and Kittitas counties. The combined herds contained approximately 260 animals. WS-Washington assisted with the removal of 48 sheep in FY 2010 and 27 in FY 2013 (MIS 2020). A similar situation with the disease treponeme-assocated hoof disease (TAHD) involving elk 2018.

Chronic Wasting Disease. Chronic Wasting Disease (CWD) is a nervous system disease affecting members of the Family Cervidae, including Rocky Mountain elk (Cervus canadensis), red deer (Cervus elaphus), mule deer (Odocoileus hemionus), black-tailed deer (Odocoileus hemionus), white-tailed deer (Odocoileus virginianus), sika deer (Cervus nippon), and Moose (Alces alces) (USDA Wildlife Services 2014) . It belongs to the family of diseases known as transmissible spongiform encephalopathies (TSE's) or prion diseases. Though it shares certain features with other TSE's like bovine spongiform encephalopathy ("Mad Cow Disease") or scrapie in sheep, it is a distinct disease apparently affecting only species of the family cervidae. CWD originally occurred in wild deer and elk primarily in northeastern Colorado, and adjacent parts of Wyoming, Nebraska, and South Dakota. At the time of the prepareation of this analysis, CWD has not been detedcted in Washington state. It is possible that it may be detected after the completion of the EA, and WS-Washington could assist WDFW in any disease response efforts.

Greater sage-grouse (*Centrocercus urophasianus)* and Columbian sharp-tailed grouse (*Tympanuchus phasianellus*) are not federally listed, but both are listed as state-threatened in Washington. WS-Washington may be requested to conduct limited predator depredation management around known nest locations in eastern Washington to protect the species from coyote predation. Coyotes are also known predators of federally-listed streaked horned larks, western snowy plovers and Columbian white-tailed deer (*Odocoileus virginianus leucurus*). WS-Washington works at the request of USFWS and WDFW to help protect these species from coyote predation.

Habitats degraded by human activities have lower capacity to support native wildlife, land managers often attempt to restore ecosystem function by reintroducing native species (e.g. planting native trees for stream bank stabilization). These reintroduced species are often exploited by native and non-native species that can disrupt restoration efforts. Non-native species like nutria are most notable as the damage caused by extensive herbivory and bank destabilization can significantly degrade wetland resources. Native beaver and burrowing mammal species can have both positive and negative impacts on natural resources. WS-Washington receives requests to assist with mammal damage to streamside restoration efforts. Burrowing from muskrat, moles, voles, marmots, and beaver into streambanks destabilizes the soil that can be washed away during high water flow events undoing efforts to restore naturally stable streambanks. Often the goal of these projects is to decrease water siltation and turbidity for salmonid recovery, but the projects also benefit the habitat quality of other waterside dwelling flora and fauna. In addition to burrowing to create bank dens beaver can negatively impact streamside restoration projects by gnawing on and damaging vegetation.

WS-Washington also receives requests from USACE assistance with protecting ESA listed salmonids species. The majority of this work is to protect salmonids from predation by sea lions at the outfall of dams. Both Steller sea lions and California sea lions have consumed tens of thousands of migrating salmon and steelhead at the fish ladders and outfalls of dams. Both species of sea lions have learned to exploit migrating salmonids at these areas where they concentrate and estimates of up to 7.2% of the associated salmonid run are consumed at Bonneville dam each year. Exclusionary methods have been partially successful at multiple points of the fish passage, but sea lions continue to feed on salmonids at the exit of the fish ladders and the tailraces of the dam. Steller sea lions have been increasingly present at the dam and began predating salmonids 3 weeks earlier than California sea lions in 2018. California sea lions are also only present at the dam for the spring run of salmon, but the Steller sea lions are present nearly year round and impact winter and summer runs (U.S. Army Corps of Engineers 2020).

The value of beaver damage is perhaps greater than that of any other single wildlife species in the U.S. (Arner and DuBose 1980). Miller (1983) estimated that annual beaver damage in the U.S. amounted to $75-$100 million more than two decades ago. Damage throughout the U.S. and requests for beaver damage management have increased since that time. Such conflicts are viewed as “damage” by resource owners and result in adverse effects. In many cases, the beaver damage exceeds landowner’s tolerance level, resulting in a demand for beaver damage management. Beaver are responsible for a variety of different kinds of damage (Loven 1985, Wade and Ramsey 1986, Willging and Sramek 1989, Miller and Yarrow 1994). This damage can conflict with human, land, or resource management objectives and can suppress different species of plants and animals, including T&E species.

Beaver have potential benefits to ESA listed salmonid species, but beaver activity can also result in negative impacts to salmonid survival. Requests for beaver damage to salmonid species are usually tied to blocking fish passage by beaver dams and plugged culverts. As salmonid populations rely on upstream migrations to reproduce prevention of upstream passage can eliminate entire population segments. Increased soil moisture within and surrounding beaver flooded areas can also result in reduced timber growth and mast production and a decrease in bank stabilization. These habitat modifications can also conflict with human land or resource management objectives and oppress some plants and animals, including T&E species. For example, WS in Oregon conducted beaver damage management to protect the Nelson's checker-mallow (*Sidalcea nelsoniana*), which was being flooded by water which had been impeded by a beaver dam. Removal of dams and blocking materials is conducted by the land managers/owners in possession of the required permits.

Beaver dams have the potential to impact local hydrology, ecology, and nutrient cycles (e.g. groundwater seepage and infiltration, water temperature, water turbidity, water nutrient composition, water chemical composition; diversity and abundance of associated vegetative and faunal communities; and soil nutrient composition). In some situations these impacts can increase fish species richness and abundance, as discussed in greater detail in Section 3.8.2. But a beaver dam in one location may have drastically different effects than one in another location, due to surrounding environmental variables. Headwater streams experience greater effects from beaver damming activity, relative to the age of the ponds, than downstream waters (Snodgrass and Meffe 1998). In floodplain scale production of salmonids, beaver presence has been shown to lower salmonid productivity through reducing habitat availability by blocking fish passage to available habitat (Malsion et al. 2016). Increased growth of salmonids in beaver ponds may negatively impact growth above and below beaver ponds as shown in (Sigourney et al. 2006).

Beaver damming and flooding can also destroy other habitat types (e.g. free-flowing water, riparian areas, bird roosting, bird nesting areas) which are important to many species. In the built environments common to western Washington where rivers and streams run through corridors with limited or no connectivity to adjacent flows, changes in upstream water quality and fish access are more pronounced than in a large connected floodplain. Beaver damming activity can completely block water flow or create impassible fish barriers that reduce cold water inputs downstream or entirely block a salmon run's access to the spawning grounds. Patterson (1951) and Avery (1992) reported that the presence of beaver dams can negatively affect fisheries. Historically WS-Washington has provided assistance in protecting ESA-listed salmonids where fish passage was blocked by beaver dams. Even without fully stopping water input, ponded water between numerous dams or on the downstream side of a dam may evaporate and percolate into the soils during drier periods of the year.

Beaver dam construction is limited by landscape features such as stream gradient, width, depth, and bank slope. Landscape features may also make dam building unnecessary or energetically cost prohibitive so not all beaver build dams. Beaver that do not build dams affect the environment differently from beavers that build dams. All of the effects on watersheds and biodiversity mentioned in Sections 3.5.6 and 3.8.2 either do not apply or are dramatically less pronounced. Beaver destabilizing stream banks through chewing vegetation or burrowing to create bank dens can increase siltation, water turbidity, stream width, and decrease vegetative cover of the stream. Beaver activities can also destroy critical habitat (e.g., free-flowing water, riparian areas, and bird roosting and nesting areas) which are important to many wildlife species, including certain species of fish and mussels.

Land and resource management agencies (e.g. USFWS, USFS, WDFW) set management goals for the areas and resources they manage (Sections 1.8 and 1.9). The impacts of beaver are often desirable and directly benefit management goals however, resource management agencies may request MDM in areas where the interaction of human features on the landscape or natural environmental factors result in beaver impacts conflicting with management goals. Through coordination with respective management agencies all MDM activities would be consistent with the requesting entities' management objectives. WS-Washington's has consulted with USFWS and NOAA NMFS (Section 2.4 C) on its actions (to include beaver removal) for either protection of T&E species or that may affect T&E species.

1.11.5 What is the Need for MDM in Washington for Protecting Property?

1.11.5.1 What is the Need for MDM in Washington for Protecting Residential Property?

Wildlife conflict with residential property is unique from non-residential property damage due to; damage may result in temporary/total loss of use of a primary residence and the higher likelihood to result in conflicts with human and pet health and safety.

Many mammal species covered in this EA rely on dens, burrows, or cavities in natural structures to live and reproduce. In areas where natural structures are unavailable or when human built structures area more attractive than natural options wildlife conflicts can occur. Often homeowners/residents have attempted to exclude wildlife to the fullest extent of their knowledge and ability but request assistance after wildlife have circumvented those exclusions and started occupying the structure.

Other wildlife activities can result in damage to residential structures without occupying the building. Burrowing or digging animals can undermine residential structures or cause damage to a structure's foundation. Materials like siding or insulation can be removed from residential structures and for nests/bedding.

Examples of damage to residential properties include; flooding of homes from beaver damming, float material damage on house boats by otters and nutria (that directly impact homes buoyancy), damage to house weather proofing (e.g. siding, insulation) by raccoons, fouling of insulation due to animal waste, and damage to foundation by burrowing animals.

1.11.5.2 What is the Need for MDM in Washington for Protecting Non-Residential Property?

Wildlife damage to non-residential property includes commercial businesses (e.g. golf courses, restaurants, manufacturing centers, warehouses, stadiums), private property (e.g. person vehicles, watercraft, landscaping, swimming pools, storage sheds), and public property (e.g. public sports fields, park structures, public docks). Examples of damage to non-residential property include; beaver girdling trees causing trees to fall into a car lot or non-residential structures; marmot burrowing causing damage to oil production equipment requiring equipment replacement; raccoon damage to insulation and walls; and, squirrel damage to walls of airplane hangar and outbuilding.

1.11.5.3 What Actions Does WDFW Take to Address Property Damage Caused by Damaging Wildlife?

WDFW continues to work with timber industry cooperatives to address issues related to property damage caused by bears, including lethal and non-lethal options, to reduce timber damage and provide non-lethal recommendations to timber and agricultural operators and property owners on ways to reduce or eliminate damage from depredating bears.

The department provides advice and education to the general public to attempt to resolve conflicts with bears, first through simple precautions in as many instances as possible. Chemical and noise repellents, hazing, and electric fencing may be effective methods to reduce damage depending on specific situations. Because bears are sensitive to electricity, electric fences may eliminate bear damage to beehives, orchards, livestock, domestic fowl, or other property. However, electric fences may be difficult and costly to install and maintain, or may be prohibited by local ordinances, particularly in residential areas. Electric fences may present some risk of starting wildfires under certain conditions. Bears are strong, agile climbers, and as a result, other types of fences may be ineffective at preventing damage from bears.

Black bears are classified as a "big game" animal (RCW 77.08.030). A hunting license and open season are required to hunt black bears. A property owner or the owner's immediate family, employee, or tenant may kill one bear on that property if it is damaging crops or domestic animals. WDFW requires all parts of the animal must be lawfully disposed of as specified by the department. If in possession of a damage prevention cooperative agreement or a WDFW issued kill permit, multiple animals may be taken and must be disposed of in accordance with agreements/permits. The local WDFW office must be notified within 24 hours after taking a black bear in these situations (WAC 220-440-060).

The killing of a black bear in self-defense, or defense of another, should be reasonable and justified. A person taking such action must have reasonable belief that the bear poses a threat of serious physical harm, that this harm is imminent, and the action is the only reasonable available means to prevent that harm.

Any bear that is killed, whether under the direct authority of RCW 77.36.030 or for the protection of a person, remains the property of the state and must be turned over to WDFW (WAC 220-440-050, WAC 220-440-090).

WDFW established spring black bear hunts in eastern and western Washington to provide hunters the opportunity to harvest bears and those that may otherwise be removed through MDM efforts. Although spring bear hunters rarely target specific bears causing damage, hunters may lower densities of black bears in areas experiencing damage. As black bear and human abundance and distribution increase, an increase in the level of human-black bear conflicts may be expected (Garshelis and Hristienko 2006). Harvest regulations involving season length and number of tags available may be modified to address situations where certain management units are experiencing property damage over several years. Concentrating hunting effort in these units, when necessary, may reduce actual damage from bears as well as the number of damage complaints.

1.11.6 What is the Need for MDM in Washington for Protecting Timber?

1.11.6.1 How Do Black Bears Damage Commercial Forestry Crops?

Objective 23 in WDFW's species management plan 2015-2021 is "to improve and expand

WDFW's tree damage program". Timber damage by black bears primarily occurs in the western portion of the state, though the number of reports in eastern Washington is growing. Primarily during the spring and early summer, black bears peel the bark of trees to eat the sugar-rich sapwood (phloem) by scraping it from the surface with their teeth (Poelker and Hartwell 1973, Schmidt and Gourley 1992, USDA Wildlife Services 2003). This behavior is referred to as "tree peeling."

Although bear damaged timber has been observed since the mid 1800's it was not until 1940's that timber managers in western Washington became involved in even-aged stand production that damage attracted attention (Pierson 1966). Black bears exhibit a preference for the healthiest and fastest-growing trees, such as those in recently thinned or fertilized stands that are 15 to 30 years old (Mason and Adams 1989, Kanaskie et al. 1990, Schmidt and Gourley 1992) because these trees may have higher sugar concentrations in the lower trunk of the tree (Kimball et al. 1998). In even-aged timber production, the majority of trees in the stand will be similar in age and growing condition making stands that meet the above criteria attractive to bears and prone to bear damage. In western Washington, Douglas-fir (*Pseudostuga menziesii*) and western hemlock (*Tsuga heterophylla*) are the most common species on which black bears forage, with western red cedar (*Thuja plicata*) peeled to a lesser extent (Kanaskie et al. 2001).

Tree-peeling has been hypothesized to be a learned behavior that cubs learn from females (Schmidt and Gourley 1992). Energetics may also play a role during spring, as damage may be higher in areas where bears have diets containing relatively high proportions of grasses and forbs as opposed to areas with bears having diets dominated by berries, which have higher nutritional value (Noble and Meslow 1998).

Damaged boles significantly reduce the quality of "butt logs," which are often the most valuable section of trees. The peeling and feeding behavior may also completely or partially girdle the tree, killing or reducing the health and growth of the tree (Pierson 1966, Schmidt and Gourley 1992, Kanaskie et al. 2001).

The percent of the tree's circumference girdled (sapwood removed) is used to calculate volume lost. With 7% volume lost when girdling is under 50% and 10% volume lost when girdling is greater than 50%. When 60% of a tree is girdled or greater, tree mortality rate increase mortality stops all future growth resulting in lost value (Kline et al. 2018). Damage of this extent is substantial especially so for small landowners and may impact their ability to replant after harvest.

Damage to young timber stands can be extensive, which can negatively affect the economic value and health of timber stands (Kanaskie et al. 1990). Bears may peel up to 70 trees/day during the spring months, varying from a few trees to more than 75% of the trees in a particular stand (Hartwell and Johnson 1988, Mason et al. 1989, Schmidt and Gourley 1992). On the east side of the Cascades, a study indicated that 18% of affected trees suffered damage to over 75% of their circumference and were expected to die (Barnes Jr. and Engeman 1995).

In an effort to assess bear damage to timber resources in Washington, the WA Department of Natural Resources in cooperation with U.S. Forest Service initiated aerial surveys in western

Washington in 1980. Ground-verification is frequently used for studies as aerial estimates may overestimate bear damage because other sources such as root rot cause red crowns (Kanaskie et al. 1990). A combined aerial survey and ground-verification effort conducted in 1989 covered 2.4-million forested acres and found that bears damaged an estimated 347,000 conifers annually. Of the damaged trees, complete girdling killed about one-third, and about two-thirds were damaged but alive (Kanaskie et al. 1990). In 2000, a similar aerial survey and ground verification covered greater than 6.4-million forested acres and an estimated 55,180 trees were damaged annually, of which one-third had died (Kanaskie et al. 2001). Although the proportional area of timber damaged may not seem significant, damage is often concentrated locally and may significantly impact individual commercial landowners.

Certain silvicultural or management practices may reduce this damage to trees. Nolte et al. (1998) suggested that cultivating trees at higher stand densities and pruning live crown cover of trees may reduce sugar-to-terpene ratios (terpene is an organic compound that may be unattractive to bears), and that genetic selection of trees may increase terpene concentrations.

Supplemental feeding of black bears has been attempted and found to have some efficacy (Flowers 1986, Ziegltrum 2004); however, as with most supplemental feeding programs for wildlife, potential issues exist, including efficacy and costs over large areas and multiple years; discontinuation of supplemental feeding once started can result in substantially increased damage (recorded 7 times more damage than before the supplemental feeding program); concern with concentrating wildlife into relatively small area which may result in dependence on feeding stations; an increased probability of disease transmission as bears are unnaturally concentrated for longer periods; an increased rate of illegal harvest as poachers discover high localized bear densities; and habitat degradation in the surrounding area due to large numbers of bears (Flowers 1986, Ziegltrum 2004).

1.11.6.2 How Do Mountain Beaver Damage Commercial Forestry Crops?

Mountain beaver are fossorial (live underground a majority of their lives) and dig tunnels 8-10 inches in diameter centered on a nesting chamber but can span 2-3 acres. Damage following thinning operation is common as beaver aerate and feed on root systems creating infection corridors for root rot. In addition to damage from feeding, mountain beaver nests are constructed of vegetation with Douglas fir saplings clipped at ground level, commonly being used.

Mountain beaver cause more damage to Douglas-fir seedlings and saplings than any other mammal in the Pacific Northwest and are responsible for millions of dollars in damage annually to forest seedling plantations (Arjo and Nolte 2004). Mountain beavers' need for high water content forage results in damage on seedling regeneration following timber harvests especially prior to the growth of emergent vegetation. Thinning operations increase water availability to the understory until canopy closure, which can increase mountain beaver activity and damage (Campbell et al. 2015).

Density of mountain beaver is largely dependent on access to and quality of forage. Due to their primitive kidney systems being unable to concentrate urine, water content is a primary factor in forage selection.

1.11.6.3 How Do Other Species Damage Commercial Forestry Crops?

Beaver, nutria, deer, elk, porcupine, pocket gopher, marmots, mice, moles, and voles damage timber at different stages of timber production. Most damage occurs during 1 to 2-year periods of time when timber stands are most susceptible, typically during early regeneration. Moles, ground squirrels, voles, and mice primarily feed on seed plantings which are infrequently used. Damage from seed consumers typically is restricted to the first year of establishment. Seedling and sapling plantings are the primary means of timber regeneration in Washington. Deer, elk, pocket gophers, mountain beaver, rabbit, and ground squirrels that damage seedling/saplings feed on non-woody vegetation during the summer and fall. Prior to the emergence of this vegetation, they feed on the abundant timber saplings. Porcupine feed on outer growth of trees, typically in the canopy and on second growth stands where growth is most rapid and bark is thinner than at the stem of trees or in mature forests. Increases in herbaceous vegetation found in disturbed areas (e.g. thinning, wildfire, etc.) also attract more porcupine to the area. Densely wooded areas are favored during the winter to reduce the time porcupines spend outside of their dens, this results in hot spots of damage from winter foraging.

Beaver typically cannot construct persistent dams on timber lands due to steep slopes and narrow drainage channels that result in dam washouts during peak water flow events. Beaver plugging culverts for logging roads and damming streams can flood timber stands resulting in large areas of damage. The majority of reported damages from losses from beaver damage are from girdling trees. Some of these trees will be harvested and have economic value while other trees in riparian areas are an environmental protection measure required by timber operations. In areas where timber has recently been harvested the vegetation in the riparian buffer remaining in the area of the harvest is critical to protecting water quality. This removal of live trees from the stream banks destabilizes soil, contributes to erosion, and increases sedimentation of connected waterways.

Pocket gophers, like mountain beavers, are fossorial and contribute to root damage and aeration of soil around roots.

1.11.7 What is the Need for MDM to Protect Livestock in Washington?

The mammalian predators included in this EA 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. 2002) 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. 1999, Bodenchuk et al. 2002, 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 to experience years of financial loss (Fritts et al. 1992, Mack et al. 1992, Shelton 2004, Rashford et al. 2010). Losses are not evenly distributed among producers and may be concentrated 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. Studies show that profit margins in livestock production do not allow a 20% loss rate, and in the absence of MDM, such losses would likely result in the loss of the livestock enterprise(Nass 1977, Howard Jr. and Shaw 1978, Nass 1980, O'Gara et al. 1983, Bodenchuk et al. 2002, Shelton 2004, Rashford et al. 2010). Without effective methods of reducing predation rates such as those used by APHIS-WS, economic losses due to predation would likely continue to occur and possibly increase.

Other mammalian species including, beaver, nutria, opossum, raccoons, rats, and pocket gophers may damage livestock resources. This damage may be in the form of flooding and tunneling in pastures, contamination of feed stocks by mammals living in the feed storage building or consuming the feed, and diseases transmitted directly to livestock from wildlife species.

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

Rates of loss of different types of livestock in the presence and absence of MDM 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, lack of 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 MDM activities:

- Losses in the absence of direct MDM 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 1977);
    - Lambs ranged from 12% to 29% and ewes 1% to 8% when producers were compensated for losses in lieu of MDM (Windberg and Knowlton 1988);
    - 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. 2002);
    - 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 (O'Gara et al. 1983);
    - Lambs could be as high as 22.3% (Houben et al. 2004).

- Losses with direct MDM activities in place:
    - Adult sheep 1.6%, lambs 6%, goats and kids 12%, and calves 0.8% (Bodenchuk et al. 2002);
    - Lambs 1% to 6% (Windberg and Knowlton 1988);
    - Lamb losses can be as low as 0.7% (Nass 1977, Tigner and Larson 1977, Howard Jr. 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).

Livestock losses can come from a variety of sources, including disease, weather conditions, market price fluctuations, and predation (Blejwas et al. 2002). Producers routinely address disease concerns through responsive and preventative 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 only addresses livestock losses from predation and in the context of APHIS-WS statutorily authorized activities and appropriations.

1.11.7.2 Which Mammals Cause the Most Predation on Livestock?

Of the mammalian predators that kill livestock, coyotes are responsible for the highest percentage (Knowlton et al. 1999, Shelton 2004, National Agricultural Statistics Service 2005;2006;2010;2011). 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 cougars (31%) and black bears (2%). Other mammals that cause measurable predation on cattle, calves, sheep and lambs are black bear, cougar, red fox and feral or free-roaming dogs. Data captured in MIS 2020 supports that while predation by black bears and cougars is not as frequent as coyote predation, the damage caused by these species has negatively impacted producers (National Agricultural Statistics Service 2005) (National Agricultural Statistics Service 2010) (USDA Veterinary Services 2015).

Coyotes are responsible for 63% of the damage to cattle in Washington State (USDA Veterinary Services 2017) and while coyotes are only confirmed to be responsible for 13% of sheep losses the 52.8% of unknown predator events is likely accounted for, at least in part, by coyote predations because the national average for 2014 was 54% of adult sheep losses and 63% of lamb losses (USDA Veterinary Services 2015).

Although, in general, cougar predation is lower than that of coyotes, cougars are occasionally responsible for large sheep and lamb loss events, sometimes called "*surplus killing*." This occurs when a single mammal, for unknown reasons, kills several animals in one event, but only consumes selected tissues or parts of some animals or the carcasses are not fed on at all (Shaw 1987). Cougars may also frighten an entire flock of sheep as they attack, resulting in a mass stampede, which sometimes results in many animals being injured or 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.

1.11.7.3 What are Livestock Losses to Predators in Washington?

The latest comprehensive surveys of wildlife damage to livestock in Washington was released by NAHMS in 2015. The goal of the survey was to report livestock losses incurred by producers (Table 7).

Table 7. Cattle and sheep losses in WA (USDA Veterinary Services 2015;2017)

	Cattle	Calf	Sheep	Lamb
# Killed	240	1,040	818	627
$ Value Injured but Not Killed	$119,000	$155,000	$8,000	$3,000
$ Value	$351,751	$439,296	$180,000	$118,000
Percent Loss of Total	0.016%*	0.2%	2.3%	1.5%
Percent of Operations Experiencing Loss	0.8%	2.4%	6.2%	4.5%
Coyote Kill	127	655	109	77
Wolf Kill	58	52	136	0
Black Bear Kill	0	66	0	0
Dogs	20	0	57	87
Mountain Lions	35	190	74	107
Unidentified predators	0	77	443	321
* Percent cattle loss was rounded to zero in the NAHMS 2015 Cattle Death Loss report -Percent of total was given in the NAHMS 2015 Cattle Death Loss report and numbers were calculated using those percentages to get the number of cattle/calves killed				

1.11.7.4 What are livestock producers doing to prevent predation?

The losses identified above occurred despite producers using the non-lethal methods shown in Table 8. The survey did not include information on any lethal management that might have been occurring simultaneously.

Table 8. Percentage of WA livestock operations using nonlethal methods to prevent predator losses from cattle/calves, 2010 (National Agricultural Statistics Service 2011) and sheep/lambs, 2014 (USDA Veterinary Services 2015)

Nonlethal Method	Cattle/Calves	Sheep/Lambs
Guard Dogs	45.7%	49.3%
Exclusion Fencing	32.2%	68.0%
Herding	1.6%	10.8%
Night Penning	0.4%	48.7%
Fright Tactics	10.7%	9.1%
Livestock Carcass Removal	1.3%	21.3%
Culling	2.6%	6.9%
Frequent Checks	2.2%	9.6%
Other	11.4%	6.8%
Shed Lambing	-	24.9%
Llamas	-	16.6%
Donkeys	-	22.6%
Changing Bedding	-	30.0%

WS-Washington is typically contacted by landowners who have attempted several non-lethal strategies on their own. Of Washington State cattle producers, 20% reported using non-lethal deterrents (USDA Veterinary Services 2017). Although the report does not specify a percent of operations using any non-lethal methods 68% of sheep producers using fencing with presumably a larger portion using at least one type of non-lethal methods (USDA Veterinary Services 2017). After receiving a request for assistance, WS-Washington assesses the situation to determine if the non-lethal methods previously conducted by the landowner/manager were appropriate and carried out correctly, given the circumstances. Additional non-lethal methods may be recommended and or implemented by WS-Washington if deemed potentially effective by field personnel. Sometimes, however, resolution of the conflict requires supplemental lethal operational damage management assistance.

1.11.7.5 What portion of Washington's MDM activities are for livestock protection?

WS-Washington activities to protect livestock comprise 4.2% of all MDM activities, or an average of 67 responses per year. Fowl (44%), cattle (33%), and goats (12%) are the resources WS-Washington is most frequently requested to assist with. 66.7% of the conflicts with livestock were associated with damage or threat of damage from coyotes, with other mammals contributing a smaller proportion each (MIS 2020) (Table 9).

Table 9. Number of Work Tasks for PDM for Livestock by Mammal Species Recorded by WS -Washington, FY 2015 – FY 2019 (MIS 2020)

Species	Number of Work Tasks for Livestock Protection	Percent of Total Livestock Protection-Related Work Tasks
COYOTES	258	77.5%
BEAVERS	27	8.1%
RACCOONS	13	3.9%
RATS, NORWAY (BROWN)	11	3.3%
OPOSSUMS, VIRGINIA	9	2.7%
BOBCATS	3	0.9%
POCKET GOPHERS, NORTHERN	3	0.9%
CATS, FERAL/FREE RANGING	2	0.6%
RATS, BLACK (ROOF)	1	0.3%

1.11.7.6 What Proportion of WS-Washington Livestock Protection Work Occurs on Public and Private Lands?

Washington comprises nearly 46 million acres, with approximately 28% under the management of federal agencies (20% FS, 3.8% NPS, 1% DOD, 1% BLM). Private lands comprise approximately 55.13%, state lands approximately 8.49%, Tribal lands approximately 7.08%, and local and other lands approximately 1.3% (Washington State Department of Recreation and Conservation Office). In Washington, mammal conflicts specific to livestock occur mostly on private land (97.8%), followed by BLM lands (1.8%), and state lands (0.4%) (MIS 2020). The primary livestock grazing use of these lands is for cow-calf production and production of range bands of sheep.

The need for MDM activities on public lands depends upon the type of livestock, time of year, and location where they are grazed. For example, most cattle grazing occurs when calves are older and therefore less vulnerable to coyote predation when put onto grazing allotments. Grazing by range bands (large flocks) of sheep is permitted during early summer through fall. As sheep and lambs are smaller than cattle, sheep tend to be more susceptible to predation than cattle. Additionally, lambs are put on allotments shortly after birth when they are more vulnerable to predation by coyotes and other mammals. Producers are most likely to request assistance from WS-Washington during the spring season when livestock are more susceptible to predation.

1.11.7.7 What Diseases Do Mammals Transmit to Livestock in Washington?

In addition to direct livestock losses through predation and injury, livestock can also be impacted by a number of diseases transmissible from mammals. The following pathogens are known to circulate in mammal populations outside of Washington, so it is possible that some pathogens may be undetected in Washington mammal populations or may be introduced to those populations in the future. Mammal damage management can have an indirect effect by reducing the risk of livestock contracting a disease by minimizing the potential for livestock-mammal interactions. Transmittable diseases include the rabies virus (raccoons, skunks, foxes, coyotes); leptospirosis (canines, raccoons, opossums); *Neospora caninum* (feral dogs, coyotes, and fox); and *Toxoplasma gondii* (domestic cats) (Adler 2010, Centers for Disease Control and Prevention 2011, McAllister 2014). WS-Washington has not been requested to conduct MDM specifically for livestock disease control, but MDM activities for other reasons can indirectly assist disease control efforts.

Of great concern for biosecurity in Europe and Asia is *Asfivirus sp.* or African Swine Fever, a highly contagious pathogen that can be transmitted from feral swine populations into domestic stock. While its not currently present in the United States, *Asfivirus* has a potential mortality rate up to 100% and if in the event that the disease is found in Washington state, WS-WA may be asked to respond. There are no known persistent feral swine populations in Washington State so a viral outbreak and subsequent removal efforts, should they be required, are unlikely and would be of a small scale should they occur.

1.11.8 What is the Need for MDM in Washington for Protecting Agriculture Resources Other Than Livestock?

As discussed previously, mammals within the scope of this EA cause conflicts with livestock. Damage to other agricultural resources include fruit and nut crops, field crops, and range/pasture. Agricultural resources are damaged by badger, bear, beaver, feral pigs, porcupine, raccoons, skunks, coyotes, elk/deer, marmots, mice/rats/voles, moles, muskrats, nutria, pocket gophers, rabbits, and squirrels.

Several species burrow in improved or planted pasture, inhibiting the use of planting and mowing equipment or leading to damage when the equipment is used. Herbivorous and frugivorous mammals can also damage crops above and below ground through feeding directly on leaves, stems, seeds, fruits, flowers, or root systems. Burrowing animals can directly damage root systems with their burrows or indirectly through aeration of the soil. Badgers, coyotes, gophers, ground squirrels, pocket gophers, muskrats, and nutria damage irrigation pipe systems. Rodents can cause contamination of human food stores (e.g. grain stores). Beavers, frequently in eastern Washington, attempt damming manmade agricultural drainages resulting in substantial loss of crops or pasture flooding. Coyotes, deer, marmots, mice/voles, moles, nutria, rabbits, and raccoons destroy gardens, lawns, or turf farms.

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

1.12.1 What are Considerations for Evaluating Program Effectiveness?

The purpose of 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. 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, non-target animals, and public/political pressure can also be important considerations.

To maximize effectiveness, field personnel must be able to consistently apply the APHIS-WS Decision Model (Section 2.2.1.2) to assess the damage problem, determine the most advantageous methods or actions, and implement the strategic management actions expeditiously, conscientiously, ethically, and humanely address the problem and minimize 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 are applied. This may be attributed to attractants that continue to exist at the location where damage occurred, predator densities and/or the availability of other individuals to immigrate into the area, and/or if predators cannot be fully restricted from accessing the problem area due to conditions and size of the damage site. However, effectiveness is determined by the ability to reduce the risk of damage or threats caused by predators at the time and, if possible, in the future.

The use of non-lethal methods described in Appendix A, 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 conditions that attracted those mammals to damage areas remain unchanged. Therefore, non-lethal (and lethal to a certain extent) 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 restricted from the area, such as by fencing.

One of WS-Washington's objectives is to ensure that all MDM actions towards native wildlife would not cause cumulative adverse effects on wildlife statewide (Sections 3.5 and 3.6). Therefore, WS-Washington's policy is not to cause population-wide or even localized long-term adverse impacts to native target species' populations (unless to meet management objectives of WDFW), or any adverse impacts to populations of native non-target species.

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

1.12.2 How Has the U.S. Government Evaluated the Effectiveness of APHIS-WS MDM Activities?

The government conducted 2 detailed audits of APHIS-WS, including the effectiveness of the programs and compliance with federal and state laws and regulations. The audits found that the APHIS-WS program was 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 APHIS-WS received considerable media attention creating animosity among the general public, animal rights organizations, and conservation groups based on allegations of unsanctioned activities conducted by some APHIS-WS field personnel. The OIG received numerous hotline complaints and letters from the general public and animal rights and environmental groups alleging the use of indiscriminate 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 non-target 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 mammal control.

Auditors observed field personnel setting and checking traps, snares, and conducting other typical field activities, and interviewed employees regarding their use of the APHIS-WS Decision Model to assess wildlife damage, including auditor confirmation of mammal 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, which adhered to applicable laws and regulations. Auditors also observed two 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 mammal 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."

APHIS-WS is required to follow all applicable state and local laws that do not directly and substantively conflict with APHIS-WS' federal statutory authorities. The auditors interviewed various state game wardens who confirmed that APHIS-WS personnel were acting accordingly.

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 damage management and aerial shooting program actions and found them both to be justified and effective.

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. These conditions resulted in inflated wildlife numbers impacted by operational management activities and the transmission of inaccurate data to the public. However of almost 30,000 entries in the management system, 98% were correct with discrepancies of 2% identified including under- and over-reporting of take. APHIS-WS is committed to and actively addressing OIG recommendations intended to further reduce discrepancies (Office of Inspector General 2015)

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

The U.S. 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' 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 wildlife 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 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, mammals (primarily coyotes) killed nearly half a million livestock – mostly lambs and calves – valued at about $70 million. Some mammals 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 were already using some non-lethal methods before they requested assistance from APHIS-WS.

1.12.3 Are Field Studies of Effectiveness of Lethal MDM for Livestock Protection Sufficient for Informed Decision-Making?

A recent paper (Treves 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.

APHIS-WS agrees that predation damage management tools and techniques must be based on rigorous, scientifically-sound principles. But field and laboratory studies require different study designs. APHIS-WS scientists do not agree with Treves et al.'s assessment that existing research is flawed and believe it would be irresponsible to limit the ability of wildlife managers and trained experts to effectively resolve predator damage issues.

APHIS-WS experts are dedicated to gathering information, testing new ideas and methods and using experiments (versus observational studies) as much as possible. NWRC's scientists at its Utah Field Station are leaders in the design and implementation of controlled studies to evaluate predation and predator control methods. They collaborate 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 predator removal (using WS-California personnel or other entities with equivalently high standards), livestock producers hired a commercial company or took action themselves to remove coyotes, often using methods that are not selective for the offending animal partially discussed in Section 1.14.5 (Shwiff et al. 2005, Larson 2006, Larson et al. 2016).

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.

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, which is a very difficult standard. Unreplicated sampling involved in the BACI model inherently does not provide the strong inferences (Underwood 1992) that Treves et al. (2016) requests for their “gold standard”.

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.”*

APHIS-WS understands and appreciates interest in ensuring MDM methods are as robust and effective as possible. The APHIS-WS NWRC collaborates with experts from around the world to conduct studies publish results in legitimate 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.

A detailed analysis conducted by APHIS-WS NWRC scientists found that Treves et al. (2016) misinterpreted and improperly assessed the quality and conclusions of many of the peer-reviewed articles included in their analysis, which causes us to question the authors' abilities to professionally critique such papers and reach such black-and-white conclusions and recommendations. The details of the evaluation of Treves et al. (2016) analyses and conclusions are found in Appendix C. The NWRC evaluation found that the authors:

- Selectively disregarded studies conducted in Australia, which are some of the more rigorous field studies on working livestock operations with free-ranging, native carnivores that assess the effectiveness of lethal control of predators to protect livestock. Given their explicit criterion to only use studies in their native languages, it is odd that they would purposefully exclude this body of rigorous science published in English;

- Incorrectly confused and combined unrelated papers, reaching unsupportable conclusions;

- Misrepresent the conditions and protocol quality associated with a study testing the effectiveness of fladry;

- Misinterpret study design and criteria used for selection of paired pastures, and incorrectly understand the roles of dependent and independent variables;

- Make false equivalency regarding the use of government-conducted lethal PDM that focuses on removing the individual predators or small groups of predators identified as causing the depredation problem, and regulated public hunting, which is not intended to address predator-caused damage; and

- Use conclusions from studies that they identify as "flawed" for reaching their conclusions.

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

1.12.4 Conclusion

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

- Human health and safety, including threats from mammals and zoonotic diseases,
- 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.

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

A common concern expressed by commenters about government-supported MDM is whether the value of losses are less than the amount of public funds used to provide MDM services. However, this concern indicates a misconception of the purpose of MDM, which is not to wait until the value of losses is high, but to prevent, minimize, or stop losses and damage where it is being experienced, the property/resource owner's level of tolerance has been reached, and assistance is requested. Mammal damage management would reach its maximum success if it prevented all losses or damage, which would mean the value of losses or damage due to mammals would be zero. 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 MDM program as part of decision-making (Section 1.5.1). In addition to authorizing the MDM services, it provides for entering into agreements for collecting funds from cooperators for the services the agency provides.

1.13.1 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 requires 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.

WS-Washington 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. Estimates of non-monetary cost and benefit values for public projects that are not priced in private markets can be difficult to obtain, and methodologies can only produce implied monetary values that are subjective and require value judgments. Selecting an appropriate discount rate to measure the present monetary value of costs and benefits that will occur in the future is also difficult and subjective, with the level of the discount rate creating dramatically different project benefits.

Cost-effectiveness is not the primary goal of APHIS-WS. Environmental protection, land management goals, safety of people and pets, and sociocultural concerns are considered by the field employee using the APHIS-WS Decision Model whenever a request for assistance is received. These constraints sometimes increase the cost of implementing MDM 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 may limit the methods available for MDM. 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.

1.13.2 What Economic Concerns Have Been Expressed by Public Commenters to APHIS-WS MDM EAs?

Commenters occasionally request economic analyses be prepared that incorporates 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 mammals, on ecosystem services and recreation opportunities. Aspects of these values are included in this EA in the evaluation of impacts to target and non-target populations (Sections 3.4, 3.5, and 3.6), ecosystem services and biodiversity (Section 3.7), sociocultural values and impacts to recreation (Section 3.110).

Commenters to APHIS-WS MDM EAs commonly express concerns about the economic costs of MDM 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. These are discussed here, and several are included in Sections 1.12 and 2.5.

1.13.2.1 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 mammals as a cost of doing business. WS-Washington is funded by a combination of Congressional appropriations and by funds provided by governmental, commercial, private, and other entities that enter into an agreement with APHIS-WS for assistance. For FY03- FY19. WS-Washington received only 13% of its annual budget from Congressional allocations. 87% of the budget was supplied from cooperative funding from any one of several sources, including private individuals, local governments, state agencies, or other federal agencies. In Washington, cooperators are generally responsible for contributing a majority of the costs associated with the MDM assistance they request.

The majority of the congressional allocation goes towards office and administration costs as well as providing technical assistance to callers, not towards operational damage management actions by field personnel. Most public and private entities requesting MDM assistance from WS-Washington pay for those services.

Some people believe that producers receive sufficient tax write-offs for damages from wildlife damage and that taxpayer money should not be used to reduce mammal damage. However, national policies for using taxpayer dollars to subsidize private or commercial profit are established by Congress through statutes and Congressional appropriations. Wildlife belongs to the American public and is managed for many uses and values by tax-supported state and federal agencies. Therefore, Congress has implemented policies and funded activities that offer relief for damage caused by wildlife

APHIS-WS is not involved in establishing or approving national policies regarding livestock grazing on federal lands or supporting private livestock operations, and such decisions are outside the scope of this EA. WS-Washington provides federal leadership in resolving wildlife-human conflicts and supporting coexistence of wildlife and humans. It is publicly accountable for the work that it conducts following requests from 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-Washington is aware of beliefs that federal wildlife damage management should not be allowed until economic losses become "unacceptable," (Section 1.4.4) and that livestock losses should be considered as a cost of doing business by producers. WS-Washington receives requests for assistance when the producer 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/resource owners/managers, WS-Washington 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 1.5.2 and 1.14.1).

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 2019). 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.

1.13.2.2 Compensation for Losses or Damage Should Replace APHIS-WS MDM

Most wildlife is held in the public trust by the states and generally managed by state agencies, regardless of public/private land ownership. Some states have established programs to partially accept monetary responsibility for some types of wildlife damage, and some states or counties may provide for compensation for wildlife damage (Bruscino and Cleveland 2004). Sheep, cattle, or horses that are killed or injured by bear, cougars, or wolves are eligible for compensation from state funds through WDFW. Damages caused by coyotes is not eligible for compensation from state or federal funds (Section 1.12.2.4).

WDFW's policy regarding compensation for damage done by bear and cougar (RCW 77.36.100[2]) is:

…the department shall offer to distribute money appropriated to pay claims to the owner of commercial crops for damage caused by wild deer or elk or to the owners of livestock that has been killed by bears, wolves, or cougars, or injured by bears, wolves, or cougars to such a degree that the market value of the livestock has been diminished.

RCW 77.36.010 defines "commercial", "damage", "livestock", and "owners" as follows:

- **Commercial crop** means a commercially raised horticultural and/or agricultural product including the growing or harvested product but does not include livestock or rangeland. For the purposes of this chapter, commercially grown Christmas trees, managed pasture (fertilized, irrigated, or planted), and all parts of horticultural

[2] This RCW and program also include gray wolf management, WA-Washington does not conduct wolf management therefore making wolf damage and wolf WDM outside the scope of this EA

trees shall be considered a commercial crop and shall be eligible for cash compensation.

- **Damage** means economic losses caused by wildlife interactions.
- **Livestock** means cattle, sheep, and horses.
- **Owner** means a person who has a legal right to commercial crops, commercial livestock, or other private property that was damaged during a wildlife interaction.

Resource owners who work with WDFW to prevent/reduce damage to commercial crops from deer and elk may be eligible to receive compensation for ongoing deer and elk damage. To be eligible, the landowner must have a Damage Prevention Cooperative Agreement (DPCA) with WDFW and go through the claims process with WDFW (WAC 220-440-150). WDFW uses state licensed and federally certified crop adjusters to evaluate the damage (WAC 220-440-160). WS-Washington may be asked to assist WDFW to minimize future damage by removing deer or elk (e.g. to prevent disease transmission), but WDFW would make the determination as to whether lethal removal of deer or elk is necessary.

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 and grizzly bears) 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 mammals 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-Washington budget, even if resources are reallocated from current operational and technical assistance projects to confirming losses. Searching for lost animals, especially in large grazing 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) suggests that compensation does not necessarily improve tolerance for depredating wildlife, and some producers may reject payments in favor of lethal control.

Compensation could 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-Washington 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.

1.13.2.3 Livestock Producers Should Pay All Costs of MDM

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 MDM. 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 Washington, this funding is made up of about 11.5%-14.5%% from Congressional appropriations, 48%-63% from private or commercial cooperators, and the remaining 24%-36% from federal and state interagency agreements. Most cooperators pay the costs of their own lethal and nonlethal MDM (even when recommended by WS-Washington), any operational damage management actions conducted by WS-Washington, and a substantial proportion of the administrative overhead.

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

1.13.2.4 A Program Subsidizing Non-lethal Methods Implemented by Resource Owners Should Replace APHIS-WS MDM

WS-Washington subsidizes non-lethal methods in the form of supplies and limited supplemental labor to the public at no cost, when possible. These efforts are generally coordinated with WDFW and APHIS-WS's National Programs, as funding must be provided to support these efforts. WS-Washington may also loan non-lethal trapping equipment (WS Directive 4.165). Additional efforts of this sort may be augmented through political processes at the state or federal levels.

1.13.2.5 Incorporate the Environmental Costs of Livestock Grazing on Public Lands into Cost Analyses

APHIS-WS has no authority to address national policy set by multiple congressional statutes and state regulations regarding livestock grazing on public 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.

1.13.2.6 No Federal Funds Should Be Used to Kill Predators to Protect Game Species

WDFW has identified limited circumstances for which MDM for protection of native game species of mule deer, elk, and bighorn sheep, especially related to cougar predation, would meet Department objectives (Section 1.11). WDFW is authorized to conduct administrative removals of offending animals itself, it can request assistance from WS-Washington, or they can use other agents. These actions may occur without the involvement of WS-Washington and are likely to be funded by non-federal sources.

APHIS-WS' policy and objective is to consider and respond appropriately to all requests for PDM assistance.

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 EA and are described below.

Alternative 1: No Action Alternative –Continue MDM in Washington with inherent reasonable fluctuations of tempo, volume, cooperator participation, and lethal and non-lethal operational damage management assistance and technical support. WS-Washington will consider implementation of effective non-lethal operational damage management assistance before implementing lethal.

Alternative 2: WS-Washington Provides Technical MDM Assistance for Lethal and Non-Lethal Methods and only Non-Lethal Operational Damage Management Assistance. WS-Washington could provide technical assistance on lethal and non-lethal techniques, and/or provide non-lethal operational damage management assistance but would not provide lethal operational damage management assistance.

Alternative 3: WS-Washington Only Provides Lethal MDM Assistance for Cases of Human/Pet Health or Safety and/or to Protect Threatened or Endangered Species. WS-Washington could provide non-lethal and lethal MDM assistance when protecting human/pet health or safety or to protect federally-listed species. Assistance for other resources would only use non-lethal methods and/or technical assistance.

Alternative 4: No WS-Washington MDM Activities. WS-Washington would not conduct MDM activities in Washington. MDM would still be implemented by other legally authorized entities, such as WDFW, USFWS, property owners, WCOs, and certified WDFW volunteers.

2.2 What WS-Washington Activities Are Included in Each Alternative?

The 4 alternatives identified for comparative analysis are described in detail below. The effectiveness of each of these alternatives in addressing WS-Washington objectives (Section 1.5.1) is evaluated in Section 3.13).

2.2.1 Alternative 1. Continue the Current Integrated Mammal Damage Management Activities (No Action)

2.2.1.1 Why is Alternative 1 also the "No Action" Alternative?

The CEQ, in its 40 Most Asked Questions regarding the consideration of the "no action" alternative for project- and programmatic-level NEPA reviews states:

> "In situations where there is an existing program, plan, or policy, CEQ expects that the no-action alternative …would typically be the continuation of the present course of action until a new program, plan or policy is developed and decided upon."

Therefore, the current activities, with natural fluctuations in MDM actions, locations, and tempo, is also the no action alternative. The impacts of all other alternatives considered in detail will be compared to the impacts of the current activities/"no action" alternative.

2.2.1.2 How Do WS-Washington Field Personnel Select an MDM Strategy Using the APHIS-WS Decision Model?

For all alternatives in which WS-Washington provides requested services, WS-Washington uses the APHIS-WS Decision Model (Figure 1; WS Directive 2.201) as part of Integrated Mammal Damage Management for evaluating the situation and determining the most effective strategy to address the situation.

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 the situation. WS-Washington employees are trained and experienced in MDM, and they respond to a request and assess the problem using the APHIS-WS Decision Model.

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 owner monitors and evaluates the effectiveness, sometimes with WS-Washington assistance. 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 1):

1. **Receive Request for Assistance:** WS-Washington 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-Washington specialist and the requester will agree to the level of service and enter into one of the work agreements.

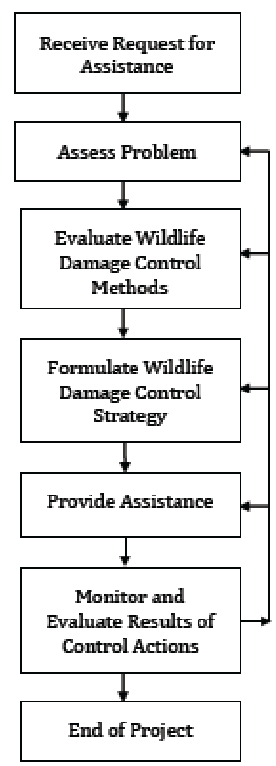

Figure 1 APHIS-WS Decision Model (WS Directive 2.201)

2. **Assess Problem:** Once on site, the WS-Washington field specialist makes a determination as to whether the assistance request is within the authority of WS-Washington. 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-Washington'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 operational damage management assistance is provided to the requester, as appropriate (see WS Directive 2.101).

6. **Monitor and Evaluate Results of Management Actions:** When providing operational damage management assistance, effectiveness of the management strategy is monitored, primarily by the cooperator, with assistance by WS-Washington when appropriate. Monitoring is important for determining whether further assistance is required or whether the management strategy resolved the problem.

7. **End of Project:** When providing technical assistance, a project normally ends after the WS-Washington field specialist provided recommendations and/or advice to the requester. Operational damage management assistance project normally ends when WS-Washington'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-Washington 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.

2.2.1.3 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 mammals in Washington.

The mission of APHIS-WS is to safeguard health, welfare, and American agricultural and natural resources by providing federal leadership in managing human-wildlife conflicts. To meet this goal, WS-Washington responds to requests for assistance with technical assistance and/or operational damage management assistance.

WS-Washington 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-Washington will continue to respond to requests for assistance 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 damage management assistance and, when appropriate, technical assistance to a property owner or manager.

WS-Washington would also continue to work with NWRC and other professional entities to produce and distribute materials and provide educational programs on methods for preventing or reducing mammal damage.

2.2.1.4 What are the General Components of the WS-Washington Activities in Alternative 1?

The current WS-Washington MDM activities include the following general components (See Appendix A for detailed description of components and methods):

- **Collaboration and Project Identification**

WS-Washington enters into cooperative partnerships when requested by other federal, state, or local agencies, tribes, and private entities. These projects are initiated and funded (partially or entirely) by partner agencies, tribes, or other cooperators who have experienced mammal damage or are working on research pertaining to MDM.

- **Education and Training**

APHIS-WS provides professional courses and training (e.g., wildlife management and biology, wildlife damage management, and non-lethal and lethal techniques for managing the risk of damage to encourage co-existence) to agencies, organizations, the public, property owners and managers, and cooperators upon request. 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-Washington are provided with information regarding the use of effective and practical non-lethal and lethal techniques and/or MDM strategies, including advice, training, and, to a limited degree, loan of equipment. Technical assistance is described in detail in Appendix A.

Property owners or managers may choose to implement WS-Washington's technical assistance recommendations on their own, use contractual services of private businesses, use volunteer services of private organizations, use the services of WS-Washington (operational damage management assistance), take the damage management action themselves without consulting another private or governmental agency, or take no action.

- **Operational Damage Management Assistance**

WS-Washington wildlife damage management activities involve an integrated approach that incorporates the direct use and/or recommendation for use of a range of non-lethal and lethal techniques. These techniques can be used singly or in combination to meet the need of each situation. When requested, WS-Washington may assist cooperators by providing MDM services, using the non-lethal and/or lethal methods detailed in Appendix A.

- **Carcass Disposal**

All carcass disposal is consistent with APHIS-WS Directives 2.510 and 2.515 (Section 2.4) and state law (WAC 246-203-121). Meat may be donated to food banks, tribes, or wildlife rehabilitators. When meat donation is likely, WS-Washington uses non-lead ammunition. Bears carcasses are transferred under the direction of WDFW. Cougar carcasses are provided to WDFW or disposed of at the direction of WDFW on a case-by-case basis.

- **Monitoring**

WS-Washington, in coordination with WDFW when appropriate, monitors the results and impacts of its activities. The impacts discussed in this EA are monitored and evaluated in two ways:

> 1) WS-Washington determines if any additional information that arises subsequent to the NEPA decision from this EA would trigger the need for additional NEPA analysis. WS-Washington 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 with those identified in this EA.
>
> 2) WS-Washington, in coordination with WDFW when appropriate, monitors localized and cumulative impacts on target and non-target populations through its MIS database.

WS-Washington provides detailed information on animals removed, as appropriate, to WDFW to assist those agencies with managing species and resources under their jurisdictions.

2.2.1.5 Resources protected under Alternative 1

Alternative 1 continues the current WS-Washington MDM assistance as requested, accounting for inherent, realistic fluctuations of tempo, volume, county participation, and operational damage management and technical support based on requests for assistance as they arise.

WS-Washington receives requests for MDM assistance to protect assets, such as:

- Human health and safety, including human safety from direct conflicts, threats to aviation safety, and damage to infrastructure influencing public safety.
- Agricultural resources to include livestock, crops, and the supporting infrastructure.
- Residential and Non-residential structures or properties;
- Natural resources, as managed by WDFW, USFWS, tribes, and other state/federal agencies.

Most of these requests come from private individuals. WS-Washington cooperates closely with state and federal wildlife agencies in Washington. Principal partners include the Washington Department of Fish and Wildlife (WDFW) and USFWS. These agencies have management authorities over wildlife and often fund specific projects they request WS-Washington to conduct. WS-Washington responds to requests from these agencies to assist with protection of Threatened and Endangered (T&E) wildlife as well as damaging and dangerous wildlife conflicts. WDFW also issues damage control agreements, certifies WCOs, and issues recreational harvest permits to the public to remove mammals and to regulate recreational harvest. Requests for assistance may also come from public entities, such as WDNR, USFS, and other local, state, federal, or tribal entities. MDM assistance provided by WS-Washington may be conducted on public, private, state, federal, tribal, and other lands or any combination of these land class types, as appropriate (Section 1.10.4).

APHIS-WS has signed national level MOUs with BLM, USFS, and the USFWS. In addition, WS-Washington has signed agreements with WDFW to provide wildlife damage management services upon request (Sections 1.8 and 1.9). Requests for management work on BLM, WDNR, and USFS land may come from livestock permittees or the land management agency itself. All anticipated WS-Washington activities on BLM, WDNR, and USFS lands are outlined in WS-Washington Annual Work Plans or Agreements for Control. When work is proposed, annual coordination meetings are held between WS-Washington and personnel from the land management agencies to discuss accomplishments, status of work, issues of concern, and any anticipated changes in proposed work plans.

2.2.1.6 In What Types of Areas Would WS-Washington Operate?

Washington encompasses about 71,362 square miles (mi^2). During the reporting period, FY2014-FY2018, WS-Washington worked on a total of 2664.063 mi^2 or about 3.73% of Washington State's total area. WS-Washington generally only conducts MDM on a small portion of the properties under agreement in any one year. However, those areas are generally the total acreage owned or managed by the landowner or manager and are far greater than the actual area in which WS-Washington conducts operational damage management actions.

For example, a county's department of transportation manages roads across the 800 mi^2 of the county and generally experience road damage by wildlife (e.g. road flooding by beaver) only in several small areas. If WS-Washington is responding to beaver flooding a road, we might set one suitcase trap (live trap) which would impact an area approximately 25 ft^2. So in the event that 50 areas were experiencing damage the actual area where WS-Washington would be taking action would be limited approximately 1250 ft^2 of the 800 mi^2 that are under agreement.

Under the current WS-Washington activities, the frequency, locations, cooperators (private, state, federal, tribal and others), varieties of MDM work, and numbers of target and non-target animals taken have varied over the years. WS-Washington 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-Washington recognizes that requests for its assistance are on a case-by-case basis. Regardless of the situation, the WS-Washington employees are trained and experienced, and they respond using APHIS-WS Decision Model to determine whether a response is warranted and, if so, the most effective strategy.

Therefore, this alternative includes MDM actions within public, private, and tribal owned/managed lands in Washington where requests for assistance are received and funding permits.

Unforeseen areas or currently unplanned activities, including emergency response, are those where WS-Washington has not operated or had agreements to operate, yet an entity experiencing mammal damage, threats, or risks to human/pet health or safety, property, or natural resources requests assistance from WS-Washington. Unforeseen/unplanned MDM activities are handled on a case-by-case basis as the need arises, in response to a request. If MDM is requested on lands classified as other than private, WS-Washington notifies the land management agency as soon as practicable or as agreed upon in MOUs.

This alternative includes WS-Washington conducting MDM operations within currently unforeseen areas as long as the operations are consistent with actions and impacts as described in this EA, 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 those areas with special designations, such as wilderness areas and wilderness study areas;
- The results of formal and informal consultations with the USFWS per the ESA;
- Sustainable population levels as evaluated in Sections 3.5, 3.6, and 3.7; and
- The actions would not trigger substantive environmental issues or effects that are not addressed in this EA.

2.2.1.7 What Types of Operational Damage Management Methods Are Used in Alternative 1?

As detailed in Appendix A, WS-Washington can use and/or recommend many methods, including combinations of methods, for MDM strategies.

WS-Washington, WDFW and/or its agents, WDFW-certified Wildlife Control Operators (WCOs), private individuals, or the property owners themselves may implement MDM methods. Implementing non-lethal methods such as husbandry or structural barriers are generally the responsibility of the property/resource owners/managers. Depending on the circumstances of each MDM situation, lethal methods may be needed to address the immediate problem while implementing non-lethal methods in attempt to create a long-term solution. The design of the APHIS-WS Decision Model (Section 2.2.1.2), which provides for the consideration of lethal and non-lethal methods, allows WS-Washington 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 mammals causing damage, thereby reducing the risk that mammals can cause damage or threats at the site and immediate area. WS-Washington gives non-lethal methods priority when addressing requests for assistance, when applicable and effective (WS Directive 2.101). However, non-lethal methods may not be used to resolve every request for assistance if deemed inappropriate or potentially ineffective by WS-Washington's personnel under the APHIS-WS Decision Model within the practices of MDM (Section 2.2.1.2, Figure 1). WS-Washington 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-Washington may include habitat management, exclusionary structures, aversive/harassment devices, chemical deterrents, herding, and livestock guard animals (Appendix A). WS-Washington may occasionally loan harassment equipment such as propane cannons and pyrotechnics. 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 mammals, 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, the problem has been occurring for weeks to months, if not years (i.e., wildlife hazards at airports), and a cooperating entity has already tried reasonable non-lethal methods to resolve damage prior to contacting WS-Washington 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-Washington 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-Washington field specialist 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-Washington 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 damage recurring. The use of lethal methods results in temporary and small local reductions of the numbers of mammals in the area where damage or threats are occurring or are expected to recur. A common misconception is that WS-Washington attempts to "wipe out" mammal populations. In reality, most MDM situations involve very few of the local mammals and the vast majority of the other individuals do not cause damage. As such, WS-Washington targets the one or few mammals that are causing the damage, rather than targeting the entire local population. Almost without exception, new mammals move into areas where MDM occurred, and these individuals may never cause damage. This results in no discernable impact on the species or public, other than the reduction/elimination of damage. WS-Washington strives to remove the fewest number of animals necessary to resolve the damage, which is dependent on the number mammals involved with the associated damage or threat, the duration the existing problem has been allowed to occur, the potential for recurrence of damage (especially on livestock or ESA-listed species), and the effectiveness of methods used.

Lethal methods used by WS-Washington employees include ground shooting, aerial shooting, snaring, live trapping using foot snares, nets, cage traps, and foothold traps (followed by mechanical or chemical euthanasia), and chemical toxicants. These methods are described in detail in Appendix A. WS-Washington does not use M44s or sodium cyanide. WS-Washington employees follow the American Veterinary Medical Association (American Veterinary Medical Association 2020) euthanasia recommendations for free-roaming and captured animals in MDM activities, where practical and effective (APHIS-WS Directive 2.505, and Sections 2.4 and 3.9.2), and use the most humane and rapid methods available under the circumstances and per the APHIS-WS Decision Model (Sections 2.2.1.2, Appendix A, and Section 3.9.2).

Aerial shooting is generally one of the most effective control methods for coyote and feral swine removal where terrain is relatively flat. It is the preferred method because of its selectivity, accessibility, effectiveness, and ability to traverse rough terrain during winter. In addition, it provides the greatest area of coverage needed to protect livestock resources and locate feral swine. Other control methods, such as foothold traps, foot snares, and ground shooting, may be used with aerial shooting. During spring, coyotes inflict the greatest depredation losses, coinciding with lambing and calving. Therefore, MDM is intensified with the necessary effective and practical methods. WS-Washington now conducts all aerial shooting operations with non-lead ammunition.

Good visibility and relatively clear and stable weather conditions are required for effective and safe aerial shooting operations. Summer conditions can limit the effectiveness of aerial shooting, as heat reduces coyote/feral swine activity and vegetative ground cover may hamper visibility. High temperatures, which reduce air density, affect low-level flight safety and may restrict aerial shooting activities. Other restrictions include high elevations, dense vegetation cover, and rugged terrain.

WS-Washington conducted aerial management in Adams, Benton, Columbia, Franklin, Grant, Lincoln, Stevens, Walla Walla, Whitman, and Yakima Counties. Aerial management occurs only on lands where it is authorized and when under agreement, whether on public or private lands.

WDFW has the authority to permit other entities to conduct aerial shooting to remove coyotes for livestock protection, but historically has not used its authority and has only allowed WS-Washington to conduct aerial MDM.

WDFW regulates activities involving removing several mammal species during a regulated hunting/trapping season, as authorized by state law.

The current WS-Washington activities are or may be conducted on private, public, tribal, and other lands where a request has been made, the WS-Washington employee has determined that the problem is caused by a mammal, and appropriate agreements for assistance have been finalized. All management actions comply with appropriate federal, state, territorial, tribal, and local laws.

- **Methods that May Be 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 translocation or for euthanasia following capture; depending on the circumstances, species, policy and regulatory requirements, and management objective. As described in Section 1.7, WDFW policy prohibits translocating mammals, such as coyotes, skunks, opossums and raccoons, without a permit from the Director. Some reasons why translocating native wildlife is not permitted are: 1) a risk of continuing the problem in their new location, 2) may spread disease, and 3) may not fare well due to intraspecific competition. APHIS-WS policy also discourages translocation of captured offending animals for the same reasons (APHIS-WS Directive 2.501; Section 2.4). Translocation 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.

Table 10. WS-Washington Average Annual Lethal Take of Mammals, FY15-FY19 and Percent of Take by Land Class

Species	Average Take Per Year	Lowest Annual Take	Highest Annual Take	Percent of Take on-	
				Public Lands	Private Lands
BADGERS	0.8	0	4	0%	100%
BATS (OTHER)	0.2	0	1	0%	100%
BATS, BROWN, BIG	0.2	0	1	0%	100%
BEARS, BLACK	4	0	6	100%	0%
BEAVERS	406.2	245	579	69%	31%
BEAVERS, MOUNTAIN	121.4	22	273	99%	1%
BOBCATS	0.6	0	3	100%	0%
CATS, FERAL/FREE RANGING	7.2	5	13	92%	8%
COYOTES	512.6	257	766	75%	25%
DEER, BLACK-TAILED	9	3	17	0%	100%
DEER, MULE	0.2	0	1	0%	100%
DEER, WHITE-TAILED (WILD)	2.8	0	14	0%	100%
DOGS, FERAL, FREE-RANGING AND HYBRIDS	0	0	0	0%	0%
ELK, WAPITI (WILD)	2.8	0	11	100%	0%
FOXES, RED	0.6	0	2	0%	100%
LIONS, MOUNTAIN (COUGAR)	0.4	0	2	100%	0%
MARMOTS, YELLOW-BELLIED	415.2	227	691	53%	47%
MINKS	0.2	0	1	0%	0%
MOLES (ALL)	2	0	10	0%	100%
MUSKRATS	32.8	3	67	8%	92%
NUTRIAS	532	65	1093	4%	96%
OPOSSUMS, VIRGINIA	42	14	83	91%	9%
OTTERS, RIVER	47.6	30	65	52%	48%
POCKET GOPHERS, NORTHERN	499.4	81	880	31%	69%
PORCUPINES	2.6	0	5	100%	0%
RABBITS, COTTONTAILS, EASTERN	154.8	62	267	7%	93%
RABBITS, COTTONTAILS, MOUNTAIN	1.4	0	7	0%	100%
RABBITS, FERAL	10.4	0	16	73%	27%
SHEEP, BIGHORN	0	0	0	0%	0%
RATS, NORWAY (BROWN)	27.4	0	95	99%	1%
RACCOONS	136	86	198	76%	24%
RATS, BLACK (ROOF)	16.8	0	74	100%	0%
SEA LIONS, CALIFORNIA	0	0	0	0%	0%
SEA LIONS, STELLER	0	0	0	0%	0%
SKUNKS, STRIPED	13.4	1	49	13%	87%
SQUIRRELS, DOUGLAS	0.2	0	1	100%	0%
SQUIRRELS, GROUND (OTHER)	0.2	0	1	0%	100%
SQUIRRELS, EASTERN GRAY	8.6	1	22	53%	47%
SQUIRRELS, GROUND, CALIFORNIA	73.8	0	165	0%	100%
SQUIRRELS, GROUND, COLUMBIAN	361.8	4	719	1%	99%
SWINE, FERAL	4.8	0	11	50%	50%
VOLES (ALL)	296.2	0	1019	100%	0%

2.2.1.8 What Other Entities Conduct MDM in the Absence of WS-Washington 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 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.*" (Council on Environmental Quality 1981)

Therefore, WS-Washington 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.

State agencies also have legal authority to respond to and manage wildlife conflicts. As discussed in Chapter 1 (Section 1.7), WDFW has legal wildlife damage management authority, with roughly 20 or more Wildlife Conflict Specialists each year. WDFW may issue depredation permits and permits for aerial shooting. WDFW can also certify volunteers, and trappers for mammal damage management for cougar and bears, and certify commercial mammal damage management companies, typically for addressing human conflicts with smaller mammals. For many mammals not managed as game or furbearer mammals in Washington, property owners can also remove such animals causing depredation or damage with or without a permit issued by WDFW, depending on the species and method of take. In addition, WDFW can set take limits for game and furbearers during hunting and trapping seasons to manage population levels to meet state objectives (Section 1.7). Local authorities are primarily involved with complaints regarding feral/free-ranging dogs and cats. Lastly WDFW can enter damage prevention cooperative agreements with landowners to cost share proactive methods (e.g. fencing, range riders) and permits authorizing landowners to take damaging big game species.

Private and commercial property owners can also request assistance from private Wildlife Control Operators (WCOs) certified by WDFW (WAC 220-440-110) 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 RCW 77.36.030. Approximately 320 WDFW-certified WCOs have active licenses; however, they are not authorized to handle issues involving big game (e.g. deer, elk, bear, and cougar) (Washington Department of Fish and Wildlife). Per Washington statute, landowners or their agents may trap or kill wildlife threatening human safety or causing property damage (RCW 77.36.030).

Given that federal, state, commercial, and private entities receive authorization, or do not need authorization, from WDFW to conduct MDM, and that most methods for resolving mammal damage are available to WS-Washington and to non-federal entities, it is clear that, even under all the alternatives, including those in which WS-Washington does not implement or limits implementation of lethal operational MDM, other entities will be conducting MDM, to include lethal methods (Section 2.2.5, Table 11).

All non-lethal methods and most lethal methods are available to non-WS-Washington entities. WDFW can permit non-federal entities and individuals to conduct aerial lethal removal, but their historical decision has been to only allow WS-Washington. Currently, only WS-Washington and WDFW have authority to aerial shoot coyotes, under WDFW's authority. Without WS-Washington providing this assistance, it is likely that pressure from producers would cause WDFW to grant aerial shooting permits to private individuals and companies. In the event no authorizations were granted, trapping efforts towards coyotes would likely increase and the number of non-target animals taken would increase concurrently because trapping is less target specific than shooting.

2.2.2 Alternative 2. WS-Washington Provides Technical MDM Assistance and only Non-Lethal Operational Damage Management Assistance

WS-Washington would provide non-lethal and lethal recommendations and information for others to implement themselves, but the only operational MDM activities WS-Washington would implement would be non-lethal.

This is similar to Alternative 1 (No Action), except that WS-Washington would not be available to directly provide any lethal operational damage management assistance to any requester, even if requested as an agent of WDFW or USFWS. Requestors would be dependent on assistance from commercial companies, contacting WDFW for aerial shooting, WDFW or their agents, USFWS or their agents, or volunteers/family/friends for their lethal MDM responses, or conduct the actions themselves, as allowed by state law.

Non-lethal technical assistance includes collecting information about the species involved, the nature and extent of the damage, and previous methods that the requester/cooperator had used to alleviate the problem. WS-Washington would then provide the cooperator with information on appropriate non-lethal and lethal methods to alleviate the damage themselves. Types of technical and direct non-lethal assistance projects may include a visit to the affected property, written communication, telephone conversations, and presentations to groups such as homeowner associations, civic leagues, or conservation districts, harassing mammals, and showing requesters how to set traps.

In some cases, WS-Washington may provide supplies or materials for non-lethal methods that are of limited availability for use by private entities, such as loaning propane cannons. Generally, WS-Washington could describe several non-lethal management strategies (Appendix A) to the requester for short-term and long-term solutions to managing damage, as well as recommend and provide training on lethal techniques. Those persons receiving technical assistance from WS-Washington could implement recommended methods, use other lethal and non-lethal methods not recommended by WS-Washington, seek assistance from other entities, or take no further action. While WS-Washington could recommend non-lethal and lethal methods, WS would only loan equipment or implement those non-lethal methods legally available for use by the requester and advise them of any permits needed.

Between FY2015 and 2019, WS-Washington conducted 1,609 technical assistance projects that involved mammal damage to agricultural resources, property, natural resources, and threats to human safety (MIS 2019).

WS-Washington may also recommend that property owners or managers allow hunting, to reduce the number of animals causing damage on their properties. Establishing hunting and trapping seasons and the allowed harvest during those seasons is the responsibility of WDFW. This alternative places the immediate responsibility of operational damage management work and any environmental compliance responsibilities on the resource owner, other governmental agencies, and/or private businesses. It is unlikely that any NEPA, ESA consultations, or formal monitoring would be conducted by private individuals or companies.

WS-Washington would have no responsibility for any actions implemented by a requester upon advice and recommendations from WS-Washington. The requester would be responsible for compliance with the Endangered Species Act, federal laws, and state laws and regulations.

2.2.3 Alternative 3. WS-Washington Only Provides Lethal MDM Assistance for Cases of Human/Pet Health or Safety and/or to Protect Threatened or Endangered Species.

Under this alternative, WS-Washington provides full MDM technical assistance, including lethal and non-lethal methods, and lethal operational damage management assistance only for protecting human/pet health or safety or to protect ESA-listed species. All other operational damage management assistance could only use non-lethal methods. For instances of human/pet health or safety or to protect ESA-listed species, all lethal and non-lethal MDM methods described in Alternatives 1, 2, 3 and in Appendix A are available for recommendation and/or use. For all instances not including humans, pets, and ESA-listed species, only non-lethal operational damage management methods and lethal and non-lethal technical assistance are available for use, as described in Alternatives 1, 2, 3, and in Appendix A.

Cooperators would always have the option of implementing lethal MDM measures on their own, by hunters or their friends/family, WDFW, or through commercial companies. WDFW's actions are subject to State Environmental Policy Act (SEPA) analysis and ESA consultations. It is unlikely that any NEPA, ESA consultations, or formal monitoring would be conducted by private individuals or companies.

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.

2.2.4 Alternative 4. No WS-Washington Involvement in MDM Activities

Under this alternative, WS-Washington would not be involved in any MDM efforts, including lethal and non-lethal technical or operational damage management assistance and actions. MDM would still be implemented by other legally-authorized entities, such as WDFW, USFWS, property owners, WCOs (excludes big game unless authorized under special permits), other commercial MDM companies for non-wildlife species, hunters, family members, and certified WDFW volunteers (Sections 1.7 and 2.4). Entities experiencing mammal damage could continue to resolve damage by employing whatever methods they chose. The removal of mammals to alleviate damage or threats would occur despite the lack of involvement by WS-Washington.

Requesters would need to seek MDM information on existing and new methods (including methods developed and tested by the APHIS-WS NWRC) from other sources such as WDFW, University Extension Service offices, conservation districts, or pest control companies. Legal limitations on MDM implemented by entities other than WDFW may limit the options available to entities experiencing damage. WDFW 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. Individuals and land management agencies would always have the option of implementing lethal MDM measures on their own, through WDFW conflict staff, by hunters or their friends/family, or through WDFW authorized WCOs. WDFW's actions may be subject to State Environmental Policy Act (SEPA) analysis and ESA consultations. It is unlikely that any NEPA, ESA consultations, or formal monitoring would be conducted by private individuals and companies.

2.2.5 Summary of Methods Available Under Each Alternative

The alternatives involving WS-Washington activities for MDM allow the use of different management methods, depending on the alternative. The methods that could be used or recommended under the different alternatives are summarized in Table 11. Methods denoted with "X" can be implemented as described in alternative 1. Methods marked with "Only NL" apply to methods where lethal application would be an option but are not available under that alternative. Methods marked with "Restricted L" indicate methods where lethal methods are restricted to certain applications described under that alternative. If no mark is shown that method is unavailable under that alternative.

Table 11. Operational Damage Management Assistance Methods Available to WS-Washington and Other Entities Compared by Alternative[1]

Method	Alt 1 Current Activities	Alt 2 Non-lethal Only	Alt 3 Lethal Only for HHS and T&E	Alt 4 No WS	WDFW Under all 4 Objectives	WCOs and Private Entities Under all 4 Objectives
Animal Husbandry (NL)	X	X	X		X	X
Modifying Human Behavior (NL)	X	X	X		X	X
Habitat Management (NL)	X	X	X		X	X
Modifying Wildlife Behavior (NL)	X	X	X		X	X
Range Riding (NL)	X	X	X		X_{LM}	X
Live-capture & Relocation (NL)	X	X[3]	X		X	X_{LM}
Cage/box Traps (NL/L)	X	Only NL[3]	Restricted L		X	X
Culvert Traps (NL/L)	X	X	Restricted L		X	X
Foothold Traps (NL/L)	X	Only NL[3]	Restricted L		X	X
Quick-Kill Traps (L)	X		Restricted L		X	X
foot Snares (NL/L)	X	Only NL[3]	Restricted L		X	X_{LM}
Trap Monitors (NL/L)	X	Only NL[3]	Restricted L		X	X
Catch Poles (NL/L)	X	Only NL[3]	Restricted L		X	X
Hand Nets (NL/L)	X	Only NL[3]	Restricted L		X	X
Net Guns (NL/L)	X	Only NL[3]	Restricted L		X	X_{LM}
Ground Shooting (L)	X		Restricted L		X	X
Ground Shooting with thermal or low light vision	X		Restricted L		X_{LM}	X_{LM}
Aerial Shooting (L)	X		Restricted L		X_{LM}	
Aerial Surveying (NL)	X	X	X		X	
Chemical Repellents (NL)	X	X	X		X	X
Immobilization Drugs (NL/L)	X	Only NL[3]	Restricted L		X	X_{LM}
Euthanasia (L)	X		Restricted L		X	X_{LM}
Gas Cartridges (L)	X		Restricted L		X	X_{LM}
Chemical Toxicants (L)	X		Restricted L		X	X

[1] Alternative 1 through 3 provides the same non-lethal and lethal recommendations as part of technical assistance.

[2] NL = Non-lethal method; L = Lethal Method; NL/L = the method can be applied as either lethal or non=lethal.

[3] These methods would only be used if the animal was live-captured and released on site or relocated and released alive.

[4] X_{LM} = The method is available but less likely to be implemented (especially by individuals and small companies) due to; limited resources, infrequent requests for application of method, permit requirements, and/or cost.

2.3 What Are the Protective Measures including Policies, Consultation Measures, and State Laws that WS-Washington Implements to Avoid or Reduce Adverse Effects?

The measures listed in this section improve the safety, selectivity, and efficacy of MDM activities, and reduce or eliminate unwanted environmental effects. WS-Washington MDM activities have incorporated these measures into the current activities, and these measures are also incorporated into any other described alternative in which some level of operational damage management WS-Washington activities would occur (Alternatives 1, 2, and 3), as relevant. For example, APHIS-WS policies involving lethal take included in its directives would not apply to alternatives in which WS-Washington would not take lethal action, although the agency could recommend such actions under technical assistance.

Some of the following measures implemented by WS-Washington are for the prevention or minimization of environmental impacts while others focus on personnel safety 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 four major parts:

A. APHIS-WS policies included in formal directives, categorized into sixteen topics

B. WS-Washington Minimization Measures for Mammal Damage Management

C. WS-Washington formal and informal consultations with the USFWS

D. Formal and Informal Consultations with the NOAA NMFS for Washington

E. Additional Measures

A. APHIS-WS Policies in Formal Directives

USDA-APHIS Directives can be viewed in their entirety at https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/SA_WS_Program_Directives. These policies are cited throughout the analysis.

B. WS-Washington Minimization Measures for Mammal Damage Management

Target, Non-target, and Threatened and Endangered Species

a.	Wildlife Services personnel are trained and experienced to select the most appropriate method for taking problem animals and excluding non-target species.
b.	Conspicuous, bilingual warning signs alerting people to the presence of traps and snares are placed at major access points when they are set.
c.	WS-Washington complies with conditions of all ESA consultations conducted with USFWS and NMFS. WS-Washington maintains regular contact and consultations with appropriate state and federal agencies to keep apprised of locations and information on the presence of any T&E animals and reports sightings of endangered species.
d.	WS-Washington monitors traps every 24 hours.
e.	WS-Washington incorporates pan-tension devices in foot/leg snares and foot-hold traps to reduce exposure of capture to smaller non-target animals.
f.	APHIS-WS coordinates with NWRC on research to improve MDM methods and strategies to increase selectivity for target species, to develop effective nonlethal control methods, and to evaluate and minimize non-target hazards and environmental effects of MDM techniques.
g.	In the event that WS-Washington recommends habitat modification (e.g., modifying a wetland) as a damage management practice for the landowner/manager, WS-Washington would advise the landowner/manager that they are responsible for checking with state and federal authorities regarding regulations and endangered species protections that may be applicable to the proposed project.
h.	WS-Washington uses chemical methods for MDM that have undergone rigorous research to prove their safety and lack of serious effects on non-target animals and the environment.
i.	WS-Washington follows U.S. EPA approved label directions for pesticide use. The registration process for chemical pesticides is intended to assure minimal adverse effects to the environment when chemicals are used in accordance with label directions.
j.	Traps and snares are not set within 30 feet of exposed animal carcasses to prevent the accidental capture of scavenging eagles.
k.	Captured non-target animals are released, unless it is determined by WS-Washington personnel that the animal would not survive. In this case, personnel may contact the appropriate management agency or wildlife rehab facility.
l.	Where applicable, annual WS-Washington take is considered with the statewide “total harvest” (e.g., WS-Washington take and other licensed harvest) when estimating the impact on wildlife species.
m.	Management actions are directed toward localized populations or groups and/or individual offending animals, dependent on the magnitude of the problem.
n.	AVMA (2020) recommended euthanasia procedures are followed, when feasible, to minimize pain and suffering.
o.	Where appropriate, WS-Washington conducts activities under Cooperative Agreements and MOUs with federal and state agencies. National MOU’s with the BLM (2020) and USFS (2017) delineate expectations for wildlife damage management on lands administered by these agencies.

C. Formal and Informal Consultations with the USFWS for Washington

WS-Washington has completed consultation with the USFWS under Section 7 of the Endangered Species Act for effects of WS-Washington activities on federally-listed threatened and endangered species. The effects analyses and findings pertinent to this EA on federally-listed species based on consultations completed 21 July 2014 are included in Sections 3.6.

C1. Conservation Measures from the 2014 Biological Assessment (BA) and USFWS Concurrence Letter for WS-Washington Effects on All Federally-listed Species

a.	Technical assistance and education is stressed in each control program so that property and resource managers can learn ways to avoid attracting predatory animals, and so that the public might be more willing to cooperate with recovery efforts.
b.	WS-Washington would initiate informal consultation with the USFWS following any incidental take of federally-listed threatened and endangered species per the USFWS Biological Opinion.
c.	When working in an area that has federally-listed threatened or endangered species or has the potential for these species to be exposed to MDM methods, WS-Washington personnel will be trained to recognize sign of presence of these species and integrate protective measures to minimize or avoid risk of adverse effects.
d.	APHIS will not proceed with any action that the USFWS has determined could jeopardize the continued existence of any federally-listed threatened or endangered species, or that would adversely modify or destroy designated critical habitat.
e.	Per the WS Directive 2.310, incidents involving impacts on listed species will be reported within 24 hours to the appropriate WS-Washington supervisor, and the location of dead or seriously injured listed species will be immediately reported to the appropriate USFWS Law Enforcement Office and WDFW wildlife representative.
f.	USFWS and appropriate land management agency shall be notified as soon as possible of the finding of any dead or injured federally-listed species, with cause of death, injury, or illness, if known provided.
g.	Chemicals will be applied consistent with EPA labels
h.	WS WA would prioritize control methods to be used and would include consideration of target and non-target species in making these decisions.
i.	Mapped landscape areas (designated for pygmy rabbit, Canada lynx (lynx), grizzly bear, or federally listed wolves) will be reviewed on an annual basis with USFWS, WDFW, and other appropriate species experts to determine if an increase, decrease, or other modification is necessary. Applicable section IO(a)(l)(A) permits will be reviewed at that time to ensure continued applicability and listing of appropriate staff.
j.	WS-Washington staff that are trapping large predators [e.g., cougars (*Felis concolor*), and black bears (*Ursus americana*) will be trained in the identification of large predators [particularly in distinguishing between black bears and grizzly bears (*Ursus arctos horribilis*)] and their sign.
k.	Prior to trapping within mapped landscape areas (MLAs, designated for lynx, grizzly bear, or federally listed wolves), WS WA will contact USFWS and/or WDFW for the most-recent information regarding the distribution of these species. WS WA will conduct pretrapping reconnaissance in a manner that is directed toward finding sign of these species and will report any positive findings to WDFW and USFWS.

C2. Conservation Measures from the 2021 Informal Consultation on Chlorophacinone

a.	Application shall not occur from mid-May to mid-September when juvenile mountain beavers are present.
b.	Maximum Annual Application Rate is two bait packets per burrow system per year.
c.	Bait shall not be broadcast and shall not be applied by any method not specified on the label.
d.	The label also states that chlorophacinone shall not be used where impact on listed threatened or endangered species is likely.

In addition, WS-WA has committed to additional measures:

a.	Baits would be applied after a trapping regimen is completed to reduce the amount of chlorophacinone necessary to reduce the damage.
b.	Chlorophacinone packages would be placed at least 12 inches inside a mountain beaver burrow.

D. Formal and Informal Consultations with the NOAA NMFS for Washington

WS-Washington has completed informal and formal consultation with the NOAA NMFS per Section 7 of the Endangered Species Act for effects of WS-Washington's beaver management activities on federally-listed threatened and endangered fish salmonids. The effects analyses and findings pertinent to this EA on federally-listed species based on consultations completed March 13th 2019 are included in Section 3.6. WS-Washington continues to consult with the NMFS as needed to maintain compliance with the ESA for WS-Washington activities.

D1. Terms and Conditions from the 2019 Biological Opinion (BO) for WS-Washington Effects on All Federally-listed Salmonid Species

a.	WS-Washington shall alert NMFS immediately, it becomes apparent that a take threshold has been exceeded.
b.	At beaver removal sites subject to the 20-site limit per Section 2.9.1 above, where there are established dams on natural streams, WS-Washington shall visually estimate (to the best of their ability) and record the surface area of the beaver pond i. At sites where there are not established dams, WS-Washington shall record the dam status (i.e., no evidence of a dam, partial dam).
c.	At sites in ESA-listed salmonid habitat where beaver activity poses a threat to public infrastructure and safety, WS-Washington shall report to NMFS, if the dam was not removed following removal of the beavers.
d.	WS-Washington shall report annually with the following information: i. A summary of beaver removals that occurred in ESA-listed salmonid habitat. This summary shall include: 1. The cumulative (up to and including the past 5 years) number of removal sites subject to the 20-site limit per Section 2.9.1 above, which occurred within the range of each ESU and DPS. 2. Identification of any HUC_6 with more than one removal site (cumulatively, up to and including the past 5 years).

	3. The estimated beaver pond surface acres at sites with established beaver dams (per b, above). 4. The number of removal sites within the range of each ESU and DPS where a beaver dam blocked ESA-listed salmonid passage through a transportation crossing, but where passage was subsequently restored following beaver removal. 5. The ultimate disposition of the animal(s) (e.g., transferred for relocation, killed), for each beaver removal site subject to the 20-site limit, per Section 2.9.1 above. 6. The number of Successful relocation sites within the range of each independent salmon and steelhead populations, for beavers that were initially live-trapped by WS-Washington and transferred to CBRs.
e.	After the fifth year of implementation, and at any time previously, if the facts suggest it is necessary, WS-Washington shall meet with NMFS to discuss if the original assumptions made by both parties were accurate, such that NMFS' analysis of effects is still valid.

D2. Reasonable and Prudent Measures from the 2019 Biological Opinion (BO) for WS-Washington's Beaver Management Effects on All Federally-listed Salmonids

Reasonable and Prudent measures are non-discretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02). Per the 2018 NMFS BO, WS-Washington will minimize incidental take by:

> *Conducting monitoring sufficient to document that the proposed program methods are adhered to, that the terms and conditions listed below are implemented, and that the extent of take is not exceeded.*

E. Additional Measures

E1. Protection of Human/Pet Health and Safety

a.	When there is a risk of people being present, operational damage management activities are generally conducted when human activity is low, such as at night or early morning.
b.	In most cases, live 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. Trap warning signs are placed in the immediate area around these traps.
c.	Public safety zones are delineated and defined by location or on Annual Work Plan (AWP) maps by BLM and USFS, and changed or updated as necessary. The land management agencies would be notified of MDM activities that involve methods of concern such as firearms and traps before these methods would be used in a public safety zone, unless specified otherwise in the AWP and as appropriate.

E2. Operating on Federally-Managed Lands/Facilities

a.	All WS-Washington MDM actions conducted on public lands managed by BLM or USFS are conducted per the interagency MOUs with associated annual work plans (see Section 1.9.2). MDM conducted at federal facilities (e.g. military bases, hydroelectric facilities) are coordinated with the facility management to ensure safe operations.

E3. Miscellaneous Measures

a.	Use of Non-lead Ammunition. WS-Washington has committed to using non-lead ammunition when conducting aerial MDM activities and whenever else practicable. To the extent practicable, lead ammunition will not be used when carcasses are not recoverable, when meat may be donated for human or animal consumption, when non-lead ammunitions is required by land management policies, and when and where required by ESA Section 7 consultations.
b.	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.
c	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 What Alternatives and Strategies Are Not Considered for Comparative Analysis?

Commenters responding to previous APHIS-WS wildlife damage management EAs have requested that APHIS-WS consider the following alternatives.

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-Washington reviewed alternatives and ideas proposed in comments to APHIS-WS MDM 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.

2.4.1 Use of Only Technical Assistance by WS-Washington

WS-Washington would only respond to requests for assistance through providing recommendations. These recommendations could involve lethal and non-lethal methods. WS-Washington would not conduct any operational damage management assistance. Since this does not allow for any non-lethal operational damage management assistance, this alternative is not considered in detail.

2.4.2 Use of Only Lethal Methods by WS-Washington

Under this alternative, WS-Washington would only provide technical and operational damage management assistance using lethal MDM techniques. Prohibiting WS-Washington from using or providing technical assistance on effective and practical non-lethal MDM 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 MDM, and may provide a more effective short-term or long-term solution to MDM 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 mammals 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 .5.1.2) allows WS-Washington 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).

For these reasons, this alternative is not considered in detail.

2.4.3 Use of Only Non-lethal Operational Damage Management Assistance

WS-Washington would provide only non-lethal operational damage management assistance. WS-Washington would not implement nor advise others on the use of lethal operational damage management methods.

Non-lethal operational damage management is included in Alternative 1, 2, and 3 considered in detail in this EA (Section 2.5.2) Therefore, considering this alternative in detail would be redundant and would not be reasonable, logical, or professional.

Therefore, this alternative will not be considered in detail.

2.4.4 WS-Washington Exhausts Non-Lethal MDM Assistance before Applying Lethal Operational Damage Management Assistance

A frequent request by commenters is to include an alternative that requires non-lethal methods to be used and demonstrated not to be effective in each instance where lethal operational damage management would later be applied. The deviations from how USDA-WS currently operates are requirements to implement/exhaust all non-lethal methods to include implementation of non-lethal methods that are not effective or have low likelihood of being effective may result in habituation of damaging individuals increasing the amount of lethal removals required to reduce damage/risk levels, produce excessive disturbance to the surrounding environment, and may not be appropriate for the circumstances. WS-Washington implementing and monitoring all these non-lethal methods would potentially result in more damage or damage/risk to a resource including; an elevated risk to human/pet health or safety, and/or major losses to ESA-listed species, and/or the loss of substantial time and/or resources, and potential resulting in large financial losses for the requester. Alternatives 1, 2, and 3 considered in detail 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 in detail.

2.4.5 Use of Hounds or Other Trailing Dogs for Bear Damage to Timber

WS-Washington is not proposing to use hounds or other dogs to trail or track bears in the course of addressing damage to timber.

Therefore, this strategy will not be considered in detail.

2.4.6 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.

Some states that have active bounties on predators, Utah for example has an experimental coyote bounty program for protection of mule deer, based on legislation passed in 2012 (Bartel and Bronson 2003). Some states implement bounties on invasive species such as nutria in Louisiana.

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 be a costly endeavor, result in inconsistent outcomes, and may encourage fraudulent claims.

APHIS-WS has no authority to establish a bounty system for population control, suppression, or extirpation. Over half the states have either outlawed bounties, repealed bounty laws, or have no statutory involvement in bounties (Born Free USA 2017).

Therefore, this alternative will not be considered in detail.

2.4.7 Provide Compensation for Losses

This option is discussed in Section 1.6. APHIS-WS has neither the legal authority nor the resources to establish and/or administer a program for financial compensation for livestock, crop, property, or safety losses due to mammal damage. None of the mammals included in this EA are covered by compensation allowances under the Agricultural Act of 2014 (also known as 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).

Some losses are eligible for compensation through WDFW's compensation plans (Section 1.7) but as this alternative would have APHIS-WS administer a new program it is outside the jurisdiction of APHIS-WS and will not be considered in detail.

2.4.8 Livestock Producers Should Exceed a Threshold of Loss Before MDM Actions are Taken

As explained in Section 1.6, 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 mammal 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 1.4.6). The variability in these factors preclude the assessment of a pre-determined threshold before a need is determined to exist and lethal and/or non-lethal action is requested and taken. WS-Washington is not responsible for or required to assess the economic value of a particular loss or threat of loss before taking a MDM action, and WS-Washington policy is to respond regardless of the requestor's threshold of loss.

For example on public lands, a history of loss may be sufficient for determining that preventative work would be appropriate while 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.

Therefore, this alternative is not considered in detail.

2.4.9 Use Regulated Hunting and/or Trapping to Reduce Mammal Damage

WDFW can and has used regulated sport hunting and trapping by private individuals as an effective management tool in areas where mammals are causing damage and/or adversely affecting wildlife populations managed by WDFW. State-sponsored sport hunting and trapping programs can be one of the most efficient and least expensive techniques for managing some types of damages over broad areas, but not many localized problem spots or issues.

This alternative is not necessarily effective for addressing localized mammal damages and threats at the time the problem is occurring. Evidence exists that humans are not effective at ecologically replacing carnivore functions because human hunting is usually conducted in the fall and winter, when damage often occurs in the spring and early summer; age and sex of animals targeted by hunters is typically different than those targeted by carnivores; and roads and other infrastructure often important for effective human hunting is not needed for hunting by carnivores (Ray et al. 2005b). In addition, regulated hunting and trapping is often not allowed in urban, suburban areas (Timm and Baker 2007), or in close proximity to schools, roads, rail lines, in the outfalls of dams, and on airfields because of safety concerns and local ordinances. Protection of ESA-listed species would likely not be possible using regulated hunting and/or trapping due to ESA species protections and liability risk to hunters. Regulated hunting and trapping would likely not be able to fully replace WS-Washington's aerial MDM due to WAC 220-413-070 which makes hunting with the aid of aircraft, boats, or other vehicles unlawful unless specifically authorized by a permit from WDFW.

Since this alternative is not within the authority of APHIS-WS to implement, it will not be considered in detail.

2.4.10 Managing Mammal Populations through the Use of Reproductive Inhibitors

Methods that limit or inhibit mammal reproduction 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), or 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 technologies that alter reproduction 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 2001 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 (Bromley and Gese 2001b;a). 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 managed 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), Shivik (2006) also describe the problems with chemical or physical sterilant 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 mammal populations (Mitchell et al. 2004). If a reproductive inhibitor becomes available and is proven effective in reducing localized mammal damage, 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 management techniques into its activities after necessary NEPA review is completed.

Therefore, this approach is not considered for further analysis in this EA.

2.4.11 Conduct Short-Term Suppression of Populations with Goal of Long-Term Eradication

An eradication alternative would direct all WS-Washington's efforts toward long-term elimination of selected mammal populations wherever a cooperative agreement has been initiated with WS-Washington. Eradication of a native species is not a desired population management goal of state or federal agencies and is outside the authority of APHIS-WS. WS-Washington does not consider eradication or suppression of native wildlife populations a responsible or effective strategy for managing mammal damage because APHIS-WS policy and authority is to reduce damage, not to reduce mammal populations. WDFW has the authority to manage population levels of regulated species of wildlife through hunting and trapping seasons and depredation permits. WS-Washington may assist WDFW as its agent for meeting specific WDFW 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 wildlife consistent with WDFW management objectives set with public input (Section 1.7).

Therefore, WS-Washington will not consider this alternative.

2.4.12 Conduct Supplemental or Diversionary Feeding

Supplemental feeding involves providing supplemental acceptable food plots or bait stations during certain seasons or on a year-round basis to lure the animal away from the locations of the valued resources. Supplemental feeding of carnivores would require a ready and consistent supply of meat, including animal carcasses, and placing those carcasses in areas that carnivores may be using. These sites could become a public nuisance, inappropriately attract large numbers of carnivores to a small area, increase intra- and inter-species competition, and require a large and continuous effort.

Supplemental feeding is primarily intended for large species that have low reproductive potential or ability to rapidly exploit changes in resource availability. Many species in this EA (e.g. nutrias, rats, ground squirrels, muskrats) have high reproductive potential or can quickly expand local populations to exploit newly available resources, therefore supplemental feeding would likely be ineffective and may potentially exacerbate the damages caused by that population.

Therefore, WS-Washington will not consider this strategy in detail.

2.4.13 Conduct Biological Control of Mammal Populations

The introduction of a species or disease to manage 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-Washington is not authorized to conduct this type of work and would not use this method for MDM.

Therefore, this alternative is not considered in detail.

2.4.14 All Livestock Losses Confirmed by an Independent Entity (Not WS-Washington)

Some commenters request that all livestock losses be confirmed by an entity independent of WS-Washington prior to WS-Washington taking any action, especially lethal action.

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 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. Also, no entity with the expertise, experience, training, and resources exists in Washington.

Coyotes are unclassified wildlife in Washington and not regulated by WDFW. Anybody with a small or big game hunting license may hunt them. The owner, the owner's immediate family member, the owner's documented employee, or a tenant of real property may trap, consistent with RCW 77.15.194, (Conover et al. 1977, Burns 1980, Burns and Connolly 1980, Burns 1983, Burns and Connolly 1985)or kill wildlife that is threatening human safety or causing property damage on that property, without the licenses required under RCW 77.32.010 or authorization from the director under RCW 77.12.240. Whether or not WS or another entity confirmed losses, livestock producers, etc. would likely continue to remove coyotes.

Requiring entities other than WS-Washington 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.

This requirement is also outside the scope of this EA as WS-Washington has no authority to implement an independent process for verifying livestock losses.

Therefore, this alternative will not be considered in detail.

2.4.15 Producers Avoid Grazing Livestock in Areas of Predator Activities and Ensure Herders Constantly Present

APHIS-WS does not have authority to require where and how ranchers graze or manage their livestock on private or federal land. However, WS-Washington may make reasonable recommendations on animal husbandry methods to reduce risk of depredation. Instead of mandating a specific set of management alternatives for all producers, the APHIS-WS Decision Model and MDM process would be used by WS-Washington under alternatives that involve some level of WS-Washington involvement in MDM.

Therefore, this alternative is not considered in detail.

2.4.16 Livestock Producers Pay 100% of WS-Washington Assistance Involving Lethal Removal

This is discussed in Section 1.13. 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-Washington 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-Washington 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 Congressional appropriations and funds provided by livestock producers that enter into cooperative agreements with APHIS-WS state offices for assistance. In most cases, livestock producers, as well as all others requesting assistance with MDM, are required to reimburse WS-Washington for the cost of assistance.

WS-Washington already provides technical support to all requesters and operational damage management support (Alternative 1), including lethal assistance to some degree under all alternatives as determined appropriate, except Alternative 4.

Therefore, this alternative is contrary to agency policy and will not be considered in detail.

2.4.17 Modify Habitats to Reduce Damage

WS-Washington may recommend habitat modification as part of its technical assistance activities (WS-Washington does not conduct this type of activity itself) in all alternatives having WS-Washington 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 4), this alternative will not be considered further as an independent alternative.

3 Environmental Consequences

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-Washington were less available to provide MDM 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.

3.1 What Issues are Analyzed in this Chapter?

The following issues are analyzed in detail in Chapter 3 for their potential environmental, social, and health impacts, as appropriate. These issues have been identified based on APHIS-WS experience, previous APHIS-WS EAs, and public comments on those EAs. They are listed here to provide context for the descriptions of the alternatives that follow. The issues are organized to indicate when they are interrelated. The brief description of each issue below identifies which issues are inherently cumulative impact analyses. The direct, indirect, and cumulative impact analyses are grouped together in sections of Chapter 3. Chapter 3 is also organized to evaluate and compare the impacts of each issue for each alternative as a change from the no action alternative (described in Section 2.2 and 2.3.1), to facilitate comparison between the degrees to which the impacts of each alternative on an individual issue differ.

Effects that can be evaluated in a NEPA document may include more than just environmental effects (40 CFR 1508.8):

> "Effects" includes ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative.

Chapter 3 includes analyses of effects that include the safety and health of employees and the public, for example, as summarized below.

The effectiveness of each alternative considered in detail in relation to meeting WS-Washington objectives is evaluated in Section 3.13.

Environmental issues are the resources that may be affected by the proposal or concerns about the risks to humans from implementing MDM 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. The following issues are analyzed in this chapter in the order outlined.

Section 3.4 - Effects on Populations of Target Mammal Species

This issue drives the analysis of the direct effects of WS-Washington's lethal MDM activities, and the cumulative effects that include all other known sources of mortality. WS-Washington, its cooperating agencies, and the public are concerned with the effects of removals on the viability of Washington state mammal populations. The effects on each species is evaluated using the best available information including the scientific literature and detailed take information from WS-Washington's MIS database and mortality reported to WDFW. WDFW's take information includes public harvest, WDFW wildlife conflict removals, and other sources of mortality.

All WDFW data are compiled and presented by calendar year and all WS-Washington's data are compiled and presented by fiscal year due to differences in record keeping. Despite the three-month difference in start and end dates the take numbers and corresponding analysis is representative of the impact to populations.

The analysis of the impacts on target species' populations examines direct and cumulative impacts. The populations of species involved in wildlife conflict management are impacted by a variety of sources of mortality, including take by WS-Washington, take by WDFW, hunters, furbearer trappers, commercial or private take reported to WDFW, collisions with vehicles reported to WDFW, and other known sources. Some species have more detailed take information available from the responsible management agencies than other species. Some take is unreported as it is legal for landowners or managers to take some mammal species causing damage without reporting that take. Some take is unreported illegal take (poaching). This analysis incorporates data from FY2015 through FY2019, because data from these years represents the most recent available.

Section 3.5 - Effects on Non-Target Species

Analysis of unintentional lethal take of mammal species is based on WS-Washington take data and evaluated within the context of their population trends. The take of non-target mammals and other non-target species by WS-Washington is based on WS-Washington take data and evaluated within the context of their population trends.

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

WS-Washington consults with the USFWS and NMFS when proposed activities may affect any federally-listed threatened or endangered species. This issue evaluates the potential for effects on such listed species. WS-Washington relies on ESA Section 7 consultations with the USFWS and NMFS to evaluate effects of the proposed alternatives. WS-Washington has not taken any non-target individuals listed as threatened or endangered under the ESA. The analyses and findings from the WS-Washington recent biological assessment and USFWS/NMFS concurrences and Biological Opinions, per Section 7 of the ESA, are incorporated into this section.

Section 3.7 - Potential for WS-Washington MDM Activities to Affect Biodiversity and Ecosystem Stability including to contribute to or Cause Ecological Trophic Cascades

The analysis of this issue is inherently a cumulative impact analysis, because many direct and indirect effects impact the complex interrelationships 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 the impact analyses for mammal species in Washington (Sections 3.5, 3.6, and 3.7). This issue has been routinely raised during APHIS-WS NEPA public comment periods and is based on a concern that the removal of key species, typically predators, during MDM 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 mammal species in Washington (Sections 3.5, 3.6, and 3.7).

Section 3.8 - How do Wildlife Professionals and Others Consider Ethics and Humaneness in Mammal Damage Management

WS-Washington and the public are concerned about the humane treatment of animals, and people hold differing ethical values related to MDM. The scientific literature related to the ethics of wildlife capture and lethal take in recreational, research, and removals to mitigate wildlife conflict, and the apparent humaneness of the use of mechanical, non-chemical, and chemical lethal and non-lethal take methods are summarized, discussed, and analyzed. These discussions are based on the scientific literature related to the ethics of wildlife capture and lethal take in recreational, research, and MDM activities, and the apparent humaneness of the use of mechanical, non-chemical, and chemical lethal and non-lethal methods.

Section 3.9 –Impacts to Sociocultural Wildlife Values and Wildlife Related Recreation

This section discusses WS-Washington's MDM actions as they potentially effect Native American cultural resources and how they interact with Native American cultural values. Wildlife-related recreational activities (i.e. hunting, fishing, and wildlife-viewing) are an important This section analyzes WS-Washington's MDM activities for the potential to negatively affect wildlife-related recreational opportunities in Washington State.

Section 3.10 - Potential Effects of MDM Methods on the Environment and Their Risks to Human/Pet Health and Safety

This issue drives the analysis of the effects of WS-Washington's use of MDM methods (mechanical, non-chemical, and chemical methods, Appendix A) on environmental resources including soil, water, air, plants, and invertebrates. It also assesses the risks associated with the use of MDM methods on human and pet health and safety. These impact analyses and risk assessments of the various mechanical, non-chemical, and chemical methods used by WS-Washington (and described in detail in Appendix A) evaluate the risks of impacts on the environment (soil, water, and air), plants, wildlife, and risks to human health and safety, including the public and WS-Washington field employees, as appropriate for each method. For chemical methods and aerial overflights, exposure can be either acute for mammals and humans ("one-off" exposure or direct effects) or possibly chronic (occurring multiple times, often at low levels, or cumulative effects). The use of lead ammunition especially has the potential for cumulative impacts, because of the high risk of lead already occurring in the environment and in wildlife and human bodies from many past and ongoing sources, as well as the contribution made by lead ammunition used by WS-Washington activities. Each impact analysis and risk assessment is analyzed commensurate with the level of concern expressed by commenters and levels of adverse impact and risk.

Section 3.11 – Ability to Meet Stated Goals and Objectives

This section summarizes in the effects discussed in previous sections.

3.2 What Issues Are Not Considered in Comparative Analysis and Why?

In addition, the following environmental resources are not evaluated in detail because the agency has found that these resources are not significantly impacted by the APHIS-WS program and WS-Washington activities.

- ***APHIS-WS activities could conflict with ongoing wildlife field research***

  Concerns that APHIS-WS MDM activities could interfere with ongoing agency or academic wildlife research have been raised. WS-Washington coordination with WDFW, 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. An example would be WS-Washington removing a cougar threatening human health and safety wearing a radio collar placed by WDFW.

- ***Environmental effects from the loss of individual animals:*** Comments on previous MDM EAs have urged APHIS-WS to analyze the environmental impacts of the loss of individual animals. WS recognizes the intrinsic value of wildlife, the importance of wildlife to humanity, and views wildlife and people as interrelated components of an ecological-cultural-economic complex. All WS-Washington MDM activities are conducted under the authorization of and in compliance with federal and state laws and in coordination with the WDFW or the USFWS/NMFS, as appropriate. Although we recognize that some individuals could find this loss distressing, analysis in Chapter 3 indicates the current and proposed actions involving only removal of individual offending animals or multiple individuals of a mammal species within a localized area, would not in any way have an adverse impact on the size or sustainability of wildlife populations involved in WS-Washington's operations.

- ***Visual quality:*** WS-Washington 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-Washington and therefore not under the agency's jurisdiction. WS-Washington may assist livestock producers with installing temporary fencing or fladry in small quantities 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.

- ***General soils*** (except for Section 3.11.2 - environmental fate of lead in soils): WS-Washington operations do not involve directly placing any materials into the soils or causing major soil disturbance. Soil disturbance is minimized 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 for limited periods of time.

- ***Minerals and geology:*** WS-Washington operations do not involve any major excavation, blasting, or contact with minerals or change in the underlying geology of an area.

- ***Prime farmlands:*** WS-Washington operations do not involve converting the land use of any kind of farmlands.

- ***Air quality:*** WS-Washington's emissions are from routine use of trucks, 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 (See Section 3.5.2 for discussion of climate change).

- ***Vegetation*, including timber and range plant communities (except for federally-listed plant species, Section 3.7):** WS-Washington operations do not involve modification to any vegetation communities, nor do they involve removal of trees or shrubs. WS-Washington's activities would have only a small potential for a negligible amount of plant disturbance. WS-Washington may provide technical assistance in the form of information or advice to land managers/owners to modify vegetation to help mitigate mammal damage, however actions by the land managers/owners are not a WS-Washington responsibility.

- **Contribution of Activities to 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 (Intergovernmental Panel on Climate Change 2014b) 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-Washington's impacts on climate change from its greenhouse gas emissions are *de minimus*.

3.3 How will Alternatives Be Assessed Where WS-Washington Activities are Modified or Absent?

Alternative 1 involves continuing the current WS-Washington MDM activities/proposed action as described in Sections 2.3.1 and Appendix A. Alternatives 2 through 4 modify the levels of WS-Washington involvement in MDM activities in Washington to differing degrees.

An important part of comparing the environmental impacts and risks to human health and safety of the alternatives is understanding what MDM may be implemented when WS-Washington 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 MDM, and how those activities are likely to compare with WS-Washington's proposed action, its impacts and risks. Additional information on MDM work conducted by others is available in Sections 2.3.1.9 and 3.4.1.

3.3.1 What Other Entities Could Respond if WS-Washington MDM Activities are Restricted or Absent?

WS-Washington may provide MDM services when requested on any land class, either directly or as an agent of WDFW, including technical advice on lethal and non-lethal methods and implementation of lethal methods, and keeps detailed records of take in its MIS database. Under alternatives 2-4 restrictions on WS-Washington's MDM activities could, and in many cases often would, result in other entities responding to ongoing or potential mammal damage.

Multiple agencies, other entities, and individuals can conduct MDM activities (Section 2.2.1.9):

- WDFW can either conduct MDM 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 WDFW. WDFW has the authority to conduct MDM for all non-T&E/non-marine mammal species (game and non-game species) in Washington and can work with T&E mammals through coordination with USFWS or marine mammals through coordination with NOAA. WDFW has the authority but has not historically issued 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), certified by WDFW to work with non-game species, can provide commercial services to anyone as requested but are typically local operations and availability may vary, and their take is reported to WDFW at the end of each year;

- Landowners or authorized agents may take mammals causing damage or risks on private land in accordance with state law, with WDFW requirement for reporting take dependent on species taken (no reporting is necessary for take of coyotes or unclassified wildlife, for example); and

- Table 43 provides a conservative estimate of lethal take by WS-Washington directly taken by or reported to WDFW by other entities for each species.

The largest lethal take of most mammal species is by non-WS-Washington entities during WDFW-regulated game and furbearer seasons. Though special hunting permissions issued by WDFW to manage mammal damage are used the majority of this take does not often directly address damage and risk situations caused by mammals.

3.3.2 How do MDM Activities Conducted by All Entities, Including WS-Washington, Complement and Compare?

Private individuals, WCOs, WDFW staff, and WS-Washington can all conduct some form of MDM under WDFW issued permits, in exempted circumstances described in WACs and RCWs. Individuals who request MDM assistance from WDFW may get direct assistance from the agency's conflict division, WDFW may refer the request to a WDFW agent, WS-Washington, or WDFW may authorize permits to remove animals through establishing damage prevention cooperative agreements with landowners to prevent private property damage by wildlife (WAC 220-440-060). Individual landowners may also hire or request other individuals other than certified 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, foot snares, harassment equipment, or firearms for lethal take of predators in a humane, selective, and/or effective manner. Landowners and their agents may use MDM methods in a manner inconsistent with best practice standards for humaneness and effectiveness. An owner may kill an individual (1) cougar or bear during the physical act of attacking livestock or domestic animals with or without an agreement or permit within a 12-month period (WAC 220-440-060). Landowners can take coyotes themselves with a state license or have someone else designated as their agent remove them. The owner, the owner's immediate family, employee, or a tenant of real property may kill or trap a coyote on that property if it is damaging crops or domestic animals without a license (RCW 77.36.030).

In general, all entities in Washington State can conduct MDM working with unclassified species (e.g. mountain beaver, coyote, yellow-bellied marmots) in circumstances specified by the WACs and RCWs. MDM work involving furbearing animals typically require more specialized training, permits, or equipment to work with, reducing the number of entities capable of responding. Big game animals, protected species (e.g. Douglas squirrels), and species protected by the Marine Mammal Protection Act (MMPA) are the most strictly regulated in Washington State more frequently requiring permits, sometimes from multiple entities, to perform MDM.

WDFW and WS-Washington have trained biologists capable of responding to incidents in which private individuals and WCOs may not be authorized or trained. WDFW conflict staff have the authority and training to respond to conflicts with all mammal species in Washington excluding some ESA-listed species and marine mammals in some situations. WDFW and WS-Washington have the training and expertise to offer MDM technical assistance when requested for mammal species in Washington. WDFW and WS-Washington have the authority to conduct MDM on big game species in Washington State through agreements and coordinate game species MDM between the two agencies. WDFW conflict staff primarily conduct big game species MDM and provide technical assistance for non-game species but do not typically conduct MDM for non-game species. Therefore, WDFW's responses to MDM for non-game species may be limited by current resources and to certain situations as funding/resources allow. WDFW can enter damage prevention cooperative agreements with landowners, including private individuals, to proactively prevent, minimize, or correct damage caused by wildlife to crops or livestock. These agreements, similar to WS-Washington's MDM actions emphasize non-lethal methods but allow for lethal management of game mammal species by WCO's and other private landowners who demonstrate that non-lethal efforts have been implemented and are ineffective.

WDFW has a certification process for commercial entities (WCOs) that conduct MDM whereby each entity must demonstrate proficiency and experience, and annually report their take to WDFW. WDFW does not currently authorize WCOs to take big game animals, including black bear, deer, elk, and cougar (Washington Department of Fish and Wildlife), unless operating under a permit issued to a landowner by WDFW.

WS-Washington and WDFW are the only aerial operators authorized to operate in Washington State and are restricted to conducting aerial operations only after approval by the landowner. WDFW does not currently issue permits for aerial shooting of coyotes, but retains that authority and requires entities requesting a permit for aerial shooting of coyotes to report methods previously used and their effectiveness. Landowners may rely on less selective methods such as trapping if aerial gunning permits issued by WDFW are unavailable, as they currently are, to private WCO's or individuals. When taking coyotes damaging crops or domestic animals no license or report is required and therefore accounts for an unknown portion of coyote mortality.

Few commercial WCOs have the capability and/or interest to respond to requests some of the non-game species in this EA. WCOs may not be equipped, prepared, or experienced to address conflicts with some of the species addressed in this EA. Through consultation and coordination with USFWS/NMFS, WS-Washington implements measures to reduce potential impacts of its actions on listed species. Commercial and private entities are not required to consult with USFWS/NOAA on potential take or impacts to endangered species.

If WS-Washington is restricted in its ability to take coyotes lethally under alternatives 2 through 4, it is assumed that producers would request more WDFW assistance with 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.

WCOs do not have authority to handle issues involving game animals including black bear, deer, elk, and cougar (Washington Department of Fish and Wildlife). An owner may kill an individual (1) cougar or bear during the physical act of attacking livestock or domestic animals with or without an agreement or permit within a 12-month period (WAC 220-440-060).

3.3.2.1 Conclusion

There are several types of entities conducting MDM (WDFW, WCO, WS-Washington, permitted individuals, private individuals). There is some overlap in expertise and abilities to manage damage from the species included in this EA.

However, there are differences as to where and when the various entities would be involved in conducting MDM. Because there is a difference in the level of efficiency and effectiveness, it would be hard to know what the outcome would be in the absence of one or the other. In the absence of WS-Washington, availability of MDM assistance would likely vary by species and location unless other entities fill in the gap in expertise and availability. The circumstances (e.g. MDM in urban environments, big game conflicts, threats to human health and safety, or ESA species protection) and which species involved typically determine which entities are available to respond. Although complimented by other entities in some capacity WS-Washington's absence or restrictions in MDM (alternatives 2, 3, and 4) would likely result in greater impact to wildlife, target and non-target species alike.

3.3.3 Benefits of WS-Washington MDM

There are several benefits to using WS-Washington's MDM services that may not be available when other entities, especially private citizens and NGOs, provide such services. WS-Washington employees are highly trained professionals that adhere to a myriad of protective measures, such as APHIS-WS Directives (Section 2.4), that are designed to minimize adverse effects on the environment and reduce risks to humans. WS-Washington 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 take of all target and non-target species, regardless of their status, is presented in program data reports for each state and summarized nationally (https://www.aphis.usda.gov/aphis/ourfocus/wildlifedamage/SA_Reports). WS-Washington's use of the APHIS-WS Decision Model helps to ensures that MDM is performed according to all applicable federal, state, and local laws and agency policies in the most effective, selective, and humane way possible (Section 1.10.3, Section 2.4).

As a federal agency responsible for compliance with NEPA, APHIS-WS documents and analyzes its planned activities and involves other agencies, tribes, and the public to ensure that it makes informed and transparent decisions about MDM. It is under the umbrella of NEPA that all APHIS-WS's MDM activities are reviewed for their effects on the human environment. The NEPA process provides transparency and disclosure of WS-Washington activities and their effects for other agencies, tribes, and the public to view and engage in through comment periods. The effects of MDM 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.

All USDA-APHIS programs, including APHIS-WS, engage Native American Tribes to protect agriculture and cultural resources through government-to-government consultation and as part of the NEPA process. APHIS Directive 1040.3 defines the consultation process and WS-Washington respects the rights of sovereign tribal governments, provides early opportunities for all federally-recognized tribes in Washington to participate in planning and developing MDM strategies. WS-Washington works with Native American Tribes in planning MDM that may have effects on tribes and provides government-to-governments consultation opportunities during the NEPA process or as requested. WDFW works and coordinates with tribes in Washington routinely. However, opportunities for cooperation and input are unlikely to be provided by private individuals or WCO companies.

Unlike private entities, WS-Washington is obligated to account for direct and indirect effects of MDM on federally listed species under the ESA through Section 7 consultation with USFWS. These consultations analyze the potential impacts to listed species, define conservation measures that minimize impacts, and allow USFWS to monitor impacts to listed species and critical habitat. Private individuals do not have the same responsibility to consult, modify actions, or report to USFWS when conducting the same activities. Therefore, activities conducted by WS-Washington are more likely to by conducted in a manner which will have the least impact on federally listed species or their habitat than those conducted by private individuals or companies.

3.4 What are the Impacts on Target Mammal Species Populations?

This section includes the direct and cumulative analyses of potential impacts on populations of individual mammal species in Washington. These analyses include all take (lethal removal) by WS-Washington, 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.

3.4.1 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 or WDFW data. Tables for each species analyzed in Section 3.4 provide an overview of the status of the statewide populations and estimated populations for the mammal 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 3.3 through 3.26).

As the state wildlife regulatory agency, WDFW is responsible for measuring mammal populations' numbers and trends for the purposes of establishing and monitoring management goals and hunter harvest limits. WDFW uses data based on WDFW wildlife surveys and hunter reporting of harvest. The quality of the data is contingent upon surveys being current and hunter harvest reporting being adequate. With WDFW's limited resources monitoring of big game and some more sensitive furbearer species tends to be intensive, with fewer resources allocated to monitoring of lower risk furbearers and small game species, and fewer for unclassified wildlife monitoring. In order to estimate population size and status (e.g. increasing, decreasing, stable) for species with limited data available, conservative estimates are derived from the best available density estimates reported in the literature, with preference given to publications and studies in Washington or states having similar habitat. The lowest estimate is assumed to be the minimum population and is further validated through WDFW review. Habitat suitability indices, localized density fluctuations, and immigration/emigration are not factored into these calculations, nor is density in Washington 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.

Washington has a land area of 71,362 mi^2. 57% of WS-Washington's MDM responses occurs on public lands (i.e. lands belonging to; ports, airports, USFWS, BLM, USFS, USACE, military, county, and state) with public lands account for 47% of the acreage worked by WS-Washington (or 1.75% of the state's total land acreage). Some land is managed for the public but has restricted access such as military lands, dams, and airports. Of the work occurring on public lands 41% of MDM responses are on lands with restricted access accounting for 2% of acreage worked by WS-Washington (or 0.09% of the state's total land acreage). Approximately 42% of WS-Washington's MDM responses occurs on private land accounting for 53% of the acreage worked (or 1.98% of the state's total land acreage). Approximately 83.42% of WS-Washington's MDM responses are on land inaccessible to the general public as it accounts for private land, military land, dams, and airport property. The land area under agreement with WS-Washington (3.73% of the state's total land acreage) is provided to show the proportional breadth of area in which WS-Washington may work compared to the total range of mammal species in the state. Furthermore, WS-Washington actively works on only a small number of the properties under cooperative service agreements or federal annual work plans at any given time. Of those properties being actively worked, MDM activities are conducted on only a fraction of the property. For instance, WS-Washington may conduct MDM activities, including setting equipment, in a small "footprint" of the total property's area and for a limited duration. Therefore, totaling the acreage of all the areas WS-Washington has the potential to work is an overestimation when assessing the magnitude of impacts on statewide mammal populations. These figures provide an indicator of the consistently limited impact on overall state mammal populations through WS-Washington activities.

In order to analyze the level of effects of WS-Washington on the individual species' populations, available take data is presented annually by species for FY 2015 through FY 2019. WS-Washington's take is used to analyze the direct effects on species populations.

All sources of WS-Washington take of mammal species are combined with all known sources of non-WS take in Washington to represent the cumulative take for FY 2015 through FY 2019. Cumulative take may include measures of:

- WS-Washington take of a target mammal species;
- WS-Washington take of non-target mammal species;
- WDFW conflict removal (lethal removal conducted by WDFW conflict staff or its agent);
- Recreational take regulated by WDFW;
- Private Wildlife Control Operators (WCOs) take (reported to WDFW by WDFW-certified WCOs);
- Other allowable take for damage or threats to human health or safety reported to WDFW per WAC 220-440-060;
- Other known mortality sources, such as vehicle collisions or reports of poaching.

To assess whether cumulative take could negatively affect a species population, cumulative take is compared to the maximum sustainable yield (harvest), which is the amount of mortality from all known sources that can be sustained in perpetuity (Botsford 2016). The proportion of the estimated take by all sources within a year (based on the highest known take) 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 is likely an overestimation of effects.

Additionally, similar calculations are made to determine the projected cumulative impacts under the projected WS annual maximum take scenario. The WS annual maximum take is the greatest number of any species that WS-Washington could lethally take in a given year under current activities (Alternative 1) given the potential for fluctuations in requests for assistance. The projected annual cumulative take provides a conservative estimate of the highest proportion of the species' estimated population that could be taken by all sources, under projected WS 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 annual maximum take be interpreted as the target number of animals WS-Washington seeks to remove, nor does APHIS-WS have a policy of ever taking the maximum sustainable harvest proportion of the population for any species. WS-WA takes individuals of a species to manage the damage or threats caused by those individuals and attempts to take only the number of individuals required to reduce damage or threats to levels within the ability of the cooperating entity to tolerate. As explained in detail in Chapters 1 and 2, APHIS-WS personnel work to resolve conflicts with wildlife and facilitating human-wildlife coexistence while minimizing risk of adverse impacts to humans and wildlife on a case-by-case basis. To this end, efforts focus on removing specific damaging individuals or local groups of mammals. 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 (Section 1.10.1.2) mortality can't be calculated, however WS-Washington has used maximum take projections and conservative population estimates to consider potential impacts. These analyses do not incorporate take from MDM activities conducted in adjacent states, as wildlife management authorities and goals resides with those states. WS-Washington's analysis is on assisting the State of Washington and other entities that are within Washington and according to applicable Washington statues and rules. The information compiled in the analysis of this EA is sufficient to address the impacts associated with the alternatives for WS-Washington involvement in MDM in Washington.

3.4.2 What is the Relationship of Climate Change to Mammal Species Population Dynamics?

The Intergovernmental Panel on Climate Change (2014b) reports Intergovernmental Panel on Climate Change (2014a) 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-Washington considers the best available information when assessing impacts on the environment, thus new information about climate effects on vulnerable resources would be considered appropriately. WS-Washington sought to consider predicted climate effects on the environment from two perspectives: the potential for climate change to affect MDM needs, and the potential for cumulative impacts on wildlife and other issues evaluated in this EA.

WS-Washington considered predicted climate change effects on many species in this EA including; mountain beaver, beaver, coyotes, black bears, cougars, raccoons, striped skunks, badgers, bobcats, elk, and red fox.

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 fox 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 IMDM in Washington would likely be low to non-existent given the low presence of rabies in the state, the limited number of fox damage management activities that occur in Washington, and the relative success of rabies disease control activities (MacInnes et al. 2001, Rosatte et al. 2007, Slate et al. 2014). Rabies in grey foxes is likewise under control (Sidwa et al. 2005). 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. Lineage decline in the Aplodontidae family which mountain beaver, a primitive rodent that, based on the species physiological characteristics (e.g. dependent on water availability due to primitive kidneys) would potentially be susceptible to the effects of climate change. The study found that with mountain beaver, as with many other studies across mammal taxa, there is little relationship between changes in global climate and diversity dynamics (Hopkins 2007). Some exceptions to this trend is 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). Endothermic animals (metabolic processes regulate body temperature), like mammals, can adjust body temperatures typically allowing them to persist in a wider range of environmental temperatures than ectotherms (environmental temperature regulates body temperature). McCain and King (2014) assessed likelihood of select mammal species to respond to climate change and found that species with flexible activity times were less likely to respond and small bodied mammals were less likely to respond to climate change. Of the species listed in this EA the majority have variable activity schedules (e.g. coyotes, beaver, river otter) and the species that WS-Washington works with the most are typically smaller bodied (e.g. squirrels, rabbits, coyotes, marmots, raccoons). Reductions in habitat availability/quality and direct mortality from various sources (e.g. diseases, human harvest) have historically and are projected to continue to be large drivers of population dynamics. As portrayed in literature the changes from climate change are additive on factors that already have significant effects on mammal populations (Baruch-Mordo et al. 2014, Johnson et al. 2018, Stoner et al. 2018, Rickbeil et al. 2019).

Evidence for effects from global climate change from or to current or proposed IMDM activities in Washington is lacking. Because of the limited timeframe of activities/impacts and limited geographic scale of WS-Washington's IMDM activities, WS-Washington expects no climate-related impacts to or from its proposed activities. WS-Washington remains committed to monitoring 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 and NMFS up-to-date (Sections 2.3 and 3.6), WS-Washington ensures that its IMDM activities would not jeopardize even the most vulnerable species.

3.4.3 What are the Direct and Cumulative Impacts on Black Bear Populations?

3.4.3.1 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 Jr. 2007, Herrero et al. 2011). Black bear generally prefer forested areas and, in Washington, still occupy most of their original range excluding the heavily urbanized area of the Puget Sound. In Washington, relative densities of bears are highest in the Coastal areas, Cascade Ranges, and the Blue Mountain region in the southeast, and lowest in the arid central region (Washington Department of Fish and Wildlife 2018a).

Black bears are omnivores and eat a wide variety of plants and animals, including insects. The diet of black bears changes seasonally, 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 (Section 1.11.6).

There are few natural predators of adult black bears, but young bears may be killed by cougars, bobcats, and coyotes, or by other adult black bears (Larivière 2001).

3.4.3.2 Black Bear Population Information

The black bear population in Washington is managed by WDFW in accordance with the current game management plan (Washington Department of Fish and Wildlife 2015b). WS-Washington coordinates black bear take with WDFW to ensure all take is within management guidelines. WDFW uses a combination of research, long term data, modeling, sex and age ratios of black bear harvest, and hunter harvest reports to monitor and manage black bear populations in a sustainable manner (Washington Department of Fish and Wildlife 2015b). According to the latest WDFW Game Management Plan, Washington has an "abundant and healthy black bear population, however currently there is not normal estimate of black bear population size in Washington" (Washington Department of Fish and Wildlife 2015b).

In 2019, WDFW and Washington State University published a study assessing bear densities in Washington State. The study accounted for human developments effects on bear densities and the differences in densities in east and west of the Cascade Mountains. Average black bear densities were then calculated for the western Cascades (0.52 black bears/mi^2) and eastern Cascades (0.49 black bears/mi^2) (Welfelt et al. 2019).

To generate a statewide population estimate the habitat estimate of 33,976 mi^2 from the 2018 WDFW's Game Status and Trend Report was used. The lowest density estimate of 0.49 black bear/mi^2 was applied to the area available habitat estimate to generate a conservative statewide population estimate of 16,648 black bears. This number is likely an overly conservative estimate as WDFW estimates there are approximately 25,000 black bears occur within Washington (Washington Department of Fish and Wildlife 2020).

Washington State has an abundant and healthy black bear population (Washington Department of Fish and Wildlife 2015b). Washington Natural Heritage Program through WDNR maintains a list of species status ranks for the majority of species in Washington, black bear is ranked as secure (Washington Department of Natural Resources 2017).

WDFW's Game Management Plan indicates that harvest levels are guided by several factors, with the sex and age ratios of the reported harvest being the primary factor in liberalizing or restricting bear hunting seasons (WDFW 2019). Additional available literature has indicated that the allowable harvest level for black bears is 16-20% of a known population (California Department of Fish and Game 2001), Mace and Chilton-Radant (2011). Based on the estimated statewide black bear population of 16,648, the annual maximum sustainable harvest for the population in Washington would be 2,664 black bears in Washington (Table 12). Based on all known black bear take, as reported in Table 12, the cumulative take of black bears in Washington is below 13%.

3.4.3.3 Black Bear Population Impact Analysis

WS-Washington receives request for assistance to from timber producers who experience bear damage (Section 1.11.6.2). WS-Washington removed an average of 4 black bear per year over the past five years, with a maximum of 6 black bears taken in any single year. All bears were taken to protect timber resources on private land.

For a landowner/manager to receive a permit for bear removal to protect timber, WDFW requires/administers the following steps:

1) Damage must be verified by an agent of WDFW (WAC 220-440-210). Each incident is documented by WDFW, including preventive measures that are used or recommended on a case-by-case basis. WDFW considers forest and bear population management objectives prior to authorizing bear removal (WAC 220-440-210(2)(d)) (Washington Department of Fish and Wildlife 2015a).
2) An application for lethal is submitted to WDFW by the landowner with GPS coordinates and certification letter
3) The application is screened by WDFW and assigned a unique number
4) If approved, permits and tags are mailed to the producer. Bear take must be reported within 24 hours and bears must be disposed of in accordance with permit conditions.

Permits for bear removal are issued by WDFW on a case-by-case basis and are issued for not more than 2 bears. Once a producer has secured a permit for bear removal, they may contact WS-Washington, or other entities as allowed by state law[3], to assist in removing the damage-causing bears. When engaging WS-Washington, cooperators pay for assistance, as no federal funds are available to support these activities.

WS-Washington may use shooting, non-lethal foot snares, and attractants[4] to target only those damage-causing bears[5], as authorized by WDFW. WS-

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[3] RCW 77.15.245(2)(a)
[4] Attractants primarily include anise oil, fatty acid scent, or other nonmeat-based attractants.
[5] In 2000, voters passed initiative 713, which made it a gross misdemeanor to capture an animal with certain traps. RCW 77.15.194. "Hounding" which is hunting with dogs, and "baiting" which is using bait

Washington is not proposing to use hounds for any MDM activities under this EA. All WS-Washington bear removal for timber protection would be part of a state-regulated program administered by WDFW, in accordance with state laws and management plans.

Based on the projected future requests for assistance, WS-Washington expects that future bear removals for MDM will be similar to take during the last five years statewide. State laws and policies regarding bear management and methods may increase the number of requests that WS-Washington receives without increasing the total black bears removed by all entities. In order to accommodate any increase in requests for assistance under Alternative 1, WS-Washington may take up to 150 black bears per year. Black bear damage management is expected to continue primarily on private lands.

3.4.3.4 Cumulative Mortality

Black bear are defined as a big game animal in Washington (RCW 77.08.030) with regulated hunting seasons. In addition to WDFW conflict staff and WS-Washington take of bear, landowners and their agents may take bear in certain situations. Landowners may take one bear in the act of attacking livestock (WAC 220-440-060) or multiple bear posing immediate risk to health/human safety on private land at any time without a permit (WAC 220-440-050). If in possession of a kill permit by WDFW multiple bear may be taken to protect livestock (RCW 77.36.030, WAC 220-440-050, WAC 220-440-060). Take from situations not requiring a permit must be reported to WDFW within 24 hours and the animal/all parts must be provided to WDFW or its designees (WAC 220-440-090). With a damage prevention or kill permit issued by WDFW (WAC 220-440-060) must be disposed of consistent with the conditions identified under the permit (WAC 220-440-090).

Hunter harvest reporting is mandatory for black bear in Washington State though black bear do not have a pelt sealing requirement like cougar do in Washington State. Thus, reporting for landowner conflict take, WDFW conflict take, hunter harvest, and WS-Washington take are considered known mortality sources.

Poaching, wounding loss, roadkill, and natural causes are more difficult to track. WDFW's game status and trend report (Washington Department of Fish and Wildlife 2019a) references an ongoing project that is providing information on black bear mortality in the North Cascades. WDFW takes these additional forms of mortality into consideration when regulating black bear harvest statewide. To estimate

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to attract animals, are considered by some to be "unfair, unsporting and inhumane" hunting methods. The use of body-gripping traps is also regarded by some as an inhumane hunting method.
To protect private property, both initiatives contained exceptions to the prohibition of baiting, hounding, and using body-gripping traps. I-655 allowed for "the killing of black bear with the aid of bait by employees or agents of county, state, or federal agencies while acting in their official capacities for the purpose of protecting livestock, domestic animals, private property, or the public safety." RCW 77.15.245(1)(a) (Washington State Court of Appeals Division Two, 2020).

statewide mortality in this EA, the highest reported non-harvest and non-conflict take were used.

Hunting is the primary source of mortality for bears where hunting is allowed. However, an estimated 75% of the bear habitat in Washington is located on federal land or private industrial lands, meaning that the habitat is secure and the long term outlook for black bears in Washington state is “generally good”(Washington Department of Fish and Wildlife 2015b).

Table 12. Population impact analysis of black bear take in Washington, FY 2015- FY 2019.

Mortality source	2015	2016	2017	2018	2019	5-year average	5-year high
WS Target take	6	3	5	6	0	4.0	6
WS Non-Target take	0	0	0	0	0	0.0	0
WCO take	0	0	0	0	-	0.0	0
WDFW Conflict take	500	446	472	369	-	446.8	500
General Harvest	1,442	1,377	1,285	1,386	2071*	1,512.2	2,071
Special Permit	94	124	139	97	114	113.6	139
Other Mortality	65	35	50	30	-	45.0	65
Total WS take	6	3	5	6	0	20.0	6
Total non-WS take	2,101	1,982	1,946	1,882	2,185	2,019.2	2,185
Cumulative take	2,107	1,985	1,951	1,888	2,185	2,023.2	2,185
Statewide population estimate:			16,648			25,000	
Statewide population trend:			Stable			Stable	
Annual maximum sustainable harvest:			16% (2,664)			16% (4,000)	
Current total WS take as a % of the population:			0.04%			0.02%	
Current cumulative take as % of population:			13.12%			8.74%	
Maximum Analyzed WS annual take:			150			150	
Projected total WS take as a % of the population:			0.90%			0.60%	
Projected annual cumulative take as a % of the population:			14.03%			9.34%	

*A lawsuit stopped bear-timber conflict removals by WDFW or permitted individuals for 2019. This work stoppage may partially account for the larger than average general harvest in 2019.

3.4.3.5 Conclusion: Black Bear

WS-Washington used the lowest end of the annual maximum sustainable harvest rate range (16-20%) found in literature, making this a very conservative population analysis. Given the presumed population stability for black bears in the state, the lack of non-target take, and an annual maximum sustainable harvest level of 16%, cumulative impacts on the black bear population from all causes, including take by WS-Washington, WS-Washington’s MDM is not significantly impacting the population.

Therefore, WS-Washington concludes that the cumulative impact of all recorded black bear mortality in Washington, including all take by WS-Washington, is not significantly impacting the size or sustainability of the Washington black bear population.

Should an increase in requests for assistance with black bear damage result in the projected annual WS maximum take, cumulative impacts on the statewide black bear population would still be expected to remain below annual maximum sustainable harvest level. Given the low proportion of cumulative take, and even lower WS-Washington take, direct and cumulative impacts from take would not adversely impact the size or sustainability of the black bear population.

3.4.4 What are the Direct and Cumulative Impacts on Mountain Lion (Cougar) Populations?

3.4.4.1 Cougar Life History Information

The range of cougars, the largest North American feline, covers an extensive distribution across western North America, including throughout Washington. However, densities vary across landscapes likely reflecting local distribution of their primary prey (deer and elk) but are also be affected by territorial behaviors. Cougars inhabit many habitat types from desert to alpine environments, indicating a wide range of adaptability. In Washington, the primary cougar prey items include mule deer, Columbian black-tailed deer, elk, mountain goats, moose, and big horn sheep.

Cougar density is related closely to prey availability and competitive social interactions for other cougars. Prey availability is directly related to prey habitat quality, which in turn directly influences cougar nutritional health and reproductive and mortality rates. Studies indicate that as available prey increases locally, so do cougar densities. As cougar population density increases, mortality rates from intra-specific fighting and cannibalism also increase, and/or cougars disperse into unoccupied or less densely occupied habitat, if available. The relationship between cougar and their prey and territorial disputes are why cougars may disperse into atypical cougar 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 cougars through seasonal declines in their primary prey, in this case deer. Therefore, this allows an artificially high density to be reached in areas where cougar 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 cougar population density. Arrangement of home ranges in relation to each other is governed by the cougar'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 cougars 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. Cougars breed and give birth year-round but most births occur during late spring and summer following a 90-day gestation. One to six offspring per litter is possible, with an average of two to three young per litter.

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). All males that established an independent territory after dispersal were not 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.

3.4.4.2 Cougar Population Information

Cougars inhabit many habitat types and are closely associated with deer and elk as primary prey. Cougars are distributed throughout Washington and cougar harvest is reported from most counties across the state. However, areas of human development and land use are generally unfavorable to cougars.

Cougar 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 cougars is difficult because of the animal's solitary and elusive behavior (Davidson et al. 2014). Cougar 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 population surveys and analysis have been conducted in Washington by WDFW to estimate cougar population densities. Historically WDFW only provided adult, >2 year old, population estimates but recently included all independent aged cougars, >18 months, documenting a density of .057 cougars/mi^2 in Washington (Washington Department of Fish and Wildlife 2018a). When that density is multiplied by the available habitat of 40,347 mi^2 it estimates a population of 2,300 cougars in Washington State and also indicates the population is stable with a potential slight decline in the Northeastern corner of the state (Washington Department of Fish and Wildlife 2018a).

Cougar 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%)" cougar 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 cougars (average = 36.6%) than for female cougars (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 cougars. 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 cougar population recovery after hunting removal was slow, with hunting losses apparently additive to other mortality. In this study, resilience of cougar populations to hunting appears to depend on the rate of immigration into the population and the availability of females of breeding age recruited.

Because cougar populations are connected and readily subject to immigration, 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 cougar populations, and consistent with the average annual mortality rate reported by Laundré et al. (2007).

3.4.4.3 Cougar Population Impact Analysis

From FY 2015 and 2019, WS-Washington removed an average of 0.4 cougars per year during the reporting period (Table 13), 100% were taken on private lands. WS-Washington has no take of non-target cougar during the analysis period. The most cougars removed in one year was 2.

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future cougar removals for MDM would be similar to take during the last five years. Therefore, under Alternative 1 (current activities with fluctuations), t the projected WS-Washington annual maximum take was analyzed up to but would not exceed 10 cougar per year (Table29).

Table 13. Population impact analysis of cougar take in Washington, FY 2015- FY 2019.

Mortality source	2015	2016	2017	2018	2019	5-year average	5-year high
WS Target take	0	0	2	0	0	0.4	2
WS Non-Target take	0	0	0	0	0	0.0	0
WCO take	0	0	0	0	-	0.0	0
WDFW Conflict take	0	0	0	0	-	0.0	0
General Harvest	163	172	222	222	306	217.0	306
Special Permit	15	15	20	17	-	16.8	20
Other Mortality	26	26	34	28	-	28.5	34
Total WS take	0	0	2	0	0	0.4	2
Total non-WS take	204	213	276	267	306	253.2	306
Cumulative take	204	213	278	267	306	253.6	306
Statewide population estimate:		2,300					
Statewide population trend:		Stable					
Annual maximum sustainable harvest:		30% (690)					
Current total WS take as a % of the population:		0.09%					
Current cumulative take as % of population:		13.31%					
Projected WS annual maximum take:		10					
Projected total WS take as a % of the population:		0.43%					
Projected annual cumulative take as a % of the population:		13.74%					

3.4.4.4 Cumulative Mortality

Cougar are defined as a big game animal in Washington (RCW 77.08.030) with regulated hunting seasons. In addition to WDFW conflict staff and WS-Washington take of cougar, landowners and their agents may take cougar in certain situations. Landowners may take one cougar in the act of attacking livestock (WAC 220-440-060) or multiple cougar posing immediate risk to health/human safety on private land at any time without a permit (WAC 220-440-050). If in possession of a kill permit by WDFW multiple cougar may be taken to protect livestock (RCW 77.36.030, WAC 220-440-050, WAC 220-440-060). Take from situations not requiring a permit must be reported to WDFW within 24 hours and the animal/all parts must be provided to WDFW or its designees (WAC 220-440-090). With a damage prevention or kill permit issued by WDFW (WAC 220-440-060) must be disposed of consistent with the conditions identified under the permit (WAC 220-440-090).

Hunter harvest reporting is mandatory for cougar in Washington State and do have a sealing requirement. Thus, reporting for landowner conflict take, WDFW conflict take, hunter harvest, and WS-Washington take are considered known mortality sources.

Poaching, wounding loss, roadkill, and natural causes are more difficult to track though in the case of big game predators, WDFW's game status and trend report (Washington Department of Fish and Wildlife 2019a) provides enough information to form an estimate of cougar mortality.

Cougar populations are monitored in Washington by a WDFW funded long-term research project. As a result, information on population metrics if fairly well known with limited uncertainty when compared to other WDFW managed species. Other mortality including road kills, poaching, and landowner kills frequently unknown for other species are, to some extent, accounted for through WDFW monitoring. Information for all WDFW tracked cougar mortality is displayed in Table 13.

3.4.4.5 Conclusion: Cougar

Given the presumed population stability for cougar in the state, the low level of anticipated take (2 per year), and an annual maximum sustainable harvest level much higher than the current cumulative take in the state, WS-Washington's MDM will not have a significant impact on the population. This conclusion is consistent with historic WS-Washington MDM activities and WDFW cougar population trend information (Washington Department of Fish and Wildlife 2018a). WS-Washington also coordinates with WDFW to ensure MDM activities are in with the bounds of the management goals for the species.

Should an increase in requests for assistance with cougar result in WS-Washington taking of the analyzed maximum (10 cougars per year), cumulative impacts on the statewide cougar 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-Washington take, direct and cumulative impacts from take would not adversely impact the size or sustainability of the Washington cougar population.

3.4.5 What are the Direct and Cumulative Impacts on Elk Populations?

3.4.5.1 Elk Life History

Elk, the second largest member of the deer family (Cervidae), are found in nearly every portion of Washington State. Seasonal diet shifts from herbaceous grazing in late spring, summer, and early fall to woody browsing during late fall, winter, and early spring. Elk's breeding season (rut) lasts for 10-12 weeks and typically starts as early as late-August running as late mid-November. Gestation lasts 244 to 265 days resulting in one calf from birthed sometime from May through June. Initial breeding age is determined by weight though most elk are large enough to breed by 2 years old. Elk are gregarious though herd size, age composition, and gender composition vary by time of year and habitat. Elk can be non-migratory but typically move from wintering grounds to calving grounds each year especially in mountainous regions of the state. Home ranges for elk can vary from as little as 1 mi^2 to 95 mi^2. Primary predators on elk include gray wolves, coyotes, black bears, and mountain lions.

3.4.5.2 Elk Population Impact Analysis

WDFW conducts monitoring surveys on elk populations by herd and while population dynamics and trends vary regionally WDFW's statewide estimate of elk populations is between 45,000 and 55,000 (Kyle Garrison, WDFW, personal communication, 2020).

In response to requests for assistance with elk damage between FY 2015 and 2019, WS-Washington removed an average of 2.8 target elk per year during the reporting period (Table 15), all elk were taken on private lands. WS-Washington has not lethally taken any non-target elk during the analysis period. The most elk taken by WS-Washington in a single fiscal year was 11.

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future black-tailed deer removals for MDM would be similar to take during the last five years. Therefore, under Alternative 1 (current activities with fluctuations), the projected WS-Washington annual maximum take was analyzed up to but would not exceed 30 elk per year (Table 15).

Table 14. Percentage of Take by the Resource Protected, FY 2015- FY 2019.

<table>
<tr><td rowspan="3">Human Health and Safety</td><td>General</td><td>10%</td></tr>
<tr><td>Infrastructure</td><td>0%</td></tr>
<tr><td>Aviation</td><td>0%</td></tr>
<tr><td rowspan="2">Agriculture</td><td>Crops</td><td>60%</td></tr>
<tr><td>Livestock</td><td>0%</td></tr>
<tr><td rowspan="2">Property</td><td>Residential</td><td>0%</td></tr>
<tr><td>Non-Residential</td><td>10%</td></tr>
<tr><td>Timber</td><td>Timber</td><td>0%</td></tr>
<tr><td rowspan="2">Natural Resources</td><td>Wildlife</td><td>20%</td></tr>
<tr><td>Habitat</td><td>0%</td></tr>
</table>

3.4.5.3 Cumulative Mortality

Elk are defined as a big game animal in Washington (RCW 77.08.030) with regulated hunting seasons. Other than protected and endangered species, elk is one of the most heavily regulated, monitored, and managed species in Washington State.

It is permissible to kill elk posing an immediate threat of physical harm to a person without a permit (WAC 220-440-050). Removal of elk for wildlife damage requires special coordination with WDFW and WCO's may not take elk unless under special

permit issued from WDFW (WAC 220-440-200). Take from situations not requiring a permit must be reported to WDFW within 24 hours and the animal/all parts must be provided to WDFW or its designees (WAC 220-440-090). With a damage prevention or kill permit issued by WDFW (WAC 220-440-060) carcasses must be disposed of consistent with the conditions identified under the permit (WAC 220-440-090).
Poaching, wounding loss, and natural causes are more difficult to track though in the case of elk, WDFW's game status and trend report (Washington Department of Fish and Wildlife 2019a) provides some information to form an estimate for poaching. WDFW uses this estimation in regulating elk populations.

Hunter harvest reporting is mandatory for elk hunts in Washington State. Salvage permits can be issued by WDFW for the collection of elk killed by motor vehicles. Entities such as Washington Department of Transportation also track roadkill of elk along major roads in Washington State. Thus, reporting WDFW conflict take, hunter harvest, roadkill, WS-Washington, and landowner take are considered known mortality sources. All reported mortality information is shown in Table 15.

Table 15. Population Impact Analysis of Elk Take in Washington, FY 2015- FY 2019.

Mortality source	2015	2016	2017	2018	2019	5-year average	5-year high
WS Target take	0	1	11	2	0	2.8	11
WS Non-Target take	0	0	0	0	0	0.0	0
WCO take	0	0	0	0	-	0.0	0
WDFW Conflict take	120	251	249	181	-	200.3	251
General Harvest	5,572	4,899	4,235	4,477	4,554	4,747.4	5,572
Special Permit	0	0	0	0	-	0.0	0
Other Mortality	-	112	230	274	89	176.3	274
Total WS take	0	1	11	2	0	2.8	11
Total non-WS take	5,692	5,262	4,714	4,932	4,643	5,048.6	5,692
Cumulative take	5,692	5,263	4,725	4,934	4,643	5,051.4	5,692
Statewide population estimate:			45,000				
Statewide population trend:			Stable				
Annual maximum sustainable harvest:			-				
Current total WS take as a % of the population:			0.02%				
Current cumulative take as % of population:			12.65%				
Projected WS annual maximum take:			50				
Projected total WS take as a % of the population:			0.11%				
Projected annual cumulative take as a % of the population:			12.76%				

3.4.5.4 Conclusion: Elk

Given the presumed population stability for elk in the state (Kyle Garrison, WDFW, personal communication, 2020 (Washington Department of Natural Resources 2017)), the low levels of anticipated take (less than 5 elk per year), the lack of non-target take, and cumulative impacts on the elk population from all causes, including take by WS-Washington, WS-Washington's MDM is not adversely impacting the size or sustainability of the elk population.

Should the increase in requests for assistance with elk damage increase, WS-Washington projections annual WS maximum take (50 elk per year) and the cumulative impacts on the statewide elk 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-Washington take, direct and cumulative impacts from take would not adversely affect the Washington elk population.

3.4.6 What are the Direct and Cumulative Impacts on Mule Deer and White-tailed Deer Populations?

3.4.6.1 Mule Deer Life History

Mule deer are primarily found east of the Cascades. These deer breed during late fall and give birth to 1 or 2 fawns during May and June after a gestation period that is between 180-210 days long. Mule deer begin breeding at 2 years of age and tend from 5-14 years of age. Forage is primarily new growth on woody plants and herbaceous vegetation. Where Columbian black-tailed deer tend to have small home ranges and are rarely migratory, mule deer are often migratory and have home ranges from 1 mi^2 to 55 mi^2. Preferred habitats range from alpine habitats, to dense coniferous forests, to open plains and scrubland. Primary sources of predation are cougars, coyotes, bears, and dogs.

Airfields have habitat that is attractive to mule deer where they can come into conflict with aviation safety.

3.4.6.1.1 Columbian Black-Tailed Deer Life History

The smaller subspecies of mule deer, Columbian black-tailed deer (*Odocoileus hemionus columbianus*), are primarily found west of the Cascades. These deer breed during late fall and give birth to 1 or 2 fawns during May and June after a gestation period that is 180-210 days long. Black-tailed deer begin breeding at 2 years of age and tend from 5-10 years of age. Forage is primarily new growth on woody plants and herbaceous vegetation. Mixed landscape cover of forested and cleared areas (e.g. clear-cut areas or grassy fields) are preferred habitats. Home ranges for black-tailed deer are typically 1 mi^2 or less. Primary sources of predation are cougars, coyotes, bears, and dogs though fawns may also be taken by eagles and bobcats.

Airfields have habitat that is attractive to Columbian black-tailed deer where they can come into conflict with aviation safety.

3.4.6.2 White-Tailed Deer Life History Information

White-tailed deer are primarily found east of the Cascades. These deer tend to live from 6-14 years of age, breed during late fall, and give birth to 2 fawns during May and June after a gestation period that is between 187-213 days long. White-tailed deer begin breeding at 2 years of age. Social groups of females are typically composed of the young of the current and prior year. Social groups of young (>1 year old) males are looser knit composed of 2-5 individuals. Forage is primarily new growth on woody plants and herbaceous vegetation. Many factors influence whether or not white-tail deer are migratory and home range size, which typically ranges from 1 mi^2 to 10 mi^2. Preferred habitats range is edge habitat with woody plant cover and access to open areas with herbaceous forage. Primary sources of predation are cougars, coyotes, bears, and dogs.

Airfields have habitat that is attractive to white-tailed deer where they can come into conflict with aviation safety.

3.4.6.3 Deer Population Information

To derive a conservative estimate, information from WDFW’s 2018 Game Status and Trend Report was used (Washington Department of Fish and Wildlife 2018a). For populations of deer that WDFW provided population estimates the lowest and most recent estimates were used. For populations without an estimated population the lower end of the deer harvest estimate was used, at a minimum there are the number of deer in the population as was harvested in the last year. This is a conservative estimate of deer in the state. Use of such a conservative estimate means the analysis will overstate the impacts of WS-Washington’s proposed activities.

3.4.6.4 Cumulative Mortality

Deer are defined as a big game animal in Washington (RCW 77.08.030) with regulated hunting seasons. It is permissible to kill deer posing an immediate threat of physical harm to a person without a permit (WAC 220-440-050). Removal of deer for wildlife damage requires special coordination with WDFW and WCO’s may not take deer unless under special permit issued from WDFW (WAC 220-440-200). Take from situations not requiring a permit must be reported to WDFW within 24 hours and the animal/all parts must be provided to WDFW or its designees (WAC 220-440-090). With a damage prevention or kill permit issued by WDFW (WAC 220-440-060) carcasses must be disposed of consistent with the conditions identified under the permit (WAC 220-440-090).

Hunter harvest reporting is mandatory for deer hunts in Washington State. Salvage permits can be issued by WDFW for the collection of deer killed by motor vehicles.

Entities such as Washington Department of Transportation also track roadkill of deer along major roads in Washington State. Thus, reporting WDFW conflict take, hunter harvest, roadkill, WS-Washington, and landowner take are considered known mortality sources.

Poaching, wounding loss, and natural causes are more difficult to track and are unreported sources of mortality. All relevant reported mortality information is shown in Table 16. Levels of mortality that result from poaching, wounding loss, and natural causes are not likely to substantially alter the results of this analysis.

3.4.6.5 Deer Population Impact Analysis

In response to requests for assistance with mule deer damage between FY 2015 and 2019, WS-Washington removed an average of 0.2 target mule deer during the reporting period (Table 16), on public land (an airport). WS-Washington took the mule deer for the protection of human health and safety through the protection of aviation. WS-Washington has not lethally taken any non-target mule deer during the analysis period. The most mule deer taken by WS-Washington in a single fiscal year was 1.

In response to requests for assistance with black-tailed deer damage between FY 2015 and 2019, WS-Washington removed an average of 9 target black-tailed deer per year during the reporting period (Table 16), all were taken were from airports to protect aviation safety. All black-tailed deer WS-Washington took were for the protection of human health and safety for aviation safety. WS-Washington has not lethally taken any non-target black-tailed deer during the analysis period. The most black-tailed deer taken by WS-Washington in a single fiscal year was 17.

In response to requests for assistance with white-tailed deer damage between FY 2015 and 2019, WS-Washington removed an average of 2.8 target white-tailed deer during the reporting period (Table 16), all were taken on public land at one airport. All white-tailed deer WS-Washington took were for the protection of human health and safety through the protection of aviation. WS-Washington has not lethally taken any non-target white-tailed deer during the analysis period. The most white-tailed deer taken by WS-Washington in a single fiscal year was 14.

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future deer removals for MDM would be similar to take during the last five years. Therefore, under Alternative 1 (current activities with fluctuations), the projected WS annual maximum take was analyzed up to but would not exceed 100 deer (Table 16).

Table 16. Population Impact Analysis of Deer Take in Washington, FY 2015- FY 2019.

Mortality Source	2015	2016	2017	2018	2019	5-year average	5-year high
WS Target take	17	14	22	3	4	12.0	22
WS Non-Target take	0	0	0	0	0	0.0	0
WCO take	0	0	0	0	-	0.0	0
WDFW Conflict take	11	34	13	10	-	17.0	34
General Harvest	37,963	33,494	26,537	25,741	25,495	29,846.0	37,963
Special Permit	-	-	-	-	-	-	0
Other Mortality	-	944	1,783	2055	468	1,312.5	2,055
Total WS take	17	14	22	3	4	12.0	22
Total non-WS take	37,974	34,472	28,333	27,806	25,963	30,910	37,974
Cumulative take	37,991	34,486	28,340	27,809	25,967	30,919	37,991
Statewide population estimate:			100,000				
Statewide population trend:			Stable				
Annual maximum sustainable harvest:			- -				
Current total WS take as a % of the population:			0.02%				
Current cumulative take as % of population:			37.99%				
Projected WS annual maximum take:			100				
Projected total WS take as a % of the population:			0.10%				
Projected annual cumulative take as a % of the population:			38.07%				

3.4.6.6 Conclusion: Deer

Given the presumed population stability for deer in the state, the low levels of anticipated targeted take (less than 20 deer per year), the lack of non-target take, and cumulative impacts on the deer population from all causes, including take by WS-Washington, WS-Washington’s proposed MDM activities will not adversely impact the size or sustainability of any deer population.

Should the increase in requests for assistance with deer damage increase, WS-Washington analyzed an annual WS maximum take of 100 deer per year. That level of take and the cumulative impacts on the statewide deer population would still be low relative to the annual maximum sustainable harvest level (Table 20). Given the low proportion of cumulative take, and even lower WS-Washington take, direct and cumulative impacts from take would not adversely affect the Washington deer population.

3.4.7 What are the Direct and Cumulative Impacts on Eastern Cottontail Rabbit Populations?

3.4.7.1 Eastern Cottontail Rabbit Life History

In the 1930's eastern cottontail rabbits were introduced to Washington to supplement game rabbit populations and are now commonly found throughout Washington State. Forage for eastern cottontails is herbaceous vegetation throughout the year in western Washington but may shift to woody vegetation if more palatable forage is unavailable (typically in winter months). Breeding for rabbits begins in February and continues to late summer after a short 30-day gestation period can produce litters containing 4 to 8 young. Multiple litters may be produced each year and are reared in a bowl nest in dense cover or an opportunistically acquired burrow. Females feed the young for 2 weeks until they can begin eating vegetation and at 4 weeks the female will lead young to foraging outside of the nest. Predators of rabbits are hawks, owls, dogs, coyotes, foxes, bobcats, mink, skunk, long-tailed weasel, gopher snake, and cats. High rates of mortality from predators tend to limit a rabbit's lifespan to under a year though they are capable of living for 2 or more years (Washington Department of Fish and Wildlife 2019e).

3.4.7.2 Eastern Cottontail Rabbit Population Information and Analysis

Washington Natural Heritage Program through WDNR maintains a list of species status ranks for the majority of species in Washington eastern cottontail is not ranked as it is a non-native species. WDFW considers eastern cottontail populations to be stable, though monitoring data are limited (Anis Aoude, WDFW, personal communication, January 06, 2021). Eastern cottontail rabbits are classified as game animals. WDFW does not estimate population levels or densities but collects data on harvest. Due to this statutory classification, WDFW does not track or attempt to estimate eastern cottontail rabbit population levels or densities and has minimal information on harvest levels. WDFW estimates statewide cottontail rabbit harvest using non-mandatory reports mailed to 25,000 hunting license holders in Washington State. This estimate does not discern between eastern cottontails and Nuttall's cottontails. Though harvest in Washington State is more likely eastern cottontails than Nuttall's cottontails due eastern cottontails being more commonly associated with highly developed areas with more people. The responses are used to generate confidence intervals for the statewide eastern cottontail rabbit take. For our analysis the conservative estimate of the highest estimated harvest (the upper 95% confidence interval) is used.

Eastern cottontail rabbit population densities range from 0.08 to 11.6 rabbits/ha (Haugen 1942, Scribner 1982)(Haugen 1942, Scribner 2012). To generate a statewide population estimate, a digitized range map of the species5F[6] was used to measure the eastern cottontail rabbit's range within Washington6F[7]. The number of square miles of eastern cottontail rabbit habitat was multiplied by the lowest density estimate from the literature (20.71 eastern cottontails/mi^2); identified area to generate a conservative statewide population estimate of 64,491 eastern cottontail rabbits.

Annual maximum sustainable harvest for eastern cottontail populations has been estimated to be 80% (Virginia Department of Game and Inland Fisheries 2019) or conservatively about 51,593 eastern cottontail rabbits in Washington (Table 18).

3.4.7.3 Eastern Cottontail Rabbit Population Impact Analysis

In response to requests for assistance with eastern cottontail rabbit damage between FY 2015 and FY2019, WS-Washington removed an average of 154.8 target eastern cottontail rabbits per year during the reporting period (Table 14), 7% were taken on private lands and 93% were taken were on public lands. WS-Washington has taken an average of 0.4 non-target eastern cottontail rabbits per year during the analysis period. The most eastern cottontail rabbits taken by WS-Washington in a single fiscal year was 267.

Table 17. Percentage of Take by the Resource Protected, FY 2015- FY 2019.

Human Health and Safety	General	12%
	Infrastructure	0%
	Aviation	79%
Agriculture	Crops	0%
	Livestock	0%
Property	Residential	0%
	Non-Residential	9%
Timber	Timber	1%
Natural Resources	Wildlife	0%
	Habitat	0%

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future eastern cottontail removals for MDM would be similar to take during the last five years. Therefore, a WS-Washington is analyzing a maximum take of up to 500 eastern cottontail rabbits per year (Table 18).

[6]Digitized maps from the Digital Distribution Maps of the Mammals of the Western Hemisphere version 3.0Patterson, B. D., G. Ceballos, W. Sechrest, M. F. Tognelli, T. Brooks, L. Luna, P. Ortega, I. Salazar, and B. E. Young. 2007. Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0. *in* NatureServe, natureserve.org. were used in ESRI's ArcGIS ArcPro software.
[7]Digitized map of Washington State's Boundary from Washington State Geospatial Open Data Portal. 2015. WA State Boundary Mask. November 1, 2019. https://geo.wa.gov/datasets/wa-state-boundary-mask were used in ESRI's ArcGIS ArcPro software.

Table 18. Population Impact Analysis of Eastern Cottontail Rabbit Take in Washington, FY 2015-FY 2019.

Mortality Source	2015	2016	2017	2018	2019	5-year average	5-year high
WS Target take	267	61	120	153	171	154.4	267
WS Non-Target take	0	1	1	0		0.4	1
WCO take	0	0	0	0	0	0.0	0
WDFW Conflict take	0	0	0	0	0	0.0	0
General Harvest	10,137	6,281	9,935	11,811	-	9,541.0	11,811
Special Permit	1	2	0	1	-	1.0	2
Other Mortality	-	-	-	-	-	-	0
Total WS take	267	62	121	153	171	154.8	267
Total non-WS take	10,138	6,283	9,935	11,812	0	7,633.6	11,812
Cumulative take	10,405	6,345	10,056	11,965	171	7,788.4	11,965
Statewide population estimate:			64,491				
Statewide population trend:			Stable				
Annual maximum sustainable harvest:			80% (51,593)				
Current total WS take as a % of the population:			0.41%				
Current cumulative take as % of population:			18.55%				
Projected WS annual maximum take:			500				
Projected total WS take as a % of the population:			0.78%				
Projected annual cumulative take as a % of the population:			19.09%				

3.4.7.4 Cumulative Mortality

Eastern cottontail rabbits are classified as game animals in Washington and a state license is required to lethally remove them (RCW 77.32.010). No special permits are required when using live traps. Special trapping permits are issued by WDFW (RCW 77.15.192, RCW 77.15.194, and WAC 220-417-040). Under WAC 220-440-060, landowners or commercial wildlife control operators can also remove eastern cottontail rabbits on private land when eastern cottontails are causing damage to private property, crops, livestock, or presenting a public health risk without a license. It is unlawful to release any species anywhere within the state, other than on the property where it was legally trapped, without a permit to do so (RCW 77.15.250; WAC 220-450-010).

Although private landowner removals and other forms of mortality (e.g. roadkills, poaching, other incidental forms of mortality) are not typically reported the impacts of these unreported mortality sources are unlikely to significantly change the conclusions drawn from this analysis.

3.4.7.5 Conclusion: Eastern Cottontail Rabbit

Given the presumed population stability for eastern cottontail in the state, the low non-target take, and an annual maximum sustainable harvest level of 80%, cumulative impacts on the eastern cottontail rabbit population from all causes, including take by WS-Washington, WS-Washington's MDM has not adversely impacted the population.

Therefore, WS-Washington concludes that the cumulative impact of all recorded eastern cottontail rabbit mortality in Washington, including target and non-target take by WS-Washington, would not adversely impact the size or sustainability of the Washington eastern cottontail rabbit population.

Should an increase in requests for assistance with eastern cottontail rabbit result in the projected annual WS maximum take, cumulative impacts on the statewide eastern cottontail rabbit 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-Washington take, direct and cumulative impacts from take would not adversely impact the size or sustainability of the Washington eastern cottontail rabbit population.

3.4.8 What are the Direct and Cumulative Impacts on Nuttall's Cottontail Rabbit Populations?

3.4.8.1 Nuttall's Cottontail Rabbit Life History

Nuttall's cottontail rabbits are the native rabbit common to sagebrush, grasslands, orchards, and low-density woodlots in eastern Washington State. Forage for Nuttall's cottontails is herbaceous vegetation during the spring and fall when available in Washington but shifts to woody vegetation when more palatable forage is unavailable (typically in winter months and drier summer months). Breeding for rabbits begins in February and continues to late summer after a short 30-day gestation period can produce litters containing 4 to 8 young. Multiple litters may be produced each year and are reared in a bowl nest in dense cover or an opportunistically acquired burrow. Females feed the young for 2 weeks until they can begin eating vegetation and at 4 weeks the female will lead young to foraging outside of the nest. Predators of rabbits are hawks, owls, dogs, coyotes, foxes, bobcats, mink, skunk, long-tailed weasel, gopher snake, and cats. High rates of mortality from predators tend to limit a rabbit's lifespan to under a year though they are capable of living for 2 or more years (WDFW Rabbit Life History 2005).

3.4.8.2 Nuttall's Cottontail Rabbit Population Information

In a study in shrub-juniper scrublands in central Oregon Nuttall's cottontail rabbit densities vary from 0.06 to 2.5 rabbits/ha as reported in by the IUCN and Status Survey and Conservation Action Plan for rabbits, Hares, and Pikas by Chapman and Flux (1990). Washington Natural Heritage Program through WDNR maintains a list of species status ranks for the majority of species in Washington, the following is the state species ranks of the species that Washington works with; Nuttall's cottontail is ranked as secure (Washington Department of Natural Resources 2017). WDFW considers nuttall's cottontail populations to be stable, though monitoring data are limited (Anis Aoude, WDFW, personal communication, January 06, 2021).

To generate a statewide population estimate, a digitized range map of the species[8] was used to measure the Nuttall's cottontail rabbit's range within Washington[9]. The number of square miles of Nuttal's cottontail rabbit habitat[10] was multiplied by the lowest density estimate from the literature (15.53 Nuttall's cottontails/mi^2); identified area to generate a conservative statewide population estimate of 285,410 Nuttall's cottontail rabbits.

Because annual sustainable harvest levels have not been as closely analyzed for Nuttall's cottontails. To account for their lower density on the landscape, half of the eastern cottontail sustainable harvest level will be used. Annual maximum sustainable harvest for Nuttall's cottontail populations would then be estimated at 40% or conservatively about 114,164 Nuttall's cottontail rabbits in Washington (Table 19).

Nuttall's cottontail rabbit populations are managed by WDFW as game animals and not as wildlife. Due to this statutory classification, WDFW does not track or attempt to estimate Nuttall's cottontail rabbit population levels or densities and has minimal information on harvest levels. WDFW estimates statewide cottontail rabbit harvest using non-mandatory reports mailed to 25,000 hunting license holders in Washington State. This estimate does not discern between eastern cottontails and Nuttall's cottontails, though species may be inferred based on location of harvest. The responses are used to generate confidence intervals for the statewide eastern cottontail rabbit take. Although there is some inherent error in harvest estimations using this method, particularly since the survey is stratified to target game bird hunters, our analysis uses the highest estimated harvest (the upper 95% confidence interval) in order to be conservative.

3.4.8.3 Nuttall's Cottontail Rabbit Population Impact Analysis

In response to requests for assistance with Nuttall's cottontail damage between

[8]Digitized maps from the Digital Distribution Maps of the Mammals of the Western Hemisphere version 3.0Patterson, B. D., G. Ceballos, W. Sechrest, M. F. Tognelli, T. Brooks, L. Luna, P. Ortega, I. Salazar, and B. E. Young. 2007. Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0. *in* NatureServe, natureserve.org. were used in ESRI's ArcGIS ArcPro software.
[9]Digitized map of Washington State's Boundary from Washington State Geospatial Open Data Portal. 2015. WA State Boundary Mask. November 1, 2019. https://geo.wa.gov/datasets/wa-state-boundary-mask were used in ESRI's ArcGIS ArcPro software.
[10] Species' range excluded all planted cropland Washington State Department of Agriculture. 2019. WSDA Agricultural Land Use Data November 1, 2019. https://agr.wa.gov/departments/land-and-water/natural-resources/agricultural-land-use. Cropland was excluded because it is unlikely that landowners would allow Nuttall's cottontail rabbits to persist in crop lands.

FY 2015 and FY2019, WS-Washington removed an average of 1.4 target Nuttall's cottontail per year during the reporting period (Table 39), all were taken were on public lands. All Nuttall's cottontail WS-Washington took were for the protection of non-residential property. WS-Washington has had no non-target lethal take of Nuttall's cottontail during the analysis period. The most Nuttall's cottontail taken by WS-Washington in a single fiscal year was 7.

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future Nuttall's removals for MDM would be similar to take during the last five years. Therefore, under Alternative 1 (current activities with fluctuations), the projected WS-Washington annual maximum take was analyzed up to but would not exceed 50 Nuttall's cottontails per year (Table 19).

Table 19. Population impact analysis of Nuttall's cottontail rabbit take in Washington, FY2015- FY2019.

Mortality source	2015	2016	2017	2018	2019	5-year average	5-year high
WS Target take	0	7	0	0	0	1.4	7
WS Non-Target take	0	0	0	0	0	0.0	0
WCO take	0	0	0	0	-	0.0	0
WDFW Conflict take	0	0	0	0	-	0.0	0
General Harvest[11]	10,137	6,281	9,935	11,811	-	9,541.0	11,811
Special Permit	0	0	0	0	-	0.0	0
Other Mortality	-	-	-	-	-	-	0
Total WS take	0	7	0	0	0	1.4	7
Total non-WS take	10,137	6,281	9,935	11,811	0	7,632.8	11,811
Cumulative take	10,137	6,288	9,935	11,811	0	7,634.2	11,811
Statewide population estimate:			285,410				
Statewide population trend:			Stable				
Annual maximum sustainable harvest:			40% (114,164)				
Current total WS take as a % of the population:			0.00%				
Current cumulative take as % of population:			4.14%				
Projected WS annual maximum take:			50				
Projected total WS take as a % of the population:			0.02%				
Projected annual cumulative take as a % of the population:			4.16%				

3.4.8.4 Cumulative Mortality

Nuttall's cottontail rabbits are classified as game animals in Washington and a state license is required to lethally remove them (RCW 77.32.010). No special

[11] General harvest estimate is both cottontail species combined.

permits are required when using live traps. Special trapping permits are issued by WDFW (RCW 77.15.192, RCW 77.15.194, and WAC 220-417-040). Under WAC 220-440-060 (Section 2.4.4.1), landowners or commercial wildlife control operators can also remove Nuttall's cottontail rabbits on private land when Nuttall's cottontails are causing damage to private property, crops, livestock, or presenting a public health risk without a license. It is unlawful to release any species anywhere within the state, other than on the property where it was legally trapped, without a permit to do so (RCW 77.15.250; WAC 220-450-010). Although private landowner removals and other forms of mortality (e.g. roadkills, poaching, other incidental forms of mortality) are not typically reported the impacts of these unreported mortality sources are unlikely to significantly change the conclusions drawn from this analysis.

3.4.8.5 Conclusion: Nuttall's Cottontail Rabbit

Given the presumed population stability for Nuttall's cottontail in the state, the low non-target take, and an annual maximum sustainable harvest level of 40%, cumulative impacts on the Nuttall's cottontail rabbit population from all causes, including take by WS-Washington, WS-Washington's MDM is not adversely impacting the population. Therefore, WS-Washington concludes that the cumulative impact of all recorded Nuttall's cottontail rabbit mortality in Washington, including target and non-target take by WS-Washington, would not adversely impact the size or sustainability of the Washington Nuttall's cottontail rabbit population.

Should an increase in requests for assistance with Nuttall's cottontail rabbit result in the projected annual WS maximum take, cumulative impacts on the statewide Nuttall's cottontail rabbit 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-Washington take, direct and cumulative impacts from take would not affect the size or sustainability of the Washington Nuttall's cottontail rabbit population.

Furbearer Species

Furbearing animals are animals that may be taken with traps for their hides, pelts, or other resources during the trapping season (typically Nov 1st-Mar. 31st) and require a trapping license. Wildlife classified furbearers that are not also classified as game animals (e.g. beaver, mink) may not be taken outside of trapping season. Some furbearing animals are also classified as game animals. These species may be either trapped or taken via methods other than trapping during their respective hunting seasons. Thus, species classified as both game and furbearing species have more potential sources of take and are more accessible to recreational hunters/trappers.

Some furbearing species are also classified as game animals in Washington State. A state hunting or trapping license is required to trap or lethally remove those species (RCW 77.32.010). No special permits are required when using live traps. Special trapping permits are issued by WDFW (RCW 77.15.192, RCW 77.15.194, and WAC 220-417-040). Under WAC 220-440-060 (Section 2.4.4.1), landowners or commercial wildlife control operators can also remove small game animals on private land when they are causing damage to private property, crops, livestock, or presenting a public health risk without a license. It is unlawful to release any species anywhere within the state, other than on the property where it was legally trapped, without a permit to do so (RCW 77.15.250; WAC 220-450-010).

Trappers and wildlife control operators must submit trapping activity reports. Bobcat and river otter have mandatory pelt sealing requirements. Furbearers taken as game animals outside of trapping season are reported via hunter reports. Thus recreational harvest and WCO take of these species is considered representative of total species take.

Under WAC 220-440-060, removals of raccoon, fox, bobcat, beaver, muskrat, mink, river otter, weasel, hare, and cottontail rabbits, for damage on private property do not need to be reported to WDFW. Poaching and unreported take are not known take and cannot be factored into the analysis thought they are not expected to have a substantial change on the results of the analysis in the following sections.

3.4.9 What are the Direct and Cumulative Impacts on Badger Populations?

WS-Washington occasionally receives requests for assistance to resolve damages from badgers for the protection of aviation safety.

3.4.9.1 Badger Life History Information

Badgers are found throughout most of the western U.S. In Washington, badgers are found east of the Cascades 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.

3.4.9.2 Badger Population Information

Badgers are under the management authority of the WDFW. The Washington Natural Heritage Program, which maintains a list of species status ranks for most mammal species in Washington, ranks badgers as "apparently secure"

(Washington Department of Natural Resources 2017). However, due lack of information on badger populations and some signs that there may be a potential decline in Washington's badger information WDFW has placed the badger on its list of Species of Greatest Conservation Need (Washington Department of Fish and Wildlife 2015c). For this analysis, Washington's badger population will be treated as unknown/potentially declining.

In order to establish a population estimate, WS-Washington reviewed the available literature on badger populations and densities. Badger densities range from 0.7 badgers/mi^2 (Colorado) Hein and Andelt (1995b) up to 13 badgers/mi^2 (Idaho) Messick and Hornocker (1981). It has been estimated that the Curlew Valley on the Utah-Idaho border supported 1 badger/mi^2 (Lindzey 1971). Clark et al. (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). While the literature leans towards a greater density, we will use the lowest reported density 0.7 badgers/mi^2 to estimate the density in Washington.

To generate a statewide population estimate, a digitized range map of the species[12] was used to measure the badger's range within Washington (Washington State Geospatial Open Data Portal 2015). The number of square miles of badger habitat was multiplied by the lowest density estimate from the literature (0.7 badgers/mi^2) identified area to generate a conservative statewide population estimate of 29,526 badgers.

3.4.9.3 Badger Population Impact Analysis

In response to requests for assistance with badger damage between FY 2015 and 2019, WS-Washington removed an average of 0.8 badger/year (Table 17). Requests for assistance were limited to airfields for the protection of aviation and human health and safety. WS-Washington has not taken any non-target badger during the analysis period. The most badger taken by WS-Washington in a single fiscal year was 4.

Based on projected future requests for assistance, WS-Washington expects that badger removals for MDM would be similar to take during the last five years. Therefore, under Alternative 1 (current activities), the projected WS annual maximum take would be 10 badgers (Table 17).

3.4.9.4 Cumulative Effects

Several sources of badger removals contribute to the cumulative take of badgers in Washington (Table 17). Badgers are classified as a furbearer in

[12]Digitized maps from the Digital Distribution Maps of the Mammals of the Western Hemisphere version 3.0Patterson, B. D., G. Ceballos, W. Sechrest, M. F. Tognelli, T. Brooks, L. Luna, P. Ortega, I. Salazar, and B. E. Young. 2007. Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0. *in* NatureServe, natureserve.org. were used in ESRI's ArcGIS ArcPro software.

Washington. A trapping license is required to take badgers during the recreational trapping season. All take by a landowner, trapper, or WCO must be reported to WDFW. However, there has been no reported recreational take of badgers, and an average of 2.8 badgers taken annually by WCOs (Table 20).

The literature reviewed indicated that the annual maximum sustainable harvest for badger populations is 30% (Boddicker 1980). Based on the conservative population estimate of 29,526 badgers in Washington, the maximum sustainable harvest would be 8,858 badgers per year (Table 20). The proposed WS-Washington take of up to 10 badgers per year amounts to 0.01% of the estimated maximum sustainable harvest. WS-Washington badger take is typically restricted to airfields and is not expected to be consistent. WS-Washington is unlikely to take badger every year and impacts would likely be less than analyzed under the maximum annual take projection.

Table 20. Population impact analysis of badger take in Washington, FY 2015- FY 2019

Mortality Source	2015	2016	2017	2018	2019	5-year average	5-year high
WS Target take	0	0	0	4	0	0.8	4
WS Non-Target take	0	0	0	0	0	0.0	0
WCO take	2	0	8	0	-	2.5	8
WDFW Conflict take	0	0	0	0	-	0.0	0
General Harvest	4	3	2	7	0	3.2	7
Special Permit	0	0	0	0	-	0.0	0
Other Mortality	-	-	-	-	-	-	0
Total WS take	0	0	0	4	0	0.8	4
Total non-WS take	4	3	2	7	0	3.2	7
Cumulative take	6	3	10	11	0	6.0	11
Statewide population estimate:			29,526				
Statewide population trend:			Unknown/ Potential Decline				
Annual maximum sustainable harvest:			30% (8,858)				
Current total WS take as a % of the population:			0.01%				
Current cumulative take as % of population:			0.04%				
Projected WS annual maximum take:			10				
Projected total WS take as a % of the population:			0.03%				
Projected annual cumulative take as a % of the population:			0.06%				

3.4.9.5 Conclusion: Badger

Given the low non-target take, annual maximum sustainable harvest level of 30%, cumulative impacts on the badger population from all causes, including all take by WS-Washington, WS-Washington's MDM take for badger is 0.03% of the estimated population. Therefore, WS-Washington concludes that the proposed level of take would not have adverse direct or cumulative impacts to badger populations.

3.4.10 What are the Direct and Cumulative Impacts on Beaver Populations?

3.4.10.1 Beaver Life History Information

According to Baker et al. 2003, beaver establish shelters by burrowing into stream banks to create bank dens or construction of a lodge made of mud, sod, and limbs. Lodges and dams are made from cut sticks and mud stacked until they are above water level. Lodges have nest chambers cut from the inside with a water access point, or connection to a bank lodge, that is not typically visible from outside the lodge. Dams are also made of mud and sticks but do not have nest chamber and do not typically connect to a bank den. A pair of beaver and the 2-4 young from the last two years live in the beaver lodge or bank den at one time. Beaver reach sexual maturity at 1.5-3 years of age and typically disperse at 2 years of age to establish territories. During this dispersal, typically a large source of mortality for beavers is from depredation. Predators of beaver are coyotes, wolves, mountain lions, bears, bobcats, and dogs. Forage for beaver is a combination of herbaceous vegetation and the sapwood of deciduous broadleaf trees though coniferous trees are also fed upon. Food caches can be established under water for access during cold winter months if waters freeze. Food caches are relatively uncommon in western Washington due to infrequent long periods of freezing weather (Baker and Hill 2003).

3.4.10.2 Beaver Population Information

Beaver are widely distributed, a part of the wildlife heritage in the United States and play an important role in shaping vegetation and patterns in riparian and meadow ecosystems. Recognition of the important role that beaver play in the environment has led to increased efforts to protect and reintroduce the species (Pollock et al. 2015) Historically, beaver populations were reduced by subsistence and commercial hunting and trapping (Hill 1976, Woodward 1983, Novak 1987). However increased trapping regulations and low demand for short-haired fur have resulted in decreased beaver harvest. Beaver populations and their population is currently stable, though monitoring data are limited (Anis Aoude, WDFW, personal communication, January 06, 2021). Washington Natural Heritage Program ranks beaver populations as "secure" (Washington Department of Natural Resources 2017). The absence of an adequate beaver harvest in conjunction with insignificant predation and an abundance of suitable habitat resulted in beaver populations dramatically increasing, resulting in increased beaver complaints with similar trends seen across most of the beavers' historic range as reported in Payne and Peterson (1986).

Because there is no current beaver population estimate for Washington state, we will use the lowest reported figures for beaver colony/unit of water and number of beavers per colony presented in Novak (1987) and Pollock 2015 to estimate a population. Novak (1987) documented beaver abundance in terms of families per mile (mi) of flowing water or per square mi^2 of surface area for impounded water bodies. Novak (1987) summarized North American beaver colony abundance as ranging from 0.4 to 12.0 colonies/mi^2 of impoundments and between 0.50 and 2.02 colonies per mile of flowing water. Pollock 2015 reported colony sizes from 2.7 to 8.2 individuals/colony with colony densities from 0.82 to 4.91 colony/mi^2 (Pollock et al. 2015). Densities reported in terms of colonies for all water bodies have been reported to range from 3.2 to 9.2 individuals/colony (Novak 1987).

Beaver colony density in impounded water ranged from 1.08 - 110.4 beavers/mi^2 of surface area of impoundments[13]. Based on the estimated beaver density for flowing water, the beaver density in flowing water ranged from 1.35 - 18.58 individuals per mile of stream[14].

To estimate available habitat, water body areas and stream lengths were derived from the Washington State National Hydrography Dataset (Washington State Department of Natural Resources 2006)[15]. The total flowing water (streams and rivers) mileage available to beaver in Washington State is approximately 18,629 miles. The total surface area of impounded water (ponds, lakes, swamps, and marshes) available to beaver in Washington State[16] is approximately 390 mi^2.

Though much of these areas provide beaver habitat, it is recognized that some of them do not and conservative calculations were used to estimate populations. The calculated population density of 1.08 families per square mile multiplied by the total mileage of impounded water (390 mi^2) yields an estimate of 421 beaver colonies. The population estimate of 1.35 colonies per linear mile of flowing water multiplied by the estimated 18,629 miles of flowing water yields estimate of 25,570 colonies. The statewide estimate totals 25,570 colonies, and when multiplied by the lowest reported colony size of 2.7 beavers per family (Pollock et al. 2015), the yield is a conservative Washington State population estimate is 69,040 beavers (Table 20).

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[13] (Beaver families/mi^2 of impounded water x #/family) = 0.40 x 2.70 = 1.08 (lowest estimate) and 12.0 x 9.2 = 110.4 (highest estimate)

[14] (Beaver families/mile of flowing water x #/family) = 0.50 x 2.70 = 1.35 (lowest estimates) and. 2.02 x 9.2 = 18.58 (highest estimate)

[15] Strahler Stream Order is used to define the order of stream reaches, for our estimate of stream and river lengths we used stream orders 5-10 as the lower ordered streams contained habitat less likely to support persistent beaver populations.

[16] To determine water bodies defined as perennial and either had the value of "390 – LakePond" or "466 – SwampMarsh". As the names suggest "390 – LakePond" is a dataset of the ponds and lakes of Washington State while "466 – SwampMarsh" is a dataset of the swamps and marshes of Washington State. To avoid the bias of very large and very small waterbodies, only waterbodies between 0.33 mi^2 and 20 mi^2 were counted included in the analysis.

3.4.10.3 Beaver Population Impact Analysis

WS-Washington received more requests for assistance with MDM related to beaver (22.8% of all requests) than any other mammal species during the reporting period (FY2015-FY2019). In response to requests for assistance with beaver damage between FY 2015 and 2019, WS-Washington removed an average of 406.2 beaver per year during the reporting period (Table 20), 69% were taken on private lands and 31% were on public lands. The most beaver taken by WS-Washington in a single fiscal year was 579. WS-Washington did not lethally take any non-target beaver during the analysis period.

WS-Washington live-traps and transfers custody of trapped beaver to beaver relocators when feasible through coordination with WDFW. For beaver to be relocated, WDFW-approved relocators or tribal entities must available immediately after beaver capture to accept custody of the beaver to be relocated. Management of relocation efforts including; captive care, transport, releases, site selection, and disease monitoring is done through coordination between WDFW and approved relocators or tribal entities. Relocated beaver are not counted as part of WS-Washington's annual take.

Based on projected future requests for assistance, WS-Washington expects that future beaver removals for MDM would be similar to take during the last five years. Therefore, under Alternative 1, the projected WS-Washington annual maximum take was analyzed up to but would not exceed 1,000 beavers per year (Table 21).

Table 21. Percentage of Take by the Resource Protected, FY 2015- FY 2019.

Resource Category	Resource Type	Percentage of Take
Human Health and Safety	General	8%
	Infrastructure	33%
	Aviation	2%
Agriculture	Crops	13%
	Livestock	2%
Property	Residential	1%
	Non-Residential	19%
Timber	Timber	12%
Natural Resources	Wildlife	1%
	Habitat	8%

3.4.10.4 Cumulative Effects

There have been few studies of adult beaver mortality factors, but those factors that have been identified are trapping (Novak 1987), severe winter weather under ice starvation and malnutrition, water fluctuations and floods, and falling trees (Novak

1987). The effect of predators on beaver populations is variable and dependent on the species of predator and alternate prey bases (Novak 1987).

Canada and Russia have historically tried many variable harvest rates ranging from 10%-70% based on elevation and habitat quality at various latitudes (Novak 1987). Annual harvest quotas in Ontario, after many years of study, are set at 30% of the population regardless of habitat type (Novak 1987). An allowable harvest based on the conservative estimate would be more than 20,712 beaver annually. Included in Table 20 is WS-Washington's take and the Statewide harvest, which includes sportsman and private harvest. The 575 beavers taken in FY16 was the highest in any one year by WS-Washington.

Table 22. Population impact analysis of beaver take in Washington, FY 2015- FY 2019.

Mortality Source	2015	2016	2017	2018	2019	5-year average	5-year high
WS Target take	338	575	469	401	248	406.2	575
WS Non-Target take	0	0	0	0	0	0.0	0
WCO take	255	739	213	225	-	358.0	739
WDFW Conflict take	0	0	35	2	-	9.3	35
General Harvest	1,245	683	810	730	755	844.6	1,245
Special Permit	910	962	903	1,178	-	988.3	1,178
Other Mortality	0	0	0	0	0	0.0	0
Total WS take	338	575	469	401	248	406.2	575
Total non-WS take	2,410	2,384	1,961	2,135	755	1,929.0	2,410
Cumulative take	2,748	2,959	2,430	2,536	1,003	2,335.2	2,959
Statewide population estimate:		69,040					
Statewide population trend:		Stable					
Annual maximum sustainable harvest:		30% (20,712)					
Current total WS take as a % of the population:		0.83%					
Current cumulative take as % of population:		4.29%					
Projected WS annual maximum take:		1000					
Projected total WS take as a % of the population:		1.45%					
Projected annual cumulative take as a % of the population:		4.94%					

3.4.10.5 Beaver Population Conclusion

Given the presumed population stability for beaver in the state, WS-Washington's assistance with source beaver for relocation efforts, the lack of non-target take, and an annual maximum sustainable harvest level of 30%, cumulative impacts on the beaver population from all causes, including take by WS-Washington, WS-Washington's MDM is not adversely impacting the population.

Therefore, WS-Washington concludes that the cumulative impact of all recorded beaver mortality in Washington, including all take by WS-Washington, is not adversely impacting the size or sustainability of the Washington beaver population.

Should an increase in requests for assistance with beaver damage result in the projected annual WS maximum take, cumulative impacts on the statewide beaver population would still be expected to remain below annual maximum sustainable harvest level. Given the low proportion of cumulative take, and even lower WS-Washington take, direct and cumulative impacts from take would not adversely impact the size or sustainability of the beaver population.

3.4.11 What are the Direct and Cumulative Impacts on Muskrat Populations?

3.4.11.1 Muskrat Life History

Muskrats are found throughout Washington-state in slow moving waterways. Muskrats forage on aquatic vegetation and herbaceous terrestrial vegetation near the water's edge. Bank dens and lodges are typically multi-chambered with an entrance below water level. Muskrat adjust for seasonal changes in water levels by adjusting the entrance to shelters, building canals for transit between waterbodies and their shelters, and increasing the size and elevation of the shelter's chambers. Food caches deposited under the water allows muskrats to survive through the winter months. Breeding occurs from March through October and after a 28-30 day gestation period between 4-7 kits are produced. Muskrats live to 4 years of age unless predated by mink, bobcat, fox, coyotes, owls, hawks, or eagles. Local populations can be cyclical when pressure from predators and other forms of mortality is not enough to keep populations from exceeding that habitats carrying capacity and degrading the habitat.

3.4.11.2 Muskrat Population Information

Sustainable muskrat harvest levels were defined between 65%-75%, beyond these harvest levels compensatory mortality responses in muskrat populations break down (Clark 1987). Muskrat densities are dependent on highly variable factors that vary seasonally and from year to year; water depth, water flow, and the amount of open water vs vegetative cover. If quality of available forage and cover are comparable, muskrat densities are typically greater in open-water habitats (1.0 to 9.3 adults/ha) than in sloughs (0.3 to 3.7 adults/ha) (Clay and Clark 1985). Other densities reported range from 2.5-62.5 muskrats/ha (Saunders 1988) and 7.4 to 86 muskrats/ha (Miller 2018).

To generate a statewide population estimate, a digitized wetland inventory map of Washington State[17] was used to measure the muskrat's range within Washington[18]. The number of square miles of muskrat habitat[19] was multiplied by the lowest density estimate from the literature (77.69 muskrat/mi^2 (Clay and Clark 1985)); identified area to generate a conservative statewide population estimate of 92,140 muskrat.

Annual maximum sustainable harvest for muskrat populations has been estimated at 65% (Clark 1987) or conservatively about 59,891 muskrat in Washington (Table 33).

Washington Natural Heritage Program through WDNR maintains a list of species status ranks for the majority of species in Washington, muskrats are ranked as secure (Washington Department of Natural Resources 2017). WDFW considers muskrat populations to be stable in Washington, though population data are limited (Anis Aoude, WDFW, personal communication, January 06, 2021).

3.4.11.3 Muskrat Population Impact Analysis

In response to requests for assistance with muskrat damage between FY 2015 and FY2019, WS-Washington removed an average of 32.8 target muskrats per year during the reporting period (Table 14), 8% were taken on private lands and 92% were taken were on public lands. WS-Washington took an average of 1.8 non-target muskrats per year during the analysis period. The most muskrat taken by WS-Washington in a single fiscal year was 67.

[17]Digitized maps from U.S. Fish and Wildlife Service Wetland Inventory U.S. Fish and Wildlife Service. 2019. National Wetlands Inventory Data. November 1, 2019. https://fws.gov/wetlands/Data/State-Downloads.html were used in ESRI's ArcGIS ArcPro software.
[18]Digitized map of Washington State's Boundary from Washington State Geospatial Open Data Portal. 2015. WA State Boundary Mask. November 1, 2019. https://geo.wa.gov/datasets/wa-state-boundary-mask were used in ESRI's ArcGIS ArcPro software.
[19] Areas categorized as freshwater ponds, freshwater emergent wetlands, and freshwater forested/shrub wetlands were included. Areas categorized as estuarine, marine deep water, riverine, and lakes were excluded.

Table 23. Percentage of Take by the Resource Protected, FY 2015- FY 2019.

Human Health and Safety	General	3%
	Infrastructure	59%
	Aviation	2%
Agriculture	Crops	3%
	Livestock	0%
Property	Residential	0%
	Non-Residential	33%
Timber	Timber	0%
Natural Resources	Wildlife	0%
	Habitat	0%

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future muskrat removals for MDM would be similar to take during the last five years. However, WS-Washington will analyze the take of up to 300 muskrats per year, to accommodate any unanticipated needs.

Table 24. Population impact analysis of muskrat take in Washington, FY 2015- FY 2019.

Mortality Source	2015	2016	2017	2018	2019	5-year average	5-year high
WS Target take	18	2	64	48	23	31.0	64
WS Non-Target take	5	1	3	0	0	1.8	5
WCO take	21	10	0	3	-	8.5	21
WDFW Conflict take	0	0	0	0	-	0.0	0
General Harvest	816	1,237	946	582	-	-	-
Special Permit	230	167	186	203	-	196.5	230
Other Mortality	-	-	-	-	-	-	-
Total WS take	23	3	67	48	23	32.8	67
Total non-WS take	1,046	1,404	1,132	785	0	873.4	1,404
Cumulative take	1,090	1,417	1,199	836	23	913.0	1,417
Statewide population estimate:	92,140						
Statewide population trend:	Stable						
Annual maximum sustainable harvest:	65% (59,891)						
Current total WS take as a % of the population:	0.07%						
Current cumulative take as % of population:	1.54%						
Projected WS annual maximum take:	300						
Projected total WS take as a % of the population:	0.33%						
Projected annual cumulative take as a % of the population:	1.85%						

3.4.11.4 Conclusion: Muskrats

Given the presumed population stability for muskrats in the state, and an annual maximum sustainable harvest level of 65%, cumulative impacts on the muskrat population from all causes, including take by WS-Washington, WS-Washington's MDM is not adversely impacting the size or sustainability of the muskrat population.

Should the increase in requests for assistance with muskrat damage outpace WS-Washington projections annual WS maximum take and the cumulative impacts on the statewide muskrat 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-Washington take, direct and cumulative impacts from take would not adversely affect the Washington muskrat population.

3.4.12 What are the Direct and Cumulative Impacts on River Otter Populations?

3.4.12.1 River Otter Life History

River otters inhabited most of North America prior to the declines caused by overexploitation during the height of the fur trade. Now, river otter are found throughout the Pacific Northwest, Atlantic coast states, and along the Mississippi river. River otters in Washington are found in wetlands, marshes, lakes, and rivers rich in prey species including fish, crustaceans, amphibians, and insects. Previously constructed den sites or opportunistic shelters are used for protection from predators and during breeding. Breeding season is a three-month period that begins in late winter ending in early spring. Implantation is delayed up to nine months and gestation lasts approximately 62 days. Litters are born between March and May consisting of 2 to 4 pups. Weaned at 90 days pups typically spend their first year in their family group and disperse to begin breeding around 2 years old. River otters can form loosely associated social groups which often break up prior to breeding season. Bobcats, dogs, coyotes, foxes, grey wolves, hawks, eagles, and owls can be important sources of mortality for river otters as they travel over land between waterbodies.

3.4.12.2 River Otter Population Information and Analysis

River otter population densities range from .27 otters/mi of waterway to 1.42 otters/mi of waterway (Melquist and Dronkert 1987). The lowest part of the estimate population density range from Melquist and Dronkert 1987 referenced an earlier study done by Melquist and Hornocker. In (Melquist and Hornocker 1983) reported the composite estimate of .43 otters/mi of waterway was more realistic due to regional variance in the Rocky Mountains of central Idaho where the study took place.

To generate a statewide population estimate, a digitized wetland inventory map of

Washington State[20] was used to measure the river otter's range within Washington[21]. The number of square miles of river otter habitat[22] was multiplied by the density estimate from the literature (0.43 river otters/mi of waterway (Melquist and Hornocker 1983)); identified area to generate a conservative statewide population estimate of 5,465 river otter.

Information on sustainable harvest rates for otters is unavailable though, Washington Natural Heritage Program through WDNR maintains a list of species status ranks for the majority of species in Washington, otters are ranked as apparently secure (Washington Department of Natural Resources 2017). WDFW determined that otter populations are stable in Washington State, though population monitoring data are limited (Anis Aoude, WDFW, personal communication, January 06, 2021).

3.4.12.3 River Otter Population Impact Analysis

In response to requests for assistance with river otter damage between FY 2015 and 2019, WS-Washington removed an average of 47.6 target river otters per year during the reporting period (Table 26), 52% were taken on private lands and 48% were taken were on public lands. WS-Washington has taken an average of 2.8 non-target river otters per year during the analysis period. The most river otter taken by WS-Washington in a single fiscal year was 64.

Table 25. Percentage of Take by the Resource Protected, FY 2015- FY 2019.

Human Health and Safety	General	31%
	Infrastructure	0%
	Aviation	1%
Agriculture	Crops	0%
	Livestock	0%
Property	Residential	2%
	Non-Residential	51%
Timber	Timber	1%
Natural Resources	Wildlife	12%
	Habitat	1%

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future river otter removals for MDM

[20]Digitized maps from U.S. Fish and Wildlife Service Wetland Inventory U.S. Fish and Wildlife Service. 2019. National Wetlands Inventory Data. November 1, 2019. https://fws.gov/wetlands/Data/State-Downloads.html were used in ESRI's ArcGIS ArcPro software.
[21]Digitized map of Washington State's Boundary from Washington State Geospatial Open Data Portal. 2015. WA State Boundary Mask. November 1, 2019. https://geo.wa.gov/datasets/wa-state-boundary-mask were used in ESRI's ArcGIS ArcPro software.
[22] Areas categorized as freshwater ponds, lakes, rivers, and freshwater forested/shrub wetlands were included. Areas categorized as estuarine, marine deep water, and emergent wetlands were excluded.

would be similar to take during the last five years. Therefore, under Alternative 1 (current activities with fluctuations), the projected WS-Washington annual maximum take was analyzed up to but would not exceed 100 river otter per year (Table 35).

Table 26. Population impact analysis of river otter take in Washington, FY 2015- FY 2019.

Mortality Source	2015	2016	2017	2018	2019	5-year average	5-year high
WS Target take	58	64	26	47	29	44.8	64
WS Non-Target take	1	1	6	5	1	2.8	6
WCO take	6	7	0	0	-	3.3	7
WDFW Conflict take	1	7	6	5	-	4.8	7
General Harvest	137	193	249	250	-	207.3	250
Special Permit	21	40	42	66	-	42.3	66
Other Mortality	-	-	-	-	-	-	0
Total WS take	59	65	32	52	30	47.6	65
Total non-WS take	158	233	291	316	0	199.6	316
Cumulative take	224	312	329	373	30	253.6	373
Statewide population estimate:			5,465				
Statewide population trend:			Stable				
Annual maximum sustainable harvest:			-				
Current total WS take as a % of the population:			1.19%				
Current cumulative take as % of population:			6.82%				
Projected WS annual maximum take:			100				
Projected total WS take as a % of the population:			1.83%				
Projected annual cumulative take as a % of the population:			7.61%				

3.4.12.4 Conclusion: River Otters

Given the presumed population stability for river otters in the state and the low cumulative impacts on the otter population from all causes, including take by WS-Washington, WS-Washington’s MDM has not adversely impacted the size or sustainability of the river otter population.

WS-Washington anticipates the current take level of approximately 45 river otter per year will continue. However, should there be an increase in requests for assistance with river otter damage, statewide annual take could reach 100 river otters per year without significant effects to the population Given the low proportion of cumulative take compared to the estimated population, direct and cumulative impacts from river otter take will not adversely affect the Washington river otter population.

3.4.13 What are the Direct and Cumulative Impacts on Mink Populations?

3.4.13.1 Mink Life History Information

The geographic range of the mink extends from Alaska through Canada to Florida excluding some areas of the dryer interior West. In Washington State mink inhabit areas west of the Cascade crest and to a lesser extent the mountainous areas of eastern Washington.

Mink can be found in a wide variety of habitats, but primarily in wooded areas with brushy or rocky areas ground cover and close proximity to water. Mink are active hunters capable of taking prey bigger than themselves, feeding primarily on rodents (mice, shrews, moles, and muskrats), but also amphibians, invertebrates, fish, and waterfowl.

Mink dig burrows in banks of waterbodies though use old dens of other animals near waterbodies as well. Breeding occurs once a year during the winter months and Females begin reproducing as early as 1 year old and have litters sizes averaging 4-5 after a gestation period averaging 51 days. Young of the year are weaned at 6 weeks and remain with the mother between 6 and 10 months when they disperse and establish their own territories.

Predators of minks are coyotes, bobcats, birds of prey, and humans due to their value as a furbearer.

3.4.13.2 Mink Population Information

Mink are under the management authority of the WDFW. WDFW does not conduct regular mink population surveys, but the population is considered stable, though monitoring data are limited (Anis Aoude, WDFW, personal communication, January 06, 2021).

Home ranges and habitat use around burrows are dependent on habitat quality, food availability, and sex with adult males typically occupying about 1.5 – 3.5 miles of shoreline and adult females occupying .3 – 1.9 miles of shoreline (Eagle and Whitman 1999). Densities likewise vary by habitat, weather, predator pressure, and season. Eagle and Whitman (1999) reviewed literature regarding mink densities and showed densities in North America measured from 0.57 mink/mi^2 to 21.91 mink/mi^2.

To generate a statewide population estimate, a digitized range map of the species[23]

[23]Digitized maps from the Digital Distribution Maps of the Mammals of the Western Hemisphere version 3.0Patterson, B. D., G. Ceballos, W. Sechrest, M. F. Tognelli, T. Brooks, L. Luna, P. Ortega, I. Salazar, and B. E. Young. 2007. Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0. *in* NatureServe, natureserve.org. were used in ESRI's ArcGIS ArcPro software.

was used to measure the mink range within Washington[24]. The number of square miles of mink habitat was multiplied by the lowest density estimate from the literature (0.57 mink/mi^2); identified area to generate a conservative statewide population estimate of 14,471 minks.

Natural Heritage Program through WDNR maintains a list of species status ranks for the majority of species in Washington, minks are listed as secure in Washington State (Washington Department of Natural Resources 2017).

3.4.13.3 Mink Population Impact Analysis and Conclusion

During the reporting period an average of .2 non-target minks were taken per year. Though it is possible for minks to cause damage it is unlikely that minks would be targeted for lethal removal by WS-Washington. Therefore, under Alternative 1, the projected WS-Washington annual maximum take was analyzed up to but would not exceed 10 minks per year. Given the low take by WS-Washington, and the reproductive capacity of minks to replace the low numbers of minks taken by WS-Washington each year, WS-Washington's take of minks is not adversely impacting the size or sustainability of Washington's mink population.

3.4.14 What are the Direct and Cumulative Impacts on Bobcat Populations?

3.4.14.1 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 Washington. 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, and dense cover for escape from predators or disturbances are factors influencing bobcat habitat selection (Kelly et al. 2016). Bobcats are resilient, and populations are doing well in the United States except in areas of dense human populations and extensive agriculture (Roberts and Crimmins 2010, Kelly et al. 2016).

Bobcats reach reproductive maturity at 9 to 12 months and have 1 to 6 kittens in early- to mid-summer (Crowe 1975, Koehler 1987). Gestation is 50-70 days. 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. Home ranges Washington are typically between 2.5 mi^2 to 6 mi^2. 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

[24]Digitized map of Washington State's Boundary from Washington State Geospatial Open Data Portal. 2015. WA State Boundary Mask. November 1, 2019. https://geo.wa.gov/datasets/wa-state-boundary-mask were used in ESRI's ArcGIS ArcPro software.

to 14 years, but annual mortality is as high as 53% in harvested populations (Rolley 1985). Bobcats are opportunistic and frequently prey on rabbits, rodents, beavers, and squirrels.

3.4.14.2 Bobcat Population Information

Bobcat are under the management authority of the WDFW. WDFW does not conduct regular bobcat population surveys, but the population is considered stable though population monitoring data are limited (Anis Aoude, WDFW, personal communication, January 06, 2021). A trapping license is required to take bobcats on public or private lands, during the regulated harvest season from November 1 through March 31. A hunting license is required to hunt bobcats between September 1 and March 15. WDFW requires trappers and hunters contact WDFW regional offices to seal all hides by April 20 after of the close of the hunting or trapping season. WDFW records method of harvest, sex of animals, age, and county in which the animal was trapped for population monitoring.

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. Bailey (1974) estimated bobcat densities in the same area to average about 0.14/mi^2. To generate a statewide population estimate, WS-Washington used a digitized range map of the species[25] to measure the bobcat's range within Washington[26]. The number of square miles of bobcat habitat was multiplied by the lowest density estimate from the literature (0.4 bobcats/mi^2); identified area to generate a conservative statewide population estimate of 26,778 bobcats.

WS-Washington expects its annual lethal removal of bobcats to remain similar to previous years. Washington Natural Heritage Program through WDNR maintains a list of species status ranks for the majority of species in Washington, bobcat are ranked as secure. WDFW has indicated that bobcat populations are stable, though population monitoring data are limited (Anis Aoude, WDFW, personal communication, January 06, 2021).

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

[25]Digitized maps from the Digital Distribution Maps of the Mammals of the Western Hemisphere version 3.0Patterson, B. D., G. Ceballos, W. Sechrest, M. F. Tognelli, T. Brooks, L. Luna, P. Ortega, I. Salazar, and B. E. Young. 2007. Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0. *in* NatureServe, natureserve.org. were used in ESRI's ArcGIS ArcPro software.
[26]Digitized map of Washington State's Boundary from Washington State Geospatial Open Data Portal. 2015. WA State Boundary Mask. November 1, 2019. https://geo.wa.gov/datasets/wa-state-boundary-mask were used in ESRI's ArcGIS ArcPro software.

estimated that bobcats can sustain a 20% annual harvest. An annual maximum sustainable harvest of 20% of the estimated bobcat population in Washington (26,778) equals 5,356 bobcats (Table 23).

3.4.14.3 Bobcat Population Impact Analysis

In response to requests for assistance with bobcat damage between FY 2015 and 2019, WS-Washington removed an average of 0.6 target bobcat per year during the reporting period (Table 27), all bobcat were taken on private lands. WS-Washington took bobcat for the protection of domestic fowl and did not lethally take any non-target bobcat during the analysis period. The most bobcat taken by WS-Washington in a single fiscal year was 3. Therefore, under Alternative 1 (current activities with fluctuations), the projected WS-Washington annual maximum take is analyzed up to, and would not exceed, 25 bobcats per year (Table 27).

Table 27. Population impact analysis of bobcat take in Washington, FY 2015- FY 2019.

Mortality Source	2015	2016	2017	2018	2019	5-year average	5-year high
WS Target take	0	0	0	3	0	0.6	3
WS Non-Target take	0	0	0	0	0	0.0	0
WCO take	0	0	0	1	-	0.3	1
WDFW Conflict take	0	0	0	0	-	0.0	0
General Harvest	383	609	502	746	-	560.0	746
Special Permit	0	0	0	5	-	1.3	5
Other Mortality	-	-	-	-	-	-	0
Total WS take	0	0	0	3	0	0.6	3
Total non-WS take	383	609	502	751	0	449.0	751
Cumulative take	383	609	502	755	0	449.8	755
Statewide population estimate:			26,778				
Statewide population trend:			Stable				
Annual maximum sustainable harvest:			20% (5,356)				
Current total WS take as a % of the population:			0.01%				
Current cumulative take as % of population:			2.82%				
Projected WS annual maximum take:			25				
Projected total WS take as a % of the population:			0.09%				
Projected annual cumulative take as a % of the population:			2.90%				

3.4.14.4 Conclusion: Bobcat

Given the presumed population stability for bobcat in the state, the lack of non-target take, and an annual maximum sustainable harvest level of 20%, cumulative impacts on the bobcat population from all causes, including take by WS-Washington, WS-Washington's MDM is not adversely impacting the population.

Based on existing cooperative service agreements and projected future requests for assistance, WS-Washington expects that future bobcat removals for MDM would be similar to take during the last five years. Should an increase in requests for assistance with bobcat result in the projected annual WS maximum take (25 bobcats), impacts on the statewide bobcat population would still be expected to remain low. WS-Washington concludes that the cumulative impact of all recorded bobcat mortality in Washington, including target and non-target take by WS-Washington, would not significantly impact the size or sustainability of the Washington bobcat population.

3.4.15 What are the Direct and Cumulative Impacts on Red Fox Populations?

3.4.15.1 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, Tullar Jr 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 eight to ten 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 phenomenon observed in coyotes and other canids.

WS-Washington does not work with the sub-species Cascade red fox (*Vulpes vulpes cascadensis*) which are on WDFW's list of Species of Greatest Conservation Need. The following analysis does not include this sub-species population and the areas in which this sub-species may exist alongside the introduced red fox were excluded from the species range portion of the analysis.

3.4.15.2 Red Fox Population Information

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 1.3/mi^2 throughout Washington.

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 60% annually.

To generate a statewide population estimate, a digitized range map of the species[27] was used to measure the red fox's range within Washington[28]. The number of square miles of red fox habitat, excluding the Cascade mountain range to avoid counting Cascade red fox habitat, was multiplied by the lowest density estimate from the literature (1.3 red fox/mi^2); identified area to generate a conservative statewide population estimate of 22,884 red fox.

Annual maximum sustainable harvest for red fox populations has been estimated at 60% (Pitt et al. 2001) or conservatively about 13,730 red fox in Washington (Table 29).

3.4.15.3 Red Fox Population Impact Analysis

In response to requests for assistance for red fox damage between FY 2015 and 2019, WS-Washington took an average of 0.6 target red foxes, for the protection of aviation safety. WS-Washington removed an average of 0.2 non-target red foxes per year during the analysis period.

Red foxes take would primarily be from private lands, as well as some municipal or county lands, in areas west of the Cascades and in eastern Washington.

Based on the number of cooperative service agreements and projected future

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[27]Digitized maps from the Digital Distribution Maps of the Mammals of the Western Hemisphere version 3.0Patterson, B. D., G. Ceballos, W. Sechrest, M. F. Tognelli, T. Brooks, L. Luna, P. Ortega, I. Salazar, and B. E. Young. 2007. Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0. *in* NatureServe, natureserve.org. were used in ESRI's ArcGIS ArcPro software.
[28]Digitized map of Washington State's Boundary from Washington State Geospatial Open Data Portal. 2015. WA State Boundary Mask. November 1, 2019. https://geo.wa.gov/datasets/wa-state-boundary-mask were used in ESRI's ArcGIS ArcPro software.

requests for assistance, WS-Washington expects a slight increase in future red fox removals for MDM for human health and safety at airfields. Therefore, under Alternative 1 (current activities with fluctuations), the projected WS-Washington annual maximum take was analyzed up to but would not exceed 100 red foxes per year (Table 29).

Table 28. Population impact Analysis of Red Fox Take in Washington, FY 2015- FY 2019.

Mortality Source	2015	2016	2017	2018	2019	5-year Average	5-year High
WS Target take	0	0	0	0	2	0.4	2
WS Non-Target take	0	1	0	0	0	0.2	1
WCO take	3	0	0	0	-	0.8	3
WDFW Conflict take	0	0	0	0	-	0.0	0
General Harvest	0	0	2	0	-	0.5	2
Special Permit	1	0	0	0	-	0.3	1
Other Mortality	0	0	0	0	-	0.0	0
Total WS take	0	1	0	0	2	0.6	2
Total non-WS take	1	0	2	0	0	0.6	2
Cumulative take	4	1	2	0	2	1.8	4
Statewide population estimate:		22,884					
Statewide population trend:		Stable					
Annual maximum sustainable harvest:		60% (13,730)					
Current total WS take as a % of the population:		0.01%					
Current cumulative take as % of population:		0.02%					
Projected WS annual maximum take:		100					
Projected total WS take as a % of the population:		0.44%					
Projected annual cumulative take as a % of the population:		0.45%					

3.4.15.4 Conclusion: Red Fox

Given the presumed population stability for red fox in the state, the low non-target take, and an annual maximum sustainable harvest level of 60%, cumulative impacts on the red fox population from all causes, including take by WS-Washington, WS-Washington's MDM is not adversely impacting the population.

Therefore, WS-Washington concludes that the cumulative impact of all recorded red fox mortality in Washington, including target and non-target take by WS-Washington, would not adversely impact the size or sustainability of the Washington red fox population.

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-Washington take, direct and cumulative impacts from take would not adversely impact the size or sustainability of the Washington red fox population.

3.4.16 What are the Direct and Cumulative Impacts on Raccoon Populations?

3.4.16.1 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. In developed areas raccoons frequently inhabit abandoned buildings, culverts, spaces under houses, and attics. In undeveloped areas raccoons inhabit a wider variety of den sites and in wooded areas will rest in trees. 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. Breeding typically begins as early as January and as late as June. After a 65-day gestation period females have one litter per year typically in late March through May (but may occur as late as September), with three to four young per litter. The young can forage for themselves starting at 8 weeks in the company of their mother. At 12 weeks kits can venture out on their own but return to their mother each day for the first year, after which they disperse to establish their own territories. Predators of raccoons include bobcats, coyotes, dogs, owls, hawks, and eagles. (WDFW living with raccoon life history 2005)

3.4.16.2 Raccoon Population Information

Washington Natural Heritage Program through WDNR maintains a list of species status ranks for the majority of species in Washington, the following is the state species ranks of the species that Washington works with; raccoon is ranked as secure (Washington Department of Natural Resources 2017). WDFW does not estimate raccoon population levels but has decided that raccoon population are presumed stable in Washington State, though monitoring data are limited (Anis Aoude, WDFW, personal communication, January 06, 2021).

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).

To generate a statewide population estimate, a digitized range map of the species[29] was used to measure the raccoon range within Washington[30]. The number of square miles of raccoon habitat was multiplied by the lowest density estimate from the literature (1 raccoon/mi^2); identified area to generate a conservative statewide population estimate of 66,945 raccoons.

Annual maximum sustainable harvest for raccoon populations would then be estimated at 49% (Sanderson 1987) or conservatively about 32,803 raccoon in Washington (Table 41).

3.4.16.3 Raccoon Population Impact Analysis

In response to requests for assistance with raccoon damage between FY 2015 and 2019, WS-Washington removed an average of 136 target raccoons per year during the reporting period (Table 36), 76% were taken on private lands and 24% were taken were on public lands. WS-Washington has taken an average of 0.4 non-target raccoons per year during the analysis period. The most raccoons taken by WS-Washington in a single fiscal year was 198.

Based on the number of cooperative service agreements and projected future requests for assistance, WS-Washington expects that future racoon removals would be similar to take during the last 5 years. However, WS-Washington must be able to respond to requests for assistance to meet the need for action. While WS-Washington expects for the need for MDM to stay close to the past, the analysis includes the take of more individuals to accommodate unforeseen needs. Therefore, under Alternative 1 (current activities with fluctuations) the projected WS-Washington annual maximum take would be increased to 500 raccoons.

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[29]Digitized maps from the Digital Distribution Maps of the Mammals of the Western Hemisphere version 3.0Patterson, B. D., G. Ceballos, W. Sechrest, M. F. Tognelli, T. Brooks, L. Luna, P. Ortega, I. Salazar, and B. E. Young. 2007. Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0. *in* NatureServe, natureserve.org. were used in ESRI's ArcGIS ArcPro software.
[30]Digitized map of Washington State's Boundary from Washington State Geospatial Open Data Portal. 2015. WA State Boundary Mask. November 1, 2019. https://geo.wa.gov/datasets/wa-state-boundary-mask were used in ESRI's ArcGIS ArcPro software.

Table 29. Population impact analysis of raccoon take in Washington, FY 2015- FY 2019.

Mortality Source	2015	2016	2017	2018	2019	5-year Average	5-year High
WS Target take	198	173	105	86	116	135.6	198
WS Non-Target take	0	0	0	0	2	0.4	2
WCO take	407	556	55	334	-	338.0	556
WDFW Conflict take	0	0	0	0	-	0.0	0
General Harvest[31]	269	66	77	124	-	134.0	269
Special Permit	56	5	30	13	-	26.0	56
Other Mortality	-	-	-	-	-	-	0
Total WS take	198	173	105	86	118	136.0	198
Total non-WS take	325	71	107	137	0	128.0	325
Cumulative take	930	800	267	557	118	534.4	930
Statewide population estimate:	66,945						
Statewide population trend:	Stable						
Annual maximum sustainable harvest:	49% (32,803)						
Current total WS take as a % of the population:	0.30%						
Current cumulative take as % of population:	1.39%						
Projected WS annual maximum take:	500						
Projected total WS take as a % of the population:	0.75%						
Projected annual cumulative take as a % of the population:	1.23%						

3.4.16.4 Conclusion: Raccoon

Given the presumed population stability for raccoon in the state, the low non-target take, and an annual maximum sustainable harvest level of 49%, cumulative impacts on the raccoon population from all causes, including take by WS-Washington, WS-Washington's MDM is not adversely impacting the raccoon population.

Therefore, WS-Washington concludes that the cumulative impact of all recorded raccoon mortality in Washington, including all take by WS-Washington, would not adversely impact the size or sustainability of the Washington raccoon population.

Should an increase in requests for assistance with raccoon damage result in the projected annual WS maximum take, cumulative impacts on the statewide raccoon 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-Washington take, direct and cumulative impacts from take

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[31] General harvest numbers represent only trapper take, as no harvest data is available from raccoon hunters.

would not adversely impact the size or sustainability of the Washington raccoon population.

Unclassified Species

Unclassified species vary greatly in life histories and population distributions. Species that are colonial typically have published density information within colonies but colony dispersal and metrics for estimating the number of colonies in the state are lacking. Solitary species, especially those that primarily live underground, have limited population density information. Population metrics are therefore difficult to calculate or estimate for unclassified wildlife species. Populations of these species are largely affected by habitat availability and land management actions. But in the following sections WS-Washington describes the process for all population estimates derived and any known take for the species.

Unclassified wildlife in Washington are species not classified as game or furbearing species and may be trapped or killed at any time of year if in possession of a hunting or trapping license. No special permits are required when using live traps. Special trapping permits are issued by WDFW (RCW 77.15.192, RCW 77.15.194, and WAC 220-417-040). Under WAC 220-440-060, landowners or commercial wildlife control operators can also remove unclassified wildlife on private land when they are causing damage to private property, crops, livestock, or presenting a public health risk without a license. Most by a landowner, trapper, or WCO must be reported to WDFW, however landowner removals for property damage do not need to be reported. It is unlawful to release any species anywhere within the state, other than on the property where it was legally trapped, without a permit to do so (RCW 77.15.250; WAC 220-450-010).

The limited reporting requirements and limited monitoring data make unclassified wildlife populations the least monitored by WDFW. Species in this section are not are not typically sought after by recreational hunters and trappers. Instead typically unclassified wildlife species are taken for during the resolution of human-wildlife conflicts.

Cumulative take of these species is considered low in most cases with a few notable exceptions (e.g. coyotes and mountain beaver). However, WDFW considers unclassified wildlife populations to be stable, though monitoring data are limited (Anis Aoude, WDFW, personal communication, January 06, 2021).

3.4.17 What are the Direct and Cumulative Impacts on Mountain Beaver Populations?

3.4.17.1 Mountain Beaver Life History Information

The mountain beaver's name is a primitive rodent that is not related to the North American beaver. Mountain beaver are in the suborder *Sciuromorpha* while the North American beaver is in the suborder *Castorimorpha*. According to Arjo 2007, mountain beaver prefers wet coastal lowlands over the mountains where they are found and throughout lower elevation areas of the Cascade and Olympic mountain ranges. They are solitary animals except during the during 5-7 week-long breeding season and after a 28-30 day gestation period when 2 to 3 pups are produced. They are typically associated with moist forested areas, with mostly fern ground cover. Mountain beavers' primitive kidney system is unable to concentrate urine restricting home ranges to moist environments and forage selection to high water content vegetation. During the late fall to early spring when herbaceous vegetation is unavailable timber regeneration is a primary source of high-water content forage. Mountain beaver live underground in borrow systems composed of 8-10 inch diameter tunnels with chambers for food caching and waste deposition centralized on a nest chamber. Primary predators of mountain beaver include coyotes and bobcats (Arjo 2007).

3.4.17.2 Mountain Beaver Population Information

Mountain beaver densities in Washington range from 0.49 to 4.38 per ha (Arjo et al. 2007). In California, at the southern extent of their range, the endangered Point Arena mountain beaver (*Aplodontia rufa nigra*) densities have ranged from 0.68 to 14.48 per ha (USDA Forest Service, 2013). At the northern extent of their range in Canada, mountain beaver densities ranged from 0.01 to 0.05 per ha (Environment Canada 2013).

Mountain beaver quickly recolonize areas by using existing tunnels, nest materials, and food caches (Arjo et al. 2009). Arjo et al (2007) observed that after mountain beaver were completely extirpated from two sites, the mountain beaver population recovered to 50% of the original density at one study site and 200% of the original density at another study site by the next year.

To generate a statewide population estimate, a digitized range map of the species[32] was used to measure the mountain beaver's range within Washington[33]. The number of square miles of mountain beaver habitat was multiplied by the lowest density estimate from the literature (0.01 mountain beaver/ha); identified area to generate a conservative statewide population estimate of 85,834 mountain beaver.

Annual maximum sustainable harvest for mountain beaver population is unknown but reoccupation rates have been documented to be substantial, e.g. 200% reoccupation in 1 calendar year (Arjo et al. 2007). Washington Natural Heritage Program through WDNR maintains a list of species status ranks for the majority of species in Washington, mountain beaver are ranked as secure (Washington

[32]Digitized maps from the Digital Distribution Maps of the Mammals of the Western Hemisphere version 3.0Patterson, B. D., G. Ceballos, W. Sechrest, M. F. Tognelli, T. Brooks, L. Luna, P. Ortega, I. Salazar, and B. E. Young. 2007. Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0. *in* NatureServe, natureserve.org. were used in ESRI's ArcGIS ArcPro software.
[33]Digitized map of Washington State's Boundary from Washington State Geospatial Open Data Portal. 2015. WA State Boundary Mask. November 1, 2019. https://geo.wa.gov/datasets/wa-state-boundary-mask were used in ESRI's ArcGIS ArcPro software.

Department of Natural Resources 2017).

3.4.17.3 Mountain Beaver Population Impact Analysis

In response to requests for assistance with mountain beaver damage between FY 2015 and FY2019, WS-Washington removed an average of 121.4 target mountain beaver per year during the reporting period (Table 31). 99% of mountain beaver were taken on private lands and 1% were taken on public lands. WS-Washington did not lethally take any non-target mountain beaver during the analysis period. The most mountain beaver taken by WS-Washington in a single FY was 187.

WS-Washington is proposing to take up to 1,000 mountain beaver per year. The proposed take represents an increase over the current average take by WS-Washington. While WS-Washington expects the current take level to continue, an increase in requests for assistance with mountain beaver damage may result in take levels approaching the projected annual WS-Washington maximum take, and cumulative impacts on the statewide mountain beaver population would still be expected to remain low, based on the analysis in this section.

Table 30. Percentage of Take by the Resource Protected, FY 2015- FY 2019.

Human Health and Safety	General	5%
	Infrastructure	
	Aviation	
Agriculture	Crops	1%
	Livestock	
Property	Residential	1%
	Non-Residential	15%
Timber	Timber	63%
Natural Resources	Wildlife	
	Habitat	15%

Table 31. Population impact analysis of mountain beaver take in Washington, FY 2015- FY 2019.

Mortality Source	2015	2016	2017	2018	2019	5-year average	5-year high
WS Target take	22	102	76	134	273	121.4	326
WS Non-Target take							
WCO take	114	94	73	61	-	85.5	114
WDFW Conflict take					-		
General Harvest					-	-	-
Special Permit	1268	1252	1912	1118	-	1,387.5	1,912
Other Mortality	-	-	-	-	-	-	
Total WS take	22	102	76	134	273	121.4	273
Total non-WS take	1,268	1,252	1,912	1,118		1,110.0	1,912
Cumulative take	1,404	1,448	2,061	1,313	273	1,299.8	2,061
Statewide population estimate:			85,834				
Statewide population trend:			Stable				
Annual maximum sustainable harvest:			-				
Current total WS take as a % of the population:			0.32%				
Current cumulative take as % of population:			2.40%				
Projected WS annual maximum take:			1000				
Projected total WS take as a % of the population:			1.17%				
Projected annual cumulative take as a % of the population:			3.39%				

3.4.17.4 Mountain Beaver Population Conclusion

Given the presumed population stability for mountain beaver in the state, the lack of non-target take, the high rates of fecundity, and high rates of emigration from surrounding areas to replace removed individuals cumulative impacts on the mountain beaver population from all causes, including all take by WS-Washington, WS-Washington's MDM is not adversely impacting the population.

Therefore, WS-Washington concludes cumulative impacts to mountain beaver populations, including those by WS-Washington, does not adversely impact the size or sustainability of the Washington mountain beaver population.

Should an increase in requests for assistance with mountain beaver result in the projected annual WS maximum take, cumulative impacts on the statewide mountain beaver 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-Washington take, direct and cumulative impacts from take would not adversely impact the size or sustainability of the Washington mountain beaver population.

3.4.18 What are the Direct and Cumulative Impacts on Coyote Populations?

3.4.18.1 Coyote Life History Information

Coyotes are found throughout the continental United States (Gese and Terletzky 2009), including throughout the entire State of Washington and its urban areas. 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. 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.

The coyote resembles a medium-sized dog, with adults weighing an average of 22 to 30 pounds. 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, Bromley and Gese 2001a). 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).

Coyotes annually produce one litter of four to eight pups in April and May (Knowlton et al. 1999). The young disperse at about six to nine 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 (pre-whelping) and the availability of livestock carcasses (Roy and Dorrance 1985). The pre-whelping density estimates is used for spring breeding populations, when the annual population cycle is lowest, after dispersal of young, and most or all natural and anthropogenic mortality has occurred.

3.4.18.2 Coyote Population Information

To understand the impacts of MDM and other take on the coyote population, it is useful to know the population size. However, determinations of coyote densities are frequently limited to educated guesses (Knowlton 1972). This is likely due in part to the fact that coyotes are highly mobile animals with home ranges (territories) that vary seasonally as well as with the sex, age, and breeding status of the animal (Todd and Keith 1976, Althoff 1978, Pyrah 1984). Coyote home ranges have been documented to vary from 2.0 mi^2 to 21.3 mi^2 (Andelt and Gipson 1979, Gese et al. 1988).

Some researchers have also observed a wide overlap among coyote home ranges; so much overlap in fact, that they did not consider coyotes to be territorial (Ozoga and Harger 1966, Edwards 1975, Danner 1976). Moreover, coyote pack size varies considerably. Each coyote territory may have several nonbreeding helpers at the den during whelping: thus each defended coyote territory may have more than just a pair of coyotes (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 4 animals. Gese et al. (1988) reported that 40% of coyotes were found in groups of two, whereas 53% were found in groups of 3 to 5 animals. Food density can also affect coyote density and home range. For example, a positive relationship was established between coyote densities mid-late winter (pre-whelping) and the availability of dead livestock (Roy and Dorrance 1985).

Variations in food concentrations, pack size, and home range can influence coyote densities, and complicate efforts estimate abundance (Danner and Smith 1980). As such statewide coyote estimates for Washington are not available from WDFW or other researchers. However, a conservative estimate can be made using information on coyote biology and population dynamics in the western United States.

Many authors have estimated coyote populations throughout the West and elsewhere, and coyote density has been shown to vary depending on the time of year, food abundance, and habitat (Clark 1972, Knowlton 1972, Camenzind 1978, U.S. Fish and Wildlife Service 1978, Pyrah 1984, Andelt 1985, Knowlton et al. 1985, Gese et al. 1989, Hein and Andelt 1995a, McClure et al. 1996, Voigt and Berg 1999, Fedriani et al. 2001). Coyote densities have been reported from 0.4/mi^2 to 11.9/mi^2 (Knowlton 1972, Pyrah 1984, McClure et al. 1996, Fedriani et al. 2001). The lowest reported densities (0.4/mi^2) is a pre-whelping density estimate. Those same coyote populations numbered 2.5-times higher (1.0/mi^2) in the summer, post-whelping (Pyrah 1984). Similar numbers were reported in Kansas by Gier (1968), where pre-whelping and post-whelping densities were estimated at 0.7/mi^2 and 2.0/mi^2, respectively. This represents a 2.9-fold increase.

Coyotes are ecological generalists, which frequently benefit from human from human impact due to their ability to adapt to anthropogenic sources of food and shelter (Moore 1992, Santana and Armstrong 2017). Recent coyote density estimates have shown dramatic differences due to the availability of anthropogenic food sources, including livestock and fruit (McClure et al. 1996, Fedriani et al. 2001). This may explain some of the wide variation in reported coyote densities in the western United States. For example, Fedriani et al. (2001) studied three sites: one with low human impact, one with high human impact, and one with intermediate human impact. They found the lowest coyote densities in the low-human-impact site (0.8 – 1.0/mi^2), and highest densities at the high-human-impact site (6.2-7.8/mi^2). The intermediate-human impact site had intermediate coyote density (4.1-5.2/mi^2). The high-human-impact site had some of the highest densities reported for coyotes, exceeded only by a study in suburban Arizona where human impacts were also high (McClure et al. 1996).

A few studies have estimated coyote density in Washington, but none have attempted to assess the statewide population. These studies have focused on small areas, where the researchers could determine the population with some degree of certainty. At a location with low human impact, Gese et al. (1989) estimated the coyote density at 0.75/mi^2 (range 0.36-1.2/mi^2). In a more human influenced location, Hein and Andelt (1995a) estimated the coyote density at 1.84/mi^2.

In southeastern Oregon, one study utilized 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). These densities are likely similar to that of eastern Washington.

To generate a statewide population estimate, a digitized range map of the species[34] was used to measure the coyote's range within Washington[35]. Federally-owned lands comprise 28.6% of the State of Washington (Section 1.9) and the State owns 8.6% of the lands in Washington (Washington State Department of Recreation and

[34]Digitized maps from the Digital Distribution Maps of the Mammals of the Western Hemisphere version 3.0Patterson, B. D., G. Ceballos, W. Sechrest, M. F. Tognelli, T. Brooks, L. Luna, P. Ortega, I. Salazar, and B. E. Young. 2007. Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0. *in* NatureServe, natureserve.org. were used in ESRI's ArcGIS ArcPro software.
[35]Digitized map of Washington State's Boundary from Washington State Geospatial Open Data Portal. 2015. WA State Boundary Mask. November 1, 2019. https://geo.wa.gov/datasets/wa-state-boundary-mask were used in ESRI's ArcGIS ArcPro software.

Conservation Office). These lands can be considered to have low human impact. The assumption is very conservative, because a significant portion of these lands are leased for livestock grazing, and most State lands are small acreages checker-boarded throughout Eastern Washington, both of which result in human influence. Farmland comprises 32.14% of Washington State (National Agricultural Statistics Service 2019). These lands can be considered to have intermediate or high human impact as described by Fedriani et al. (2001) (and others cited therein). 2.5% of Washington State are contained within city limits representing areas of highest human impact. There are no density estimates for coyotes in Washington State and the authors, Dunbar and Giordano, noted the pre-whelping densities (1.04-1.37 coyote/mi^2) from their 2003 study were likely underestimates for the wildlife refuge, a low human impact area as referenced by Fedriani et al. (2001), so for this analysis the density of 1.37 coyotes/mi^2 in the Dunbar and Giordano (2003) study was used. This account for the high level of human impact in Washington and considering the published range from .4/mi^2 to 11.9/mi^2, we believe that a density of 1.37 coyotes/mi^2 is a conservative estimate for Washington. The density estimate of 1.37 coyote/mi^2 was applied to the area of the species' range in Washington State to generate a conservative statewide population estimate of 91,715 coyotes. Annual maximum sustainable harvest for coyote populations has been estimated at 60% (Pitt et al. 2001) or conservatively about 55,029 coyotes in Washington (Table 33).

3.4.18.3 Coyote Population Impact Analysis

Coyotes were the second most frequent species for which (15.83%) WS-Washington's received requests for assistance during the reporting period (FY2015-FY2019). In response to requests for assistance with coyote damage between FY2015 and FY2019, WS-Washington removed an average of 512.6 target coyotes per year during the reporting period (Table 33), 75% were taken on private lands and 25% were taken were on public lands. WS-Washington has not lethally taken any non-target coyote during the analysis period. The most coyotes taken by WS-Washington in a single fiscal year was 593.

Table 32. Percentage of Take by the Resource Protected, FY2015- FY2019.

Human Health and Safety	General	23%
	Infrastructure	1%
	Aviation	41%
Agriculture	Crops	1%
	Livestock	24%
Property	Residential	0%
	Non-Residential	4%
Timber	Timber	1%
Natural Resources	Wildlife	5%
	Habitat	0%

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 MDM activities.

Coyote populations with strong social structure can be resilient in the face of moderate levels of exploitation (Ray et al. 2005b, Ripple et al. 2013). A population model developed by Pitt et al. (2001) assessed the impact of removing a set proportion of the coyote population in one year and then allowing the population to recover (referred to as "pulse removal"). In the model, all populations recovered within 1 year when <60% of the population was removed. The authors stated that actual coyote populations would recover even more quickly than the model indicated, because the model made several conservative assumptions: (1) coyote territories were retained even at low densities, (2) animals would not move out of their territories to mate, (3) no animals moved in from surrounding areas (no immigration), and (4) natural mortality rates were not reduced at low population densities. Assumptions like these are generally necessary in order to simplify population models, but in this case, each assumption removes a biological function which would serve to help the population recover more quickly.

Pitt et al. (2001) also evaluated the impact of removing a set proportion of the population every year for 50 years ("sustained removal"). When the removal rate was <60% of the population, the population size was the same as for an unexploited population. 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.

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future coyote removals for MDM would be similar to take during the last five years. Therefore, under Alternative 1 (current activities with fluctuations), future coyote removals for WS-Washington's MDM was analyzed up to but would not exceed 2,000 coyotes per year (Table 33).

Table 33. Population Impact Analysis of Coyote Take in Washington, FY 2015- FY 2019.

Mortality Source	2015	2016	2017	2018	2019	5-year average	5-year high
WS Target take	572	593	257	376	765	512.6	765
WS Non-Target take	0	0	0	0		0.0	0
WCO take	0	0	0	0	-	0.0	0
WDFW Conflict take	11	34	13	10	-	17.0	34
General Harvest	21,944	32,216	31,990	26468	-	28,154.5	32,216
Special Permit	0	0	0	0	-	0.0	0
Other Mortality	0	0	0	0	-	0.0	0
Total WS take	572	593	257	376	765	512.6	765
Total non-WS take	21,944	32,216	31,990	26,468	0	22,523.6	32,216
Cumulative take	22,527	32,843	32,260	26,854	765	23,049.8	32,843
Statewide population estimate:	91,715						
Statewide population trend:	Stable						
Annual maximum sustainable harvest:	60% (55,029)						
Current total WS take as a % of the population:	0.83%						
Current cumulative take as % of population:	35.81%						
Projected WS annual maximum take:	2,000						
Projected total WS take as a % of the population:	2.18%						
Projected annual cumulative take as a % of the population:	37.31%						

3.4.18.4 Conclusion: Coyote

Given the presumed population stability for coyotes in the state, the low non-target take, and an annual maximum sustainable harvest level of 60%, cumulative impacts on the coyote population from all causes, including take by WS-Washington, WS-Washington's MDM is not adversely impacting the size or sustainability of the coyote population.

Therefore, WS-Washington concludes that the cumulative impact of all recorded coyote mortality in Washington, including all take by WS-Washington, is not adversely impacting the size or sustainability of the Washington coyote population.

Should the increase in requests for assistance with coyote damage outpace WS-Washington projections annual WS maximum take and the cumulative impacts on the statewide coyote 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-Washington take, direct and cumulative impacts from take would not adversely affect the Washington coyote population.

3.4.19 What are the Direct and Cumulative Impacts on Yellow-Bellied Marmots Populations?

3.4.19.1 Yellow-Bellied Marmots Life History

Yellow-bellied marmots are found east of the Cascades in open rocky areas with limited or no tree cover or in low growing vegetated slopes. Being fossorial, yellow-bellied marmots primarily live in burrows that extend 3.8-4.4 meters horizontally into the hillside, coming to the surface to defend territory, sun, and collect food. Colonies are typically composed of adult males primarily recruited from outside the colony and females with their offspring. Breeding season is 2 weeks long and occurs once a year after winter hibernation. After a 30-day gestation period produced litters range in size from 3 to 8 pups. Weened at 7 weeks pups live within the colony until 1 year old when most disperse to establish new colonies or be recruited into an existing neighboring colony. Home ranges of males is defined by home ranges of females and number of females being defended though typically span from .02 to 4 acres (Salsbury and Armitage 1994). Reproductive maturity occurs at 2 years of age with most marmots living for 13-15 years (Armitage 2003). Important predators of yellow-bellied marmots include coyotes, foxes, wolves, hawks, eagles, bobcats, cougars, badgers, and black bears.

3.4.19.2 Yellow-Bellied Marmots Population Information and Analysis

Yellow-bellied marmot habitat patches are classified as colonial consisting of; 1 or more males, resident females, yearling animals, and young or satellite sites consisting of; one female, young, and potentially a male (Armitage 1991). Yellow-bellied marmot populations are difficult to estimate because of; complex dispersal dynamics between colonies and their proximate satellite sites, inconsistent densities between colonies with similar habitat characteristics, inconsistent rates of reproduction from year to year and colony to colony, and habitat sizes can range from .01 ha to 70 ha or more (Armitage 1991;2003). In a long-term study of a single colony in East River Valley, Colorado, populations can change drastically over time with reported populations ranging from 34 to 137 individuals with no discernible temporal trend (Oli and Armitage 2004).

To generate a statewide population estimate, a digitized range map of the species[36] was used to measure the yellow-bellied marmots' range within Washington[37]. The number of square miles of yellow-bellied marmot

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[36]Digitized maps from the Digital Distribution Maps of the Mammals of the Western Hemisphere version 3.0Patterson, B. D., G. Ceballos, W. Sechrest, M. F. Tognelli, T. Brooks, L. Luna, P. Ortega, I. Salazar, and B. E. Young. 2007. Digital Distribution Maps of the Mammals of the Western Hemisphere, version 3.0. *in* NatureServe, natureserve.org. were used in ESRI's ArcGIS ArcPro software.
[37]Digitized map of Washington State's Boundary from Washington State Geospatial Open Data Portal. 2015. WA State Boundary Mask. November 1, 2019. https://geo.wa.gov/datasets/wa-state-boundary-mask were used in ESRI's ArcGIS ArcPro software.

habitat[38] was multiplied by the lowest density estimate from the literature (3.7 yellow-bellied marmots/mi^2)[39] to generate a conservative statewide population estimate of 107,556 yellow-bellied marmots.

Washington Natural Heritage Program through WDNR maintains a list of species status ranks for the majority of species in Washington, yellow-bellied marmots are ranked as apparently secure (Washington Department of Natural Resources 2017). Although there is no estimated maximum sustainable harvest for yellow-bellied marmots the stable population status and species' high rate of productivity and dispersal quickly fills unoccupied habitat.

3.4.19.3 Yellow-Bellied Marmots Population Impact Analysis

In response to requests for assistance with yellow-bellied marmot damage between FY 2015 and 2019, WS-Washington removed an average of 415.2 yellow-bellied marmots per year during the reporting period (Table 35), 51% were taken on private lands and 49% were taken were on public lands. WS-Washington has not lethally taken any non-target yellow-bellied marmot during the analysis period. The most yellow-bellied marmots taken by WS-Washington in a single fiscal year was 691.

Table 34. Percentage of Take by the Resource Protected, FY 2015- FY 2019.

Human Health and Safety	General	15%
	Infrastructure	30%
	Aviation	7%
Agriculture	Crops	3%
	Livestock	0%
Property	Residential	0%
	Non-Residential	41%
Timber	Timber	3%
Natural Resources	Wildlife	0%
	Habitat	0%

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future yellow-bellied marmot removals for MDM would be similar to take during the last five years. Therefore, under

[38]Species' range excluded all planted cropland Washington State Department of Agriculture. 2019. WSDA Agricultural Land Use Data November 1, 2019. https://agr.wa.gov/departments/land-and-water/natural-resources/agricultural-land-use. Cropland was excluded because it is unlikely that landowners would allow marmot colonies to persist in crop lands.

[39] The Lowest density estimate was derived from using the largest colony area of 70 ha Armitage, K. B. 1991. Social and Population Dynamics of Yellow-Bellied Marmots: Results from Long-Term Research. Annual Review of Ecology and Systematics. 22: 379-407, Armitage, K. B. 2003. Marmots (*Marmota monax* and allies). 188-210 *in* G. A. Fledhammer, B. C. Thompson, andJ. A. Chapman. Wild Mammals of North America: Biology, Management, and Conservation. The John Hopkins University Press, Baltimore, Maryland, USA. as the area per individual because the density of colonies in Washington State is unknown.

Alternative 1 (current activities with fluctuations), the projected WS-Washington annual maximum take was analyzed up to but would not exceed 1000 yellow-bellied marmots per year (Table 35).

Table 35. Population Impact Analysis of Yellow-bellied Marmot Take in Washington, FY 2015- FY 2019.

Mortality Source	2015	2016	2017	2018	2019	5-year average	5-year high
WS Target take	227	334	395	429	691	415.2	691
WS Non-Target take	0	0	0	0	0	0.0	0
WCO take	0	0	0	0	-	0.0	0
WDFW Conflict take	0	0	0	0	-	0.0	0
General Harvest	0	0	0	0	-	0.0	0
Special Permit	0	60	174	257	-	122.8	257
Other Mortality	0	0	0	0	-	0.0	0
Total WS take	227	334	395	429	691	415.2	691
Total non-WS take	0	60	174	257	0	98.2	257
Cumulative take	227	394	569	686	691	513.4	691
Statewide population estimate:			107,556				
Statewide population trend:			Stable				
Annual maximum sustainable harvest:			-				
Current total WS take as a % of the population:			0.64%				
Current cumulative take as % of population:			0.64%				
Projected WS annual maximum take:			1,000				
Projected total WS take as a % of the population:			0.93%				
Projected annual cumulative take as a % of the population:			1.17%				

3.4.19.4 Conclusion: Yellow-bellied Marmots

Given the presumed population stability for yellow-bellied marmots in the state, cumulative impacts on the yellow-bellied marmot population from all causes, including take by WS-Washington, WS-Washington's MDM has not adversely impacted the size or sustainability of the yellow-bellied marmot population. The anticipated take of around 500 marmots per year will not have a significant effect on the population.

Should there be an increase in requests for assistance with yellow-bellied marmot damage, WS-Washington analyzed an annual maximum take of up to 1,000 muskrats per year. The take, along with the cumulative mortality (Table 27) would still be expected to be less than 2% of the estimated state-wide population and would not have an impact on the yellow-bellied marmot population.

3.4.20 What are the Direct and Cumulative Impacts on Northern Pocket Gopher Populations?

3.4.20.1 Northern Pocket Life History

Northern pocket gophers are the eastern counterpart to the Mazama pocket gopher in Washington State. Unlike the ESA listed Mazama pocket gopher, the Northern pocket gopher is widespread, ranging throughout a majority of the western United States. Pocket gophers are fossorial living nearly exclusively underground and forage above and below ground vegetation. Burrows are complex systems composed of nest chamber, surface runways, surface access tunnels, and soil casts (snow tunnels backfilled with soil). Outside of breeding season occurring from early spring to summer, pocket gophers are solitary or occur with their respective family groups. Nests are lined with dried surface vegetation and are where the year's litter of three to seven young are raised. After 5 to 6 weeks young disperse to establish new territories, and which can reach densities of up to 2 to greater than 20 gophers per acre. Pocket gophers live 1 or 2 years and are primarily preyed upon by coyotes, dogs, cats, foxes, bobcats, badgers, weasels, skunks, rattlesnakes, gopher snakes, owls, and hawks (Washington Department of Fish and Wildlife 2019d).

Brush prairie pocket gopher (*Thomomys talpoides douglasii*) is on WDFW's list of Species of Greatest Conservation Need, and white salmon pocket gopher (*Thomomys talpoides limosus*) is considered vulnerable on the Washington Natural Heritage Program through WDNR's list of species ranks. WS-Washington does not conduct MDM for these species.

3.4.20.2 Northern Pocket Gopher Population Information and Analysis

Washington Natural Heritage Program through WDNR maintains a list of species status ranks for the majority of species in Washington, Northern pocket gophers (excluding the earlier mentioned subspecies) are ranked as secure (Washington Department of Natural Resources 2017).

Densities range from 0.4 Northern pocket gophers/ha to 91.6 Northern pocket gophers/ha (Smallwood and Morrison 1999). Although there is no estimated maximum sustainable harvest for Northern pocket gophers the stable population status and species' high rate of productivity and dispersal quickly fills unoccupied habitat. However, Smallwood and Morrison (1999) compared pocket gopher density estimates across 32 published studies and came to the conclusion that the spatially dependent nature of pocket gopher densities precludes comparison among species, populations, or localities without defining the estimate to a spatial scale. This further inhibits assessing a Northern pocket gopher population for Washington State as there are no current studies assessing this species' populations at the statewide scale.

3.4.20.3 Northern Pocket Gopher Population Impact Analysis

Of all the requests for assistance with northern pocket gopher damage, 67% were for damage to non-residential property and 33% were for protection of human health and safety. Between FY 2015 and FY2019, WS-Washington removed an average of 499.4 target northern pocket gophers per year during the reporting period (Table 36), 31% were taken on private lands and 69% were taken were on public lands. WS-Washington has not lethally taken any non-target northern pocket gophers during the analysis period. The most northern pocket gopher taken by WS-Washington in a single fiscal year was 880.

Based on cooperative service agreements, county, and projected future requests for assistance, WS-Washington expects that future Northern pocket gopher removals for MDM would be similar to take during the last five years. Therefore, under Alternative 1 (current activities with fluctuations), the projected WS annual take was analyzed up to but would not exceed 2,000 northern pocket gophers (Table 36).

Table 36. Population impact analysis of Northern pocket gopher take in Washington, FY 2015- FY 2019.

Mortality Source	2015	2016	2017	2018	2019	5-year average	5-year high
WS Target take	301	489	570	454	683	499.4	683
WS Non-Target take	0	0	0	0		0.0	0
WCO take	0	0	0	0	0	0.0	0
WDFW Conflict take	0	0	0	0	0	0.0	0
General Harvest	-	-	-	-	-	-	0
Special Permit	0	0	0	0	0	0.0	0
Other Mortality	-	-	-	-	-	-	0
Total WS take	301	489	570	454	683	499.4	683
Total non-WS take	0	0	0	0	0	0.0	0
Cumulative take	301	489	570	454	683	499.4	683
Statewide population estimate:		No Statewide Estimate					
Statewide population trend:		Stable					

3.4.20.4 Conclusion: Northern Pocket Gophers

Given the presumed population stability for Northern pocket gophers in the state, cumulative impacts on the Northern Pocket Gophers population from all causes, including take by WS-Washington, WS-Washington's MDM is not adversely impacting the size or sustainability of the Northern pocket gophers.

Should the increase in requests for assistance with northern pocket gophers damage outpace WS-Washington projections annual WS maximum take and the cumulative impacts on the statewide northern pocket gopher 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-Washington take, direct and cumulative impacts from take would not adversely affect the Washington northern pocket gopher population.

3.4.21 What are the Direct and Cumulative Impacts on California Ground Squirrel Populations?

3.4.21.1 California Ground Squirrel Life History

Capable of adapting to urban, suburban and agricultural areas, California ground squirrels have spread from central California through Oregon and into Washington. California ground squirrels were once excluded from Washington State by the Columbia River but have crossed over from Oregon and now occupy habitat throughout central Washington. Habitat occupied by these ground squirrels are open habitats consisting of plains, pastures, meadows, and low-density woodlands. They are semi-fossorial meaning that they spend equivalent parts of their life cycle above and below ground. As omnivores they eat seeds, nuts, fruits, bulbs, fungi, grasses, forbs, insects, bird eggs, and carrion. California ground squirrels cache food for inactive periods. Burrow systems may be elaborate consisting of 6 to 20 entrances and be up to 42 meters long. Home ranges are approximately a half acre in size for males and slightly larger for females with extensive areas of overlap. Males defend territories encompassing as many females as can be defended. Breeding begins as early as January and as late as July though most litters are produced May through June after a 30-day gestation period. Litter size ranges from 5 to 11 and young are weened between 6 and 8 weeks. Sexually mature at 1 year old they may live up to 6 years. Predators of California ground squirrels include hawks, eagles, coyotes, foxes, badgers, weasels, cats, dogs, bobcats, mountain lion, and snakes.

3.4.21.2 California Ground Squirrel Population Information and Analysis

Washington Natural Heritage Program through WDNR maintains a list of species status ranks for the majority of species in Washington, the following is the state species ranks of the species that Washington works with; California ground squirrels is ranked as apparently secure (Washington Department of Natural Resources 2017).

Densities as wide ranging as 11.1 California ground squirrels/ha (Loredo-Prendeville et al. 1994) to 92.5 California ground squirrels/ha (Boellstorff and Owings 1995). Although there is no estimated maximum sustainable harvest for California ground squirrels the stable population status and species' high rate of productivity and dispersal quickly fills unoccupied habitat. California ground squirrels may live singly or colonially making density estimates highly variable and difficult to compare across their range. This further inhibits assessing a California ground squirrel population for Washington State as there are no current studies assessing this species' populations at the statewide scale.

3.4.21.3 California Ground Squirrel Population Impact Analysis

In response to requests for assistance with California ground squirrel damage between FY 2015 and FY2019, WS-Washington removed an average of 73.8 target California ground squirrels per year during the reporting period (Table 45), all were taken were on public lands. WS-Washington has not taken any non-target California ground squirrels during the analysis period. The most California ground squirrels taken by WS-Washington in a single fiscal year was 293.

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future eastern cottontail removals for MDM would be similar to take during the last five years. Therefore, under Alternative 1 (current activities with fluctuations), the projected WS-Washington annual maximum take was analyzed up to but would not exceed 500 California ground squirrels per year (Table 45).

Table 37 Percentage of Take by the Resource Protected, FY 2015- FY 2019.

Human Health and Safety	General	11%
	Infrastructure	0%
	Aviation	0%
Agriculture	Crops	0%
	Livestock	0%
Property	Residential	0%
	Non-Residential	89%
Timber	Timber	0%
Natural Resources	Wildlife	0%
	Habitat	0%

Table 38. Population impact analysis of California ground squirrel take in Washington, FY 2015- FY 2019.

Mortality Source	2015	2016	2017	2018	2019	5-year Average	5-year High
WS Target take	0	0	165	138	66	73.8	165
WS Non-Target take	0	0	0	0		0.0	0
WCO take	0	0	0	0	0	0.0	0
WDFW Conflict take	0	0	0	0	0	0.0	0
General Harvest	-	-	-	-	-	-	-
Special Permit	0	0	0	0	0	0.0	0
Other Mortality	-	-	-	-	-	-	-
Total WS take	0	0	165	138	66	73.8	165
Total non-WS take	0	0	0	0	0	0.0	0
Cumulative take	0	0	165	138	66	73.8	165
Statewide population trend:			Stable				
Projected WS annual maximum take:			500				

3.4.21.4 Conclusion: California Ground Squirrel

Given the presumed population stability for California ground squirrels in the state, cumulative impacts on the population from all causes, including take by WS-Washington, is not adversely impacting the size or sustainability of the California ground squirrel population.

Should the increase in requests for assistance with California ground squirrel damage outpace WS-Washington projections annual WS maximum take and the cumulative impacts on the statewide California ground squirrel 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-Washington take, direct and cumulative impacts from take would not adversely affect the Washington California ground squirrel population.

3.4.22 What are the Direct and Cumulative Impacts on Columbian Ground Squirrel Populations?

3.4.22.1 Columbian Ground Squirrel Life History

Columbian ground squirrels range from the Rocky Mountains west of Montana, from British Columbia to Oregon. Within Washington State this species is typically found in the mountainous areas in eastern Washington. Habitat occupied by these ground squirrels are open habitats typically alpine or subalpine meadows but has adapted to exploit open grassy areas common around human development. This colonial species' population size is typically limited by forage availability and the short growing season but with human subsidized food resources can expand quickly. They are semi-fossorial meaning that they spend equivalent parts of their life cycle above and below ground. As vegetarians they eat flowers, seeds, fruits, and bulbs. Columbian ground squirrels cache food for inactive periods. In alpine and sub-alpine areas were snow limits activity this species can hibernate for as long as 70% of the year. Breeding season begins immediately after emergence and with litter size ranges from 2 to 4 and young of the year typically hibernate near the mother dispersing after the first winter. Sexually mature at 2 year old, females have strong site fidelity and once established as a resident typically persist for greater than 3 years. Overlap of territories changes with seasons and tolerance for territory overlap is determined by habitat quality. Predators of Columbian ground squirrels include hawks, eagles, coyotes, foxes, badgers, weasels, cats, dogs, bobcats, bears, mountain lion, and snakes. (Elliott and Flinders 1991)

3.4.22.2 Columbian Ground Squirrel Population Information and Analysis

Density estimates vary widely from 4.6/ha to 61.7/ha, the highest estimates typically associated with exploitation of agricultural resources. Washington Natural Heritage Program through WDNR maintains a list of species status ranks for the majority of species in Washington, the following is the state species ranks of the species that Washington works with; California ground squirrels is ranked as secure (Washington Department of Natural Resources 2017).

Although there is no estimated maximum sustainable harvest for Columbian ground squirrels the stable population status and species' high rate of productivity and dispersal quickly fills unoccupied habitat. Columbian ground squirrels may live singly or colonially making density estimates highly variable and difficult to compare across their range. This further inhibits assessing a Columbian ground squirrel population for Washington State as there are no current studies assessing this species' populations at the statewide scale.

3.4.22.3 Columbian Ground Squirrel Population Impact Analysis

In response to requests for assistance with eastern Columbian ground squirrel damage between FY2015 and FY2019, WS-Washington removed an average of 361.8 target Columbian ground squirrels per year during the reporting period (Table 39), 1% were taken on private lands and 99% were taken were on public lands. WS-Washington has not taken any non-target Columbian ground squirrels during the analysis period. The most Columbian ground squirrels taken by WS-Washington in a single fiscal year was 719.

The large difference between density estimates of 4.6/ha to 61.7/ha maybe partially explained by Columbian ground squirrels' ability to capitalize on human subsidized resources such as wheat fields.

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future eastern cottontail removals for MDM would be similar to take during the last five years. Therefore, under Alternative 1 (current activities with fluctuations), the projected WS-Washington annual maximum take was analyzed up to but would not exceed 2,000 Columbian ground squirrels per year (Table 39).

Table 39. Population impact analysis of Columbian ground squirrel take in Washington, FY2015- FY2019.

Mortality Source	2015	2016	2017	2018	2019	5-year Average	5-year High
WS Target take	4	719	243	288	555	361.8	719
WS Non-Target take	0	0	0	0	0	0.0	0
WCO take	0	0	0	0	0	0.0	0
WDFW Conflict take	0	0	0	0	0	0.0	0
General Harvest	0	0	0	0	0	0.0	0
Special Permit	0	0	0	0	0	0.0	0
Other Mortality	-	-	-	-	-	-	-
Total WS take	4	719	243	288	555	361.8	719
Total non-WS take	0	0	0	0	0	0.0	0
Cumulative take	4	719	243	288	555	361.8	719
Statewide population estimate:			Unavailable				
Statewide population trend:			Stable				
Projected WS annual maximum take:			2,000				

3.4.22.4 Conclusion: Columbian Ground Squirrel

Given the presumed population stability for Columbian ground squirrels in the state, their high reproductive capacity, high levels of dispersion when habitat is available, cumulative impacts on their population from all causes, including take by WS-Washington, MDM is not adversely impacting the size or sustainability of the Columbian ground squirrel.

Should the increase in requests for assistance with Columbian ground squirrel damage outpace WS-Washington projections annual WS maximum take and the cumulative impacts on the statewide Columbian ground squirrel 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-Washington take, direct and cumulative impacts from take would not adversely affect the Washington Columbian ground squirrel damage population.

3.4.23 What are the Direct and Cumulative Impacts on Striped Skunk Populations?

3.4.23.1 Striped Skunk Life History Information

The striped skunk is the most common member of the Mephitidae, 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.

Striped skunks often are nocturnal with a generalist diet that includes insects, earthworms, beehives, birds, eggs, small mammals, and carrion (Wade-Smith and Verts 1982, Vickery et al. 1992). 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, Rosatte 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.

3.4.23.2 Striped Skunk Population Information

Washington Natural Heritage Program through WDNR maintains a list of species status ranks for the majority of species in Washington, the following is the state species ranks of the species that Washington works with; striped skunk is ranked as secure (Washington Department of Natural Resources 2017).

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 6.2/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 Washington are not available because, although managed by WDFW, their population is not sampled. For purposes of this analysis, we will conservatively estimate skunk densities at 0.26/mi^2 throughout Washington, for an estimated population of about 17,406 striped skunks. The annual maximum sustainable harvest for striped skunk is estimated at 60% of the population (Boddicker 1980) (Table 40) or about 10,443 skunks in Washington.

3.4.23.3 Striped Skunk Population Impact Analysis

In response to requests for assistance with striped skunks damage between FY 2015 and 2019, WS-Washington removed an average of 13.4 target striped skunks per year during the reporting period (Table 40), 13% were taken on private lands and 87% were taken were on public lands. WS-Washington has not taken any non-target striped skunks during the analysis period. The most striped skunks taken by WS-Washington in a single fiscal year was 49.

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future striped skunk removals for MDM would be similar to take during the last five years. Therefore, under Alternative 1 (current activities with fluctuations), the projected WS-Washington annual maximum take was analyzed up to but would not exceed 100 striped skunks per year (Table 40).

Table 40. Population impact analysis of striped skunk take in Washington, FY 2015- FY 2019.

Mortality Source	2015	2016	2017	2018	2019	5-year Average	5-year High
WS Target take	8	4	49	1	5	13.4	49
WS Non-Target take	0	0	0	0		0.0	0
WCO take	48	150	288	208	-	173.5	288
WDFW Conflict take	0	0	0	0	-	0.0	0
General Harvest	94	109	137	181	-	130.3	181
Special Permit	0	2	1	10	-	3.3	10
Other Mortality	-	-	-	-	-	#DIV/0!	0
Total WS take	8	4	49	1	5	13.4	49
Total non-WS take	94	111	138	191	0	106.8	191
Cumulative take	150	265	475	400	5	259.0	475
Statewide population estimate:	17406						
Statewide population trend:	Stable						
Annual maximum sustainable harvest:	- -						
Current total WS take as a % of the population:	0.28%						
Current cumulative take as % of population:	2.73%						
Projected WS annual maximum take:	100						
Projected total WS take as a % of the population:	0.57%						
Projected annual cumulative take as a % of the population:	1.67%						

3.4.23.4 Conclusion: Striped Skunk

Given the presumed population stability for striped skunk in the state, the lack of non-target take, cumulative impacts on the striped skunk population from all causes, including take by WS-Washington, WS-Washington's MDM is not adversely affecting the striped skunk population.

Therefore, WS-Washington concludes that the cumulative impact of all recorded striped skunk mortality in Washington, including target and non-target take by WS-Washington, would not adversely impact the size or sustainability of the Washington striped skunk population.

Should an increase in requests for assistance with striped skunk damage result in the projected annual WS 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-Washington take, direct and cumulative impacts from take would not adversely impact the size or sustainability of the Washington striped skunk population.

3.4.24 What are the Direct and Cumulative Impacts on Porcupine Populations?

3.4.24.1 Porcupine Life History

Historically damage to timber resources resulted in attempts to extirpate porcupines from the majority of their range, which had mixed success due to the concurrent removals of a majority of porcupine predators. Today porcupine are found from densely forested areas to heavily populated areas interspersed with woodlots capable of sustaining them through the winter months. In coastal lowlands west of the Cascades porcupine can feed year-round on herbaceous vegetation improving the habitability of developed areas. Like most herbivores in Washington, porcupine forage on herbaceous vegetation during the spring, summer, and fall. However, porcupine, like beaver, forage on the sugar rich phloem or sapwood of dominant or codominant trees. This unique adaptation allows them to feed year-round in habitats where other herbivores must migrate away from or hibernate during the winter. Solitary for most of the year porcupine mate from September through December with a gestation period of 7 months. From April through June the one offspring is born and begins moving and feeding on vegetation with the mother for the next 3 months. In addition to only producing one young per year females do not breed until their second fall. Home ranges are centered on an opportunistically selected den and are variable by season with size estimates range from .24 to 30 acres in the winter and 5.9 to 206 acres in the summer (Sullivan et all 1989).

3.4.24.2 Porcupine Population Information

Washington Natural Heritage Program through WDNR maintains a list of species status ranks for the majority of species in Washington, the following is the state species ranks of the species that Washington works with; porcupine is ranked as secure (Washington Department of Natural Resources 2017).

3.4.24.3 Porcupine Population Information and Analysis

Porcupine are unclassified wildlife in Washington and may be taken at any time of year without a permit. No special permits are required when using live traps. Special trapping permits are issued by WDFW (RCW 77.15.192, RCW 77.15.194, and WAC 220-417-040). Under WAC 220-440-060 (Section 2.4.4.1), landowners or commercial wildlife control operators can also remove porcupine on private land when porcupines are causing damage to private property, crops, livestock, or presenting a public health risk without a license. It is unlawful to release any species anywhere within the state, other than on the property where it was legally trapped, without a permit to do so (RCW 77.15.250; WAC 220-450-010).

3.4.24.4 Porcupine Population Impact Analysis

In response to requests for assistance with porcupine damage between FY 2015 and 2019, WS-Washington removed an average of 2.6 target porcupines per year during the reporting period (Table 14), all were taken were on private land. WS-Washington has not lethally taken any non-target porcupine during the analysis period. The most porcupine taken by WS-Washington in a single fiscal year was 5.

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future porcupine removals for MDM would be similar to take during the last five years. Therefore, under Alternative 1 (current activities with fluctuations), the projected WS-Washington annual maximum take was analyzed up to but would not exceed 10 porcupine per year (Table 11).

Table 41 Percentage of Take by the Resource Protected, FY 2015- FY 2019.

Human Health and Safety	General	0%
	Infrastructure	30%
	Aviation	0%
Agriculture	Crops	0%
	Livestock	0%
Property	Residential	0%
	Non-Residential	0%
Timber	Timber	70%
Natural Resources	Wildlife	0%
	Habitat	0%

3.4.24.5 Conclusion: Porcupine

Given the presumed population stability for porcupine in the state, the low cumulative take for all recorded mortality in Washington, including take by WS-Washington, the lack of non-target take, and the limited number of responses by WS-Washington for porcupine damage (0.16% of all responses), WS-Washington's MDM is not adversely impacting the porcupine population.

Therefore, WS-Washington concludes that the cumulative impact of all recorded porcupine mortality in Washington, including target and non-target take by WS-Washington, would not adversely impact the size or sustainability of the Washington porcupine population.

Should an increase in requests for assistance with porcupine damage result in the projected annual WS maximum take, cumulative impacts on the statewide porcupine 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-Washington take, direct and cumulative impacts from take would not adversely impact the size or sustainability of the Washington porcupine population.

3.4.25 What are the Direct and Cumulative Impacts on Vole Populations?

3.4.25.1 Vole Life History

Voles occur in nearly every area of Washington State and many species overlap ranges extensively. There are 10 species of voles in Washington state; sagebrush vole (*Lemmiscus curtatus*), gray-tailed vole (*Microtus canicaudus*), long-tailed vole (*Microtus longicaudus*), montane vole (*Microtus montanus*), creeping vole (*Microtus oregoni*), meadow vole (*Microtus pennsylvanicus*), water vole (*Microtus richardsoni*), Townsend's vole (*Microtus townsendii*), and western heather vole (*phenacomys intermedius*). Though life histories and habitat requirements vary between species they also share many similarities. Burrows with multiple entrances are constructed for shelter and rearing of young. Breeding seasons are throughout the duration of the growing season with multiple litters of around 5 young produced after a 20-25 day gestation period. Weaning occurs from 14-21 days and reproductive maturity can occur as early as 18 days for some species and as late as 75 days for others. All voles in Washington are primarily herbivores eating herbaceous vegetation (e.g. grass, forbs, roots, seeds, and bulbs). Home ranges and densities for vole species vary by food availability but typically overlap with multiple other home ranges and in some areas may reach densities as high as >200 per acre. Species that live in the higher altitudes typically have lower densities and shorter breeding seasons while coastal species can breed year-round. In agricultural landscapes, golf courses, or maintained fields vole populations can exceed natural densities greatly. Though the longevity of most species in Washington is not known some species are capable of living nearly 4 years in captivity. High mortality rates from owls, foxes, coyotes, raccoons, snakes, badgers, bobcats, skunks, cats, weasels, mink, and dogs bring average life expectancy for some mole species down to a month or two.

Kincaid meadow voles (*Microtus pennsylvanicus kincaidi*), Shaw Island Townsend's voles (*Microtus townsendii pugeti*), and gray-tailed voles (*Microtus canicaudus*) are on WDFW's list of Species of Greatest Conservation Need (Washington Department of Fish and Wildlife 2015c). WS-Washington does not work with these species.

3.4.25.2 Vole Population Information

Washington Natural Heritage Program through WDNR maintains a list of species status ranks for the majority of species in Washington, the following is the state species ranks of the species that Washington works with; southern red-backed vole is secure, heather vole is secure, meadow vole is secure (excluding kincade subspecies), montane vole is secure, Townsend's vole is secure (excluding Shaw Island subspecies), long-tailed vole is secure, creeping vole is apparently secure, water vole is secure, sagebrush vole is vulnerable. Sagebrush vole is ranked as vulnerable as the sagebrush habitat it associates with has been reduced throughout Washington State (Washington Department of Natural Resources 2017).

3.4.25.3 Vole Population Impact Analysis

In response to requests for assistance with vole damage between FY 2015 and 2019, WS-Washington removed an average of 236.4 target voles per year during the reporting period (Table 14), all voles were taken on private land. All voles WS-Washington took were for the protection of non-residential property. WS-Washington has not taken any non-target voles during the analysis period. The most vole taken by WS-Washington in a single fiscal year was 591 (all montane voles).

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future vole removals for MDM would be similar to take during the last five years. Therefore, under Alternative 1 (current activities with fluctuations), the projected WS-Washington annual maximum take was analyzed up to but would not exceed 2,000 voles per year.

3.4.25.4 Conclusion: Vole

Given the presumed population stability for voles in the state, the low cumulative take for all recorded mortality in Washington, including take by WS-Washington, the lack of non-target take, and the limited number of responses by WS-Washington for vole damage (0.17% of all responses), WS-Washington's MDM is not adversely impacting the vole population.

Therefore, WS-Washington concludes that the cumulative impact of all recorded voles mortality in Washington, including target and non-target take by WS-

Washington, would not adversely impact the size or sustainability of the Washington mole population.

Should an increase in requests for assistance with vole damage result in the projected annual WS maximum take, cumulative impacts on the statewide vole 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-Washington take, direct and cumulative impacts from take would not adversely impact the size or sustainability of the Washington vole population.

3.4.26 What are the Direct and Cumulative Impacts on Bat Populations?

3.4.26.1 Bat Life History Information

Of the fifteen species of bat species found in Washington State, little brown bat, big brown bat, California myotis, pallid bat, and Yuma myotis most frequently associate with humans. Like the majority of bats, all five of these species are slow reproducers, especially for their size, usually only having one, sometimes two, young per litter. California myotis, pallid bat, big brown bat, and little brown bat mate during late fall or during winter delaying fertilization until spring. Yuma myotis form breeding colonies in April and young are born from late May-June. Most species in Washington are capable of breeding in their first or second year. Daily and migratory habits vary by species, gender, time of year, weather but typically conflicts with bats occur when bats enter human-built structures while looking for a day roost or need to find shelter unexpectedly. WS-Washington does not work with species listed on WDFW's list of Species of Greatest Conservation Need which include; Hoary bats (*Lasiurus cinereus*), Keen's myotis (*Myotis keenii*), silver-haired bats (*Lasionycteris noctivagans*), spotted bat (*Euderma maculatum*), Townsend's big-eared bats (*Corynorhinus townsendii*) (Washington Department of Fish and Wildlife 2015c).

3.4.26.2 Bat Population Information

All bats in Washington are classified as protected and cannot be hunted trapped or killed (WAC 220-200-100) unless found in or immediately adjacent to a dwelling or other occupied building. Those animals may be removed without a permit (WAC 220-200-100). It is unlawful to release any species anywhere within the state, other than on the property where it was legally trapped, without a permit to do so (RCW 77.15.250; WAC 220-450-010). WS-Washington attempts to relocate all bats found inside found inside a building to immediately outside the facility unless there is a report of a bite as the individual would then be taken for required disease analysis. Washington Natural Heritage Program through WDNR maintains a list of species status ranks for the majority of species in Washington, the following is the state species ranks of the species that Washington works with; little brown bats are ranked as vulnerable, big brown bat is apparently secure, long-eared myotis is apparently secure, fringed myotis is either conservatively ranked vulnerable, pacific fringe-tailed bat is unrankable due to conflicting information about the species, small-footed myotis is apparently secure, pipistrelle is vulnerable, California myotis is apparently secure, pallid bat is vulnerable, and Yuma myotis is apparently secure (Washington Department of Natural Resources 2017).

3.4.26.3 Bat Population Impact Analysis

In response to requests for assistance with bat damage between FY 2015 and FY 2019, WS-Washington lethally removed 1 bat during the reporting period, it was removed from a building for the protection of human health and safety. The bat was euthanized because of its poor condition and for disease testing. WS-Washington did not lethally take any non-target bats during the analysis period. The most bats taken by WS-Washington in a single fiscal year was 1.

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future bat removals for MDM would be similar to take during the last five years. Therefore, under Alternative 1 (current activities with fluctuations), WS-Washington analyzed a maximum annual take that will not exceed 10 bats per year.

3.4.26.4 Conclusion: Bat

Given the low take by WS-Washington, the ability of WS-Washington personnel to relocate bat species instead of taking them as authorized by RCW 77.14.250 and WAC 220-450-010, and the reproductive capacity of bats to replace the low numbers of bats taken by WS-Washington each year, WS-Washington's take of bats is not adversely impacting the size or sustainability of bat populations.

Species with Other Classifications

Species that have classifications other than those listed above. Species is this section are regulated uniquely from other species in Section 3.4. Sea lions are regulated jointly between NOAA and WDFW and Douglas squirrel are classified as protected species (WAC 220-200-100).

3.4.27 What are the Direct and Cumulative Impacts on Douglas Squirrel Populations?

3.4.27.1 Douglas Squirrel Life History

Douglas squirrels are native and found primarily in western Washington. Douglas squirrels require coniferous forest stands for forage but can exist with adjacent developed areas. Feeding primarily on conifer seeds Douglas squirrels opportunistically feed on nuts, acorns, tree buds, berries, leaves, twigs, fungi, insects, bird eggs, nestlings, and human food waste. Food caches are created throughout a squirrel's territory during the fall for forage in the winter months. Squirrels prefer to construct their nests in natural or man-made cavities where they rear their litter for the year of 2 to 4 young. When cavities are unavailable squirrels can build a nest out of twigs and plant matter to rear there young. Litters are produced from March to June and are independent at 60 days of age. This short time to maturity means that second litters are occasionally produced. The second litter of squirrels stay with the mother through the winter months until the winter courtship season. Squirrels can live from 3 to 5 years if not preyed upon by an owl, hawk, dog, cat, coyote, or bobcat (Washington Department of Fish and Wildlife 2019f).

3.4.27.2 Douglas Squirrel Regulatory Information

Douglas squirrels are classified as protected species in Washington (WAC 220-200-100). As such they can be killed or trapped only in emergency situations under a special permit issued by WDFW when Douglas squirrels are damaging crops or domestic animals (RCW 77.36.030). WAC 220-450-010 allows for special permissions to be given by WDFW for relocating wild animals in Washington State.

3.4.27.3 Douglas Squirrel Population Impact Analysis and Conclusion

In response to requests for assistance with Douglas squirrels damage between FY 2015 and 2019, WS-Washington trapped and relocated an average of 7 Douglas squirrels per year during the reporting period (Table 14, all were trapped and relocated on private lands. WS-Washington trapped and relocated Douglas squirrels for the protection of; 53% human health and safety (53.3% general) and 47% property (15.5% non-private, 31.5% private). One Douglas squirrel that was trapped was humanely euthanized during the analysis period due to being in poor and unrecoverable condition. All Douglas squirrels were trapped with cage traps (100%) during the reporting period. The most Douglas squirrel trapped and relocated by WS-Washington in a single fiscal year was 34.

Based on cooperative service agreements and projected future requests for assistance, because WS-Washington traps and relocates Douglas squirrels and does not conduct targeted lethal removal WS-Washington’s actions are not expected to impact the size or sustainability of Washington’s Douglas squirrel population.

3.4.28 What are the Direct and Cumulative Impacts on California Sea Lions Populations?

3.4.28.1 California Sea Lion Life History Information

California sea lions are native to the west coast of North America including all of Washington’s coast, Puget Sound, and upstream of some large rivers. Sea lions are protected under the Marine Mammal Protection Act (MMPA) and populations have seen increases under the act’s protection since 1975. Typically, offshore foragers, sea lions prey on squid, anchovies, mackerel, rockfish, sardines, and salmonids. However, excursions into large rivers to prey on large fish, including ESA listed salmonids, are observed every year aligning with salmonid runs. California sea lions are social animals associating in large groups year-round on docks and haul-outs though breeding season involves one male defending a group of females (up to 14) from other males. Breeding season lasts from late June to early August with most pups being born from May through June. After 3 to 4 weeks after giving birth females are ready to mate again. While rearing pups female sea lions feed 2 to 5 days and nurse the pup for 1 to 2 days until weaning occurs at approximately 1 year of age. Sea lions reach sexual maturity at 4 to 5 years old but typically don't begin to hold territories until 9 to 12 years old. Predators of California sea lions include orca and sharks.

3.4.28.2 California Sea lion Population Management

California sea lions are protected by the MMPA and cannot be trapped, harassed, or killed without a permit issued by NMFS. Section 101(a)(4) of the MMPA authorizes owners of private property and government employees to deter marine mammals from damaging property. Section 109(h) of the MMPA further authorizes government employees to harass marine mammals for the protection of human health/safety and property. Harassment actions for the protection of ESA-listed salmonids are assessed in consultations (National Marine Fisheries Service 2007) between the USACE and NMFS.

3.4.28.3 California Sea Lions Population Impact Analysis

WS-Washington is proposing to use only non-lethal harassment methods to address any conflicts. WS-Washington has not and is not proposing any lethal removal of California sea lions. In response to requests for assistance with California sea lion damage between FY 2014 and 2018, WS-Washington harassed California sea lions an average of 1480.4 times per year during the reporting period, all were for the protection of ESA-listed salmonids in the tailraces of dams. In the tailraces of the Bonneville dam the USACE reported an average of 114.8 California sea lions (USACE 2018), many of these individuals were harassed multiple times while attempting to feed on ESA-listed salmonids. California sea lions were harassed through pyrotechnics (70%) and rubber ammunition (30%) during the reporting period.

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future California sea lion harassment for MDM would be similar to harassment during the last five years. As there is no lethal take being proposed any impacts to California sea lion populations would not be expected to be substantial and have short lived effects.

3.4.28.4 Conclusion: California Sea Lions

Given the presumed population stability for California sea lions in the state and the lack of take by WS-Washington, WS-Washington's MDM activities are not adversely impacting the population. Therefore, WS-Washington concludes that harassment of California sea lion not adversely impact the size or sustainability of the Washington California sea lion population.

Should an increase in requests for assistance with California sea lion damage result in increased levels of harassment by WS-Washington the effects would be localized, short lived, and would not adversely impact the size or sustainability of the Washington California sea lion population.

3.4.29 What are the Direct and Cumulative Impacts on Steller Sea Lions Populations?

3.4.29.1 Steller Sea Lion Life History Information

Steller sea lions are native to the west coast of North America including all of Washington's coast, Puget Sound, and upstream of some large rivers. Steller sea lion populations are broken into 2 distinct population segments (DPS), eastern DPS and western DPS. Sea lions are protected under the Marine Mammal Protection Act (MMPA) and the eastern DPS (the only DPS present in Washington) populations have seen increases under the act's protection since 1975. The eastern DPS of Steller sea lions was delisted in 2013. Steller sea lions typically feed offshore on squid, mackerel, walleye pollock, cod, sand lance, flounder, Irish lords, capelin, eulachon, Pacific sandfish, skates, herring, hake, rockfish, white sturgeon and salmonids. However, excursions into rivers to prey on large fish, including ESA listed salmonids, are observed every year and align with salmonid runs. Steller sea lions are social animals associating in large groups year-round on docks and haul-outs though breeding season involves one male defending a group of females (up to 14) from other males. No rookeries (>50 pups born per year) are recognized in Washington State. Breeding season lasts from May to early August with most pups being born from May through June. While rearing pup, female sea lions feed 2 to 5 days and nurse the pup for 1 to 2 days until weaning occurs between 1 to 3 years of age. Male Steller lions reach sexual maturity at 3 to 8 years old but typically don't begin to hold territories until 9 to 11 years old. Female Steller sea lions reach sexual maturity between 3 to 6 years of age but can produce young into their 20s. Predators of Steller sea lions include orca and sharks (Wiles 2015).

3.4.29.2 Steller Sea Lion Population Management

Steller sea lions were protected under the Endangered Species Act until 2013, when the eastern DPS was delisted. Steller sea lions are protected by the MMPA and cannot be trapped, harassed, or killed without a permit issued by NMFS. Section 101(a)(4) of the MMPA authorizes owners of private property and government employees to deter marine mammals from damaging property. Section 109(h) of the MMPA further authorizes government employees to harass marine mammals for the protection of human health/safety and property. Harassment actions for the protection of ESA-listed salmonids are assessed in the consultations between the USACE and NMFS (National Marine Fisheries Service 2007).

3.4.29.3 Steller Sea Lions Population Impact Analysis

WS-Washington is proposing to use only non-lethal harassment methods to address any conflicts. WS-Washington has not and is not proposing any lethal removal of Steller sea lions. All actions and methods are assessed in the consultations between

USACE and NMFS (National Marine Fisheries Service 2007). In response to requests for assistance with Steller sea lion damage between FY 2014 and 2018, WS-Washington harassed Steller sea lions an average of 2,115.2 times per year during the reporting period, all were for the protection of ESA-listed salmonids in the tailraces of dams. In the tailraces of the Bonneville dam the USACE reported 10 or more Steller sea lions at the dam daily lions (U.S. Army Corps of Engineers 2020), many of these individuals were harassed multiple times while attempting to feed on ESA-listed salmonids. Steller sea lions were harassed through pyrotechnics (92.4%) and rubber ammunition (7.6%) during the reporting period.

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future Steller sea lion harassment for MDM would be similar to harassment during the last five years. As there is no lethal take being proposed any impacts to Steller sea lion populations would not be expected to be substantial and have short lived effects.

3.4.29.4 Conclusion: Steller Sea Lions

Given the presumed population stability for Steller sea lions in the state and the lack of take by WS-Washington, WS-Washington's MDM activities are not adversely impacting the population. Therefore, WS-Washington concludes that the Steller sea lion harassment would not adversely impact the size or sustainability of the Washington Steller sea lion population.

Should an increase in requests for assistance with Steller sea lion damage result in increased levels of harassment by WS-Washington the effects would be localized, short lived, and would not adversely impact the size or sustainability of the Washington Steller sea lion population.

Mammal Species that Infrequently Cause Damage and Non-Native Species

Species included in this section are those for which WS-Washington rarely receives request for assistance, or species for which WS-Washington has not received a request for assistance during the review period. The analysis is provided so that WS-Washington could respond should someone request assistance with these species in the future.

This section also includes species that are non-native and that are not managed WDFW. The removal of individuals of these non-native species are typically considered beneficial to the human environment.

3.4.30 What are the Direct and Cumulative Impacts on Virginia Opossum Populations?

3.4.30.1 Virginia Opossum Life History Information

Virginia opossums are North America's only marsupial species and were brought into Washington State as pets and novelties from the southern U.S. by 1941. At that time, escaped opossums had become established in the western part of the state and have been steadily expanding their range over time.

Opossums are secretive, and nocturnal, living near streams, forests, agricultural lands, and urban and suburban areas. Dens are in rocks, brush piles, trash heaps, hollow trees, fallen logs and old buildings. One to two breeding periods may occur in late winter and May through June (VanDruff 1971, Edmunds et al. 1978, Gardner 1982, Hossler et al. 1994). Litter sizes can range between 1 and 17 young, with 8 to 9 young in an average litter (Holmes and Sanderson 1965, Gardner 1982, Hossler et al. 1994). Opossums typically breed in by the end of their first year, when juveniles reach sexual maturity (Gardner 1982).

Opossums are omnivorous, eating fruits, vegetables, insects, small mammals, birds, eggs, carrion, garbage, and pet food. Opossums do not forage when temperatures drop below 24° F, and they do not hibernate, needing to forage year-round. Access to human food subsidies, as well as climate change, may support continued opossum range expansion (Appling 2014). Opossum damage may consist of killing poultry, consuming eggs, and foraging in gardens.

3.4.30.2 Virginia Opossum Population Information

Reported information on current range and population density of Virginia opossums are limited in Washington State. Virginia opossums are unclassified wildlife in Washington and may be trapped or killed at any time of year without a permit. No special permits are required when using live traps. Special trapping permits are issued by WDFW (RCW 77.15.192, RCW 77.15.194, and WAC 220-417-040). It is unlawful to release any species anywhere within the state, other than on the property where it was legally trapped, without a permit to do so (RCW 77.15.250; WAC 220-450-010).

3.4.30.3 Virginia Opossum Population Impact Analysis

In response to requests for assistance with Virginia opossum damage between FY 2015 and 2019, WS-Washington in removed an average of 40.4 opossums per year during the reporting period, 82% were taken on private lands and 28% were taken were on public lands. WS-Washington captured and freed an average of 1.2 non-target opossums per year during the reporting period. WS-Washington has taken an average of 2 non-target opossums during the analysis period. The most opossums taken by WS-Washington in a single fiscal year was 83.

3.4.30.4 Conclusion: Virginia Opossum

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future opossum removals for MDM would be similar to take during the last five years. WS-Washington has determined that take of up to 200 opossum would not have a significant impact on the human environment because opossum are not a native component of the ecosystem in Washington. As a non-native species in Washington, the removal of opossum is generally considered to have a positive impact on the environment.

3.4.31 What are the Direct and Cumulative Impacts on Eastern Gray Squirrel Populations?

3.4.31.1 Eastern Gray Squirrel Life History

Eastern gray squirrels were introduced in Washington in the early 1900s and have been repeatedly released since. They are now the most common tree squirrel species in urban areas. Eastern gray squirrels are more generalists than Douglas squirrels and are less reliant on conifer seeds, but do also consume nuts, acorns, tree buds, berries, leaves, twigs, fungi, insects, bird eggs, nestlings, and human food waste. Food caches are created throughout a squirrel's territory during the fall for forage in the winter months. Squirrel nests are preferentially constructed in natural and man-made cavities where they rear their litter for the year of 2 to 4 young. When cavities are unavailable squirrels can build a nest out of twigs and plant matter to rear there young. Litters are produced from March to June and are independent at 60 days of age. This short time to maturity means that second litters are occasionally produced. The second litter of squirrels stay with the mother through the winter months until the winter courtship season. Squirrels can live from 3 to 5 years if not preyed upon by an owl, hawk, dog, cat, coyote, or bobcat (Washington Department of Fish and Wildlife 2019f).

3.4.31.2 Cumulative Mortality

Eastern gray squirrels are unclassified wildlife in Washington and may be trapped or killed at any time of year but do require a hunting license. No special permits are required when using live traps. Special trapping permits are issued by WDFW (RCW 77.15.192, RCW 77.15.194, and WAC 220-417-040). Under WAC 220-440-060 (Section 2.4), landowners or commercial wildlife control operators can also remove eastern gray squirrels on private land when eastern gray squirrels are causing damage to private property, crops, livestock, or presenting a public health risk without a license. All take by a landowner, trapper, or WCO must be reported to WDFW. It is unlawful to release any species anywhere within the state, other than on the property where it was legally trapped, without a permit to do so (RCW 77.15.250; WAC 220-450-010).

3.4.31.3 Eastern Gray Squirrel Population Impact Analysis

In response to requests for assistance with eastern gray squirrel damage between FY 2015 and 2019, WS-Washington in removed an average of 8.6 eastern gray squirrel per year during the reporting period, 53% were taken on private lands and 47% were taken were on public lands. WS-Washington captured and freed an average of .4 non-target eastern gray squirrels per year during the reporting period. WS-Washington has not taken any non-target eastern gray squirrels during the analysis period. The most eastern gray squirrels taken by WS-Washington in a single fiscal year was 22.

Table 42 Percentage of Take by the Resource Protected, FY 2015- FY 2019.

Human Health and Safety	General	30%
	Infrastructure	0%
	Aviation	0%
Agriculture	Crops	0%
	Livestock	0%
Property	Residential	32%
	Non-Residential	38%
Timber	Timber	0%
Natural Resources	Wildlife	0%
	Habitat	0%

3.4.31.4 Conclusion: Eastern Gray Squirrel

Based on anticipated future requests for assistance, WS-Washington expects that eastern gray squirrel take would be similar to take during the last five years but will not exceed 100 eastern grey squirrels per year. Take of eastern gray squirrel by WS-Washington has not had an adverse impact on the environment because eastern gray squirrels are not a native component of the ecosystem in Washington. As a non-native species in Washington, the removal of eastern gray squirrel is generally considered to have a positive impact on the environment. Therefore, no significant impacts are expected as a result of the proposed action.

3.4.32 What are the Direct and Cumulative Impacts on Mole Populations?

3.4.32.1 Mole Life History

There are three mole species common to Washington State. The Townsend's mole (*Scapanus townsendii*) is more common west of the Cascades in open fields of primarily herbaceous vegetation and is North America's largest mole species. The Pacific mole (*Scapanus orarius*) typically inhabits the eastern Washington and some coastal areas that are typically drier and composed of more woody vegetation. The shrew-mole (Neurotrichus gibbsii) is commonly found in moist riparian areas and, unlike other moles in the state, is commonly active above ground and does not create mole-hills.

Nearly all mole damage managed by WS-Washington is done by Townsend's and Pacific mole species. These two mole species primarily live underground in complex burrow systems containing surface feeding runways, nest chambers, and mole hills for surface access. Burrowing activity is less energy intensive and therefore more common during wetter months or in moist soils (e.g. irrigated areas). Moles can live up to four to six years and reproduce during their first winter. Mating occurs in winter to early summer after which a litter of 3-5 young is produced. Young are raised in the nest until weaned then disperse above ground to establish their own territories. Moles feed on subterranean invertebrates and vegetation that are accessible from there tunnel systems. Moles do come to the surface to harvest nesting materials, make new territories and collect food. On the surface moles are targeted by predators like hawks, snakes, owls, raccoons, and coyotes (Washington Department of Fish and Wildlife 2019c).

3.4.32.2 Mole Population Information

Washington Natural Heritage Program through WDNR maintains a list of species status ranks for the majority of species in Washington, the following is the state species ranks of the species that Washington works with; shrew-mole is secure, Townsend's Mole is secure, and coast mole is secure (Washington Department of Natural Resources 2017).

3.4.32.3 Cumulative Mortality

Moles are unclassified wildlife in Washington and may be taken at any time of year without a permit by landowners on their own property when moles are causing damage to crops, domestic animals, or their property (RCW 77.36.030). There are no exception for emergencies and no provisions that allow WDFW to issue verbal approval or special permits for body gripping traps for voles (RCW 77.15.192, RCW 77.15.194, and WAC 220-417-040). No special permits are required when using live traps. It is unlawful to release any species anywhere within the state, other than on the property where it was legally trapped, without a permit to do so (RCW 77.15.250; WAC 220-450-010). It is unlawful to release any species anywhere within the state, other than on the property where it was legally trapped, without a permit to do so (RCW 77.15.250; WAC 220-450-010).

Information on mole mortality from any source is limited or unreported though most mortality is likely from private landowners or their agents.

3.4.32.4 Mole Population Impact Analysis

In response to requests for assistance with mole damage between FY 2015 and 2019, WS-Washington removed an average of 2 target moles per year during the reporting period (Table 14), all moles were taken on public land. All moles WS-Washington took were for the protection of human health and safety through protection of dikes and levees. WS-Washington has not taken any non-target moles during the analysis period. The most mole taken by WS-Washington in a single fiscal year was 10.

Based on the limited number of cooperative service agreements and projected future requests for assistance, WS-Washington expects that future mole removals for MDM would be similar to take during the last five years. Therefore, under Alternative 1 (current activities with fluctuations), the projected WS-Washington annual maximum take was analyzed up to but would not exceed 100 moles per year (Table 3.8).

3.4.32.5 Conclusion: Mole

Given the presumed population stability for moles in the state (Anis Aoude, WDFW, personal communication, January 06, 2021, (Washington Department of Natural Resources 2017)), the low cumulative take for all recorded mortality in Washington, including take by WS-Washington, the lack of non-target take, and the limited number of responses by WS-Washington for mole damage (0.06% of all responses), WS-Washington's MDM is not adversely impacting the mole population.

Therefore, WS-Washington concludes that the cumulative impact of all recorded moles mortality in Washington, including target and non-target take by WS-Washington, would not adversely impact the size or sustainability of the Washington mole population.

Should an increase in requests for assistance with mole damage result in the projected annual WS maximum take, cumulative impacts on the statewide mole 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-Washington take, direct and cumulative impacts from take would not adversely impact the size or sustainability of the Washington mole population.

3.4.33 What are the Direct and Cumulative Impacts on Fox Squirrel Populations?

3.4.33.1 Fox Squirrel Life History

Fox squirrels were introduced in Washington in 1915 and have been repeatedly released since. Fox squirrels mostly established in urban areas in Eastern Washington. Fox squirrels are generalist foragers that consume nuts, acorns, tree buds, berries, leaves, twigs, fungi, insects, bird eggs, nestlings, and human food waste. Squirrels cache food throughout their territory during the fall for forage during the winter. Squirrels prefer to nest in manmade or natural cavities, where they can rear their litter for the year. When cavities are unavailable squirrels can build a nest out of twigs and plant matter to rear there young. Litters are produced from March to June and are independent at 60 days of age. This short time to maturity means that second litters are occasionally produced in a single year. The second litter of squirrels stay with the mother through the winter months until the winter courtship season. Squirrels can live from 3 to 5 years if not preyed upon by an owl, hawk, dog, cat, coyote, or bobcat (Washington Department of Fish and Wildlife 2019f).

3.4.33.2 Fox Squirrel Population Impact Analysis

WS-Washington has not removed any fox squirrels WS-Washington during the

FY2015 – FY2019 reporting period, however, has been received MDM requests for fox squirrels and therefore may have to conduct MDM for fox squirrel damage in the future. WS-Washington has not taken any non-target fox squirrels during the analysis period.

Fox squirrels are unclassified wildlife in Washington and may be trapped or killed at any time of year but do require a hunting license. No special permits are required when using live traps. Special trapping permits are issued by WDFW (RCW 77.15.192, RCW 77.15.194, and WAC 220-417-040). Under WAC 220-440-060 (Section 2.4), landowners or commercial wildlife control operators can also remove eastern gray squirrels on private land when eastern gray squirrels are causing damage to private property, crops, livestock, or presenting a public health risk without a license. All take by a landowner, trapper, or WCO must be reported to WDFW. It is unlawful to release any species anywhere within the state, other than on the property where it was legally trapped, without a permit to do so (RCW 77.15.250; WAC 220-450-010).

As entities are not required to report fox squirrel removals, the full extent of take or mortality in the state is not known. Though as the species that started as an introduced population of a few individuals and now have established populations in urban areas in Eastern Washington, their populations are likely stable.

3.4.33.3 Conclusion: Fox Squirrel

WS-Washington does not expect to receive requests for assistance for fox squirrels. However, WS-Washington must be able to meet the need for action, and has determined that take of up to 50 fox squirrels would not have a significant impact on the human environment because fox squirrels are not a native component of the ecosystem in Washington. As a non-native species in Washington, the removal of fox squirrel is generally considered to have a positive impact on the environment.

3.4.34 What are the Direct and Cumulative Impacts on Nutria Populations?

3.4.34.1 Nutria Life History

Nutria are native to southern Brazil and Peru and throughout Bolivia, Uruguay, Paraguay, Argentina, and Chile. In 1899 nutria were initially introduced then after a series of accidental releases and intentional releases to promote the fur trade and control invasive aquatic vegetation nutria have established populations in 16 states and occur in Washington State. Marshes and slow-moving water systems with abundant aquatic vegetation are preferred habitat. Home ranges are usually less than 25 acres where several adult females, a dominant male, and the year’s offspring live. Nutria breed year-round and can produce up to 3 litters per year with 4 to 5 kits per litter born after a 130 to 132-day gestation period. Annual mortality rates are high, between 53%-74% but due to high reproductive rates can still reach densities of 10 nutria per acre. Noted as voracious and wasteful foragers on herbaceous vegetation nutria can denude wetland habitats converting them into open-water systems. Predators are eagles, owls, hawks, and occasionally, coyotes.

Larger and more aggressive, nutria can outcompete native muskrats and may have contributed to past declines in muskrat populations.

3.4.34.2 Nutria Population Information

Nutria are classified as a Prohibited Aquatic Animal Species (WAC 220-640-050), as such WDFW recommends all live trapped nutria be euthanized and not returned to the wild. A hunting or trapping license in required when harvesting nutria. No special permits are required when using live traps. Special trapping permits are issued by WDFW (RCW 77.15.192, RCW 77.15.194, and WAC 220-417-040). It is unlawful to release any species anywhere within the state, other than on the property where it was legally trapped, without a permit to do so (RCW 77.15.250; WAC 220-450-010).

3.4.34.3 Nutria Population Impact Analysis

In response to requests for assistance with nutria damage between FY2015 and FY2019, WS-Washington removed an average of 532 target nutria per year during the reporting period (Table 14), 4% were taken on private lands and 96% were taken were on public lands. WS-Washington has taken an average of .2 non-target nutria per year during the analysis period. The most nutria taken by WS-Washington in a single fiscal year was 1093.

3.4.34.4 Conclusion: Nutria

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future nutria removals for MDM would be similar to take during the last five years. WS-Washington has determined that take of up to 2000 nutria would not have a significant impact on the human environment because nutria are not a native component of the ecosystem in Washington. As a non-native species in Washington, the removal of nutria is generally considered to have a positive impact on the environment.

3.4.35 What are the Direct and Cumulative Impacts on Black Rat Populations?

3.4.35.1 Black Rat Life History

Norway rats were accidentally introduced into Washington State with the arrival of early voyagers and are now common to all populated areas of Washington State. Norway rats preferentially select fresh vegetation and prey (insects, amphibians, reptiles, small mammals, and small birds) though are dietary generalists capable of consuming decomposing and waste matter. Rat populations are constrained by water access or dietary water content. Breeding occurs year-round after a 3 week gestation period that can produce litters containing 6 to 10 young. Rats are weaned at 20 days and can breed at three months of age. Predators of rats are hawks, owls, dogs, coyotes, foxes, bobcats, mink, skunk, long-tailed weasel, snakes, and cats. High rates of mortality from predators tend to limit a rat's lifespan to under a year though they are capable of living for 2 or more years.

3.4.35.2 Black Rat Population Information

Black rats are not considered wildlife by WDFW in Washington and are managed by local municipalities which do not require a permit to kill or trap. Common rat and mouse traps are not considered body-gripping traps which would otherwise be prohibited (RCW 77.15.192, RCW 77.15.194, and WAC 220-417-040). Live trapping is also allowed without a special permit. It is unlawful to release any species anywhere within the state, other than on the property where it was legally trapped, without a permit to do so (RCW 77.15.250; WAC 220-450-010).

3.4.35.3 Black Rat Population Impact Analysis

In response to requests for assistance with black rat damage between FY 2015 and 2019, WS-Washington removed an average of 16.8 target black rats per year during the reporting period (Table 14), all were taken on private land. The most black rats taken by WS-Washington in a single fiscal year was 74.

3.4.35.4 Conclusion: Black Rat

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future black rat removals for MDM would be similar to take during the last five years. WS-Washington has determined that take of up to 200 black rats would not have a significant impact on the human environment because black rats are not a native component of the ecosystem in Washington. As a non-native species in Washington, the removal of black rat is generally considered to have a positive impact on the environment.

3.4.36 What are the Direct and Cumulative Impacts on Feral Swine Populations?

3.4.36.1 Feral Swine Population Life History

Feral swine are a harmful and destructive non-native, invasive species. Their geographic range is rapidly expanding, and their populations are increasing across the United States (U.S.) (Waithman et al. 1999, Barrios-Garcia and Ballari 2012). The difficulty in managing swine damage and associated management costs increases as swine populations increase. Washington State does not have an established feral swine population, one that has been present for 2 or more years, though abandoned and intentionally released feral swine are present and must be removed before they become established. Females begin breeding at 13 months, litters typically average between 5 and 6, with 1-2 litters per year. Reproduction of feral swine is linked to food availability (Geisser and Reyer 2005, Melis et al. 2006) and the availability of supplemental feeds such as crops and livestock feed can increase the density of feral swine in the area (Groot Bruinderink et al. 1994).

3.4.36.2 Feral Swine Population Impact Analysis and Conclusion

In response to requests for assistance with feral swine damage between FY 2015 and 2019, WS-Washington removed an average of 4.8 target feral swine per year during the reporting period (Table 14), 50% were taken on public land and 50% were taken on private land. WS-Washington took feral swine for the protection of; 84% natural resources (100% habitat) and 16% property (100% non-residential property). WS-Washington has not taken any non-target feral swine during the analysis period. The most feral swine taken by WS-Washington in a single fiscal year was 11.

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future feral swine removals for MDM would be similar to take during the last five years. WS-Washington has determined that take of up to 100 feral swine would not have a significant impact on the human environment because feral swine are not a native component of the ecosystem in Washington. As a non-native species in Washington, the removal of feral swine is generally considered to have a positive impact on the environment.

3.4.37 What are the Direct and Cumulative Impacts on Norway Rat Populations?

3.4.37.1 Norway Rat Life History

Norway rats were accidentally introduced into Washington State with the arrival of early voyagers and are now common to all populated areas of Washington State. Norway rats preferentially select fresh vegetation and prey (insects, amphibians, reptiles, small mammals, and small birds) though are dietary generalists capable of consuming decomposing and waste matter. Rat populations are constrained by water access or dietary water content. Breeding occurs year-round after a 3 week gestation period that can produce litters containing 6 to 10 young. Rats are weaned at 20 days and can breed at three months of age. Predators of rats are hawks, owls, dogs, coyotes, foxes, bobcats, mink, skunk, long-tailed weasel, snakes, and cats. High rates of mortality from predators tend to limit a rat's lifespan to under a year though they are capable of living for 2 or more years.

3.4.37.2 Norway Rat Population Information

Norway rats are not considered wildlife by WDFW in Washington and are managed by local municipalities which do not require a permit to kill or trap. Common rat and mouse traps are not considered body-gripping traps which would otherwise be prohibited (RCW 77.15.192, RCW 77.15.194, and WAC 220-417-040). Live trapping is also allowed without a special permit. It is unlawful to release any species anywhere within the state, other than on the property where it was legally trapped, without a permit to do so (RCW 77.15.250; WAC 220-450-010).

3.4.37.3 Norway Rat Population Impact Analysis

In response to requests for assistance with Norway rat damage between FY 2015 and FY2019, WS-Washington removed an average of 27.4 target Norway rats per year during the reporting period (Table 14), all were taken on private land. WS-Washington has not lethally taken any non-target Norway rats per year during the analysis period. The most Norway rats taken by WS-Washington in a single fiscal year was 95.

3.4.37.4 Conclusion: Norway Rat

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future Norway rat removals for MDM would be similar to take during the last five years. WS-Washington has determined that take of up to 200 Norway rats would not have a significant impact on the human environment because Norway rat are not a native component of the ecosystem in Washington. As a non-native species in Washington, the removal of Norway rat is generally considered to have a positive impact on the environment.

Feral/Free Ranging Mammals

WS-Washington is occasionally requested to assist with domestic species that are feral or free-ranging, including dogs, cats, and rabbits. WS-Washington personnel may assist in feral and free-ranging species management at the request of local authorities and upon approval by the 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 action or programmatically with state, local, and tribal authority before taking such action, and that each APHIS-WS state office will develop a state-wide policy. If a free-ranging animal is captured and it is determined it ais a pet, WS-Washington personnel contact the owners as soon as practicable, if possible.

WS-Washington is only infrequently called upon by counties/local municipalities to manage feral or free-roaming animal conflicts (less than 1% of all responses of the species in this EA), as primary responsibility for feral animal control rests with state, county, or local authorities. However, because of Washington's cooperative wildlife damage management responsibilities, WS-Washington personnel are authorized to respond to requests for assistance with damage caused by feral and free-ranging animals.

3.4.38 What are the Direct and Cumulative Impacts on Feral, Free-Ranging, and Hybrid Dog Populations?

3.4.38.1 Feral, Free-ranging, and Hybrid Dogs Life History

Feral and free-ranging dogs are somewhat common in certain areas in Washington, where they often run in packs and prey on and harass livestock and poultry. Incidents of livestock attacks and larger pack size are more frequently associated with Eastern Washington while attacks on pets with small pack sizes more prevalent in Western Washington. Free-ranging dogs may be subsidized by food provided by owners, and depredation or harassment of livestock 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. There are also some concerns that pet and feral and free-ranging dogs may cross-breed with gray wolves which may have unknown impacts on wolf populations. Feral and free-ranging dogs may also carry and spread diseases, such as rabies and Rocky Mountain spotted fever (Centers for Disease Control and Prevention 2016).

3.4.38.2 Feral and Free-ranging Dog Population Information

Feral and free-ranging dogs are not managed by the State in Washington 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). It is unlawful to release any species anywhere within the state, other than on the property where it was legally trapped, without a permit to do so (RCW 77.15.250; WAC 220-450-010).

WS-Washington personnel are only authorized to manage damage caused by 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).

3.4.38.3 Feral and Free-ranging Dog Population Impact Analysis and Conclusion

In response to requests for assistance involving dogs, WS-Washington did not remove any feral and free-ranging dogs between FY 2015 and 2019 (Table 14 and Table 11. WS-Washington 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-Washington. WS-Washington expects the annual lethal removal of feral and free-ranging dogs in Washington to remain similar to previous years.

Feral and free-ranging dogs are not native to Washington ecosystems and would be taken under very limited circumstances. WS-Washington does not expect to receive requests for assistance for feral and free-ranging dogs. However, WS-Washington must be able to meet the need for action and has determined that take of up to 20 feral and free-ranging dogs, this limited removal of feral or free-ranging dogs would not adversely impact Washington feral and free-ranging dog population.

3.4.39 What are the Direct and Cumulative Impacts on Feral and Free-Ranging Cat Populations?

3.4.39.1 Feral and Free-ranging Cat Life History

Feral and free-ranging domestic cats are non-native and common throughout North America and Washington, 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 have greater territorial flexibility 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, Crooks and Soule 1999, Hawkins et al. 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).

3.4.39.2 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 (American Veterinary Medical Association 2012). However, there may be 60 to 120 million stray, free-ranging, and feral cats in the U.S (Jessup 2004, Lebbin et al. 2010). Feral and free-ranging cats are common in certain areas of Washington. Feral and free-ranging cats are not managed by the State of Washington, and as such, there are no population estimates for feral and free-ranging cats. It is unlawful to release any species anywhere within the state, other than on the property where it was legally trapped, without a permit to do so (RCW 77.15.250; WAC 220-450-010).

3.4.39.3 Feral and Free-ranging Cat Population Impact Analysis

Feral and free-ranging cats are common in Washington, especially in heavily developed areas of Western Washington. Requests for assistance with feral cats are approved by the appropriate state or local agency, as regulated by Washington State laws.

In response to requests for assistance with feral and free-ranging cat damage between FY 2015 and 2019, WS-Washington removed an average of 7.2 target feral cats per year during the reporting period. WS-Washington has not taken any non-target feral cat during the analysis period. The most feral cats taken by WS-Washington in a single fiscal year was 13.

The lethal removal of feral and free-ranging cats by WS-Washington has little impact on the environment because feral and free-ranging cats are not indigenous to Washington. In addition, the annual numbers of feral and free-ranging cats removed by WS-Washington is low compared to the hundreds killed by animal control and humane organizations in Washington each year.

Various non-WS sources of feral and free-ranging cat removals contribute to the cumulative take of feral and free-ranging cats in Washington (e.g. municipal animal control removals, vehicle collisions). These non-WS sources of take under the jurisdiction of local animal control departments.

3.4.39.4 Conclusion: Feral and Free-ranging Cat

WS-Washington addresses feral and free-ranging cats at the request of the local authority for animal control and private individuals, thus, this action would likely occur in the absence of involvement by WS-Washington. WS-Washington expects the annual lethal removal of feral and free-ranging cats in Washington to remain similar to previous years.

Feral and free-ranging cats are not native to Washington ecosystems and would be taken under very limited circumstances. WS-Washington does not expect to receive requests for assistance for feral and free-ranging cats. However, WS-Washington must be able to meet the need for action and has determined that take of up to 40 feral and free-ranging cats, this limited removal of feral or free-ranging cats would not adversely impact Washington feral and free-ranging cat population.

3.4.40 What are the Direct and Cumulative Impacts on Feral Domestic Rabbit Populations?

3.4.40.1 Feral Domestic Rabbit Life History

Feral domestic rabbits are periodically introduced from accidental and intentional releases typically in heavily populated areas of Washington State. Feral rabbits are capable of establishing self-sustaining populations if both genders are present and if pressure from predators is insufficient to suppress population growth. Forage for feral rabbits is herbaceous vegetation during the spring and fall when available in Washington but shifts to woody vegetation when more palatable forage is unavailable (typically in winter months and drier summer months). Breeding for rabbits begins in February and continues to late summer after a short 30-day gestation period can produce litters containing 4 to 8 young. Multiple litters may be produced each year in dense cover or in a burrow the female rabbit constructs. Females feed the young for 2 weeks until they can begin eating vegetation and at 4 weeks the female will lead young to foraging outside of the nest. Predators of rabbits are hawks, owls, dogs, coyotes, foxes, bobcats, mink, skunk, long-tailed weasel, gopher snake, and cats. High rates of mortality from predators tend to limit a rabbit's lifespan to under a year though they are capable of living for 2 or more years. (Washington Department of Fish and Wildlife 2019e)

3.4.40.2 Feral Rabbit Population Impact Analysis and Conclusion

In response to requests for assistance with feral rabbit damage between FY 2015 and 2019, WS-Washington removed an average of 10.4 target feral rabbits per year during the reporting period, 73% were taken on private lands and 27% were taken were on public lands. 60% were taken to protect aviation safety and the remaining 40% were removed from non-residential properties. WS-Washington has not lethally take non-target any feral rabbits per year during the analysis period. The most feral rabbits taken by WS-Washington in a single fiscal year was 16.

Based on cooperative service agreements and projected future requests for assistance, WS-Washington expects that future feral domestic rabbit removals for MDM would be similar to take during the last five years. WS-Washington has determined that take of up to 100 feral rabbits, this limited removal of feral rabbits would not adversely impact Washington feral rabbit population.

Take of feral rabbits by WS-Washington is considered to have no deleterious impact on the human environment because feral rabbits are not an indigenous component of the ecosystem in Washington.

3.4.41 What are the Comparative Impacts of the Alternatives on Mammal Populations?

3.4.41.1 Alternative 1. No Action Alternative: WS-Washington Continues MDM Assistance in Washington

The take for all target mammal species killed by WS-Washington on all land classes is presented for each species as a yearly total and five-year average for FY15-FY19 and summarized in Table 43. Between FY15 and FY19, the target species with the greatest average yearly take by WS-Washington for MDM were nutrias (n=532), coyotes (*n*=512), Northern pocket gophers (n=499.4), yellow-bellied marmots (*n*=415.2), beavers (n=406.2), Columbian ground squirrels (n=361.8), voles (*n*=296.2), eastern cottontail rabbits (*n*=154), and mountain beaver (n=121.4). All other target mammal species taken by WS-Washington are at an average of less than 50 per year. WS-Washington anticipates this level of take to continue, but for some species, WS-Washington has analyzed increased levels of take to accommodate unanticipated requests for assistance.

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-Washington. The number and type of requests for assistance with human-wildlife conflicts vary due to environmental, social, and economic factors, resulting in fluctuations in the type and amount of WDM provided by WS-Washington from year to year. WS-Washington expects that take of most target species in the foreseeable future will be similar to levels recorded from FY 2015 through FY 2019.

For all species in Washington included within the scope of this EA, the annual statewide known cumulative take is substantially below the annual maximum sustainable harvest level (Tables 43) as determined by a review of the available scientific literature. As indicated in the summary Table 43, the current cumulative take as a percentage of the population is below the annual maximum sustainable harvest level for all species. Even considering the projected WS annual maximum take, WS-Washington take for every species is below the annual maximum sustainable harvest level to ensure healthy and stable or increasing populations.

As indicated in Table 43, below, the majority of species populations targeted by WS-Washington are considered stable, though monitoring data are limited (Anis Aoude, WDFW, personal communication, January 06, 2021)(Kyle Garrison, WDFW, personal communication, 2020) and WDNR (Washington Department of Natural Resources 2017). Populations of all non-native species, free-ranging/feral cat, and feral/free ranging dog populations are unknown. Removal of non-native species is generally considered to have a positive impact on the environment and the limited amount of MDM conducted for free-ranging/feral cat, and feral/free ranging dog damage is not expected in impact those populations. Cumulative take and WS-Washington's direct incremental contribution to that cumulative take are substantially below the maximum sustainable harvest levels for all species. Even with unknown non-WS-Washington take, all target species populations continue to be healthy and sustainable as determined/reviewed by WDFW, WDNR, and these analyses. Based on the analysis, WS-Washington is not and would not significantly impact any native mammal species' populations under Alternative 1.

Table 43. Projected Annual WS-Washington's MDM Take and Reported Annual Take CY2015-CY2019 of all Species in this EA by Source[1].

Species	Projected WS-Washington Lethal Take	Highest Reported WCO Take	Highest Reported WDFW Conflict Take	Highest Recreational Harvest	Highest Reported Special Permit Take	Highest Reported Mortality	Projected Cumulative Take as Percent of Estimated Population	Annual Maximum Sustainable Harvest	Population Status
Black Bear	150	0	500	2,071	139	65	9.34% - 14.03%	16%	Stable
Mountain Lion	10	0	0	306	20	34	13.74%	30%	Stable
Elk[5]	50	0	251	5,572	0	274	12.76%	-	Stable
All Deer Species[1,6]	100	0	34	37,963	0	2,055	38.07%	-	Stable
Eastern Cottontail Rabbits[6]	500	0	0	11,811	2	0	19.09%	80%	Stable
Nuttall's Cottontail Rabbits[6]	50	0	0	11,811	0	0	4.16%	40%	Stable
Badger	10	8	0	7	0	0	0.06%	30%	Unknown
Beaver	1,000	739	35	1,245	1,178	0	4.94%	30%	Stable
Muskrat	300	21	0	1,237	230	-	1.85%	65%	Stable
River Otter[1]	100	7	7	250	66	0	7.61%	-	Stable
Mink[1]	10	8	0	109	0	0	0.93%	-	Stable
Bobcat	25	1	0	746	5	0	2.90%	20%	Stable
Red Fox	100	3	0	2	1	0	0.45%	60%	Stable
Raccoon	500	556	0	269	56	0	1.23%	49%	Stable
Mountain Beaver[1]	1,000	114	0	-	1,912	0	3.39%	-	Stable
Coyote	2,000	0	34	32,216	0	0	37.31%	60%	Stable
Yellow-bellied Marmots[1]	1,000	0	0	0	257	0	1.17%	-	Stable
Northern Pocket Gopher[1]	2,000	0	0	0	0	0	-	-	Stable
California Ground Squirrel[1]	500	0	0	0	0	-	-	-	Stable
Columbia Ground Squirrel[1]	2,000	0	0	0	0	-	-	-	Stable
Striped Skunk[1]	100	288	0	181	10	0	1.67%	-	Stable
Porcupine[1]	10	8	2	15	358	0	-	-	Stable
Voles[1,7]	2,000	0	0	-	0	0	-	-	Varied by Species-See text
Bats[1,7]	10	-	-	-	-	-	-	-	Varied by Species-See text

Douglas Squirrels[4]	0	0	0	-	0	0	-	-	Stable
California Sea Lions[4]	0	0	0	-	0	0	-	-	Stable
Steller Sea Lions[4]	0	0	0	-	0	0	-	-	Stable
Virginia Opossum[2]	200	97	0	0	7	0	-	-	Stable
Eastern Gray Squirrel[2]	50	255	0	52	16	0	-	-	Stable
Moles[1]	100	0	0	-	0	0	-	-	Stable
Eastern Fox Squirrel[2]	50	0	0	0	0	0	-	-	Stable
Nutria[2]	2,000	0	0	0	0	0	-	-	Stable
Black Rat[2]	200	0	0	-	0	0	-	-	Stable
Feral Swine[2]	100	0	0	-	0	0	-	-	Stable
Norway Rat[2]	200	0	0	0	0	0	-	-	Stable
Feral Dogs[3]	10	8	0	-	0	0	-	-	Unknown
Feral Cat[3]	50	-	-	-	0	0	-	-	Unknown
Feral Rabbits[2]	100	0	0	0	0	0	-	-	Unknown

[1] Population information or sustainable harvest information not available but are considered stable by WDFW or proposed take is low related to biological and ecological factors (e.g. animal fecundity, WDFW estimated population size)
[2] Non-native and non-game species in which are not managed for sustainable harvest and in which population status is not relevant
[3] Feral/free-ranging dogs and cats are managed by local authorities and their take cannot be estimated.
[4] No lethal take proposed (dispersal and trap/relocation efforts only)
[5] Take closely coordinated with WDFW and would only occur with WDFW approval except in situations involving human and health and safety
[6] WDFW take information groups multiple species (e.g. deer sp. And cottontail sp.), those numbers are used for each species analyze
[7] Specific species referenced in their respective sections as WS-Washington does not work with some of the protected species in that group.

3.4.41.2 Alternative 2. WS-Washington Provides Technical MDM Assistance for Lethal and Non-Lethal Methods and only Non-Lethal Operational Damage Management Assistance.

Under this alternative, WS-Washington operational damage management would be limited to non-lethal methods. Washington would have less take from its actions under this alternative, than under the proposed alternative (Alternative 1). Entities requesting lethal MDM assistance would have to attempt to remedy to problem themselves, or rely on WDFW, a commercial WCO or other private individual with the capabilities, approvals, and interest, if available. Other commercial, governmental, and private entities and landowners would be expected to continue to conduct MDM activities, as described in Section 2.2.1.8.

WCO's cannot conduct damage management on big game species, 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-Washington employees. WCOs may not have the experience or response capability with some of the species and methods if they are not already conducting MDM activities for those particular species (Section 3.4.2).

Depending on the readiness and interest of other entities to conduct MDM activities, the cumulative number of mammal removals could be greater than, less than, or similar to the cumulative take under Alternative 1. It is possible that more mammals could be taken by other entities, as a result of less selective removals. Conversely, fewer mammals may be removed in the absence of lethal operational damage management assistance from WS-Washington because there may be fewer entities readily available to help address conflicts, individuals experiencing damage may not take action themselves, and/or individuals may be less efficient in taking action themselves. Lastly, there is the potential for mammals to be removed by other entities at a similar level to WS-Washington's lethal take under Alternative 1.

Under Alternative 2, other entities would be expected to have a level of take similar to the cumulative take under Alternative 1. However, take of some mammal species by private individuals or their agent is not required to be reported to WDFW, potentially resulting in underreporting, compared to WS-Washington's reporting under Alternative 1. Cumulative take would not be expected to reach the annual maximum sustainable harvest levels established for the mammal species under alternative 2.

3.4.41.3 Alternative 3. WS-Washington Only Provides Lethal MDM Assistance for Cases of Human/Pet Health or Safety and /or to Protect Threatened or Endangered Species.

Under Alternative 3, WS-Washington would provide full MDM technical and operational damage management assistance (Appendix A), but lethal operational damage management assistance 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-Washington could not use lethal methods as part of MDM 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 mammal species of concern would be bears, cougars, or coyotes in residential areas, or disease vector species. Any species have the potential to be threats to T&E species. When WS-Washington responds with lethal operation damage management under the limited circumstances allowable under this alternative, the impacts on species populations from WS-Washington would be less than those described for Alternatives 1 and 2, because fewer individuals are removed under this alternative. Other commercial, governmental, and private entities and landowners would continue to conduct MDM activities as described in Section 3.4. Other entities would likely increase MDM actions in proportion to the reduction of services that would normally be provided by WS-Washington.

However, since WS-Washington 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-Washington employees. Take of unclassified mammals by private individuals or their agent is not required to be reported to WDFW, potentially resulting in underreporting, compared to WS-Washington's reporting under Alternative 1.

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 target species. Therefore, mammal populations are expected to be stable with similar levels of impacts as under Alternative 1.

3.4.41.4 Alternative 4. No WS-Washington MDM Activities

Under this alternative, WS-Washington would have no effect on mammal populations. Landowners experiencing damage or threats could only depend on advice and responses from commercial WCOs, WDFW, 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 MDM actions in proportion to the reduction of services that would normally be provided by WS-Washington.

Without WS-Washington's technical and operational damage management assistance, other entities may be less efficient and effective, potentially resulting in more mammals 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-Washington employees. Take of unclassified mammals by private individuals or their agent is not required to be reported to WDFW, potentially resulting in underreporting, compared to WS-Washington's reporting under Alternative 1.

In the absence of WS-Washington's assistance, the effects on mammal species populations would likely be higher than under Alternatives 1-3.

3.5 What are the Effects on Non-Target Species?

WS-Washington's MDM activities are highly selective for target species, but occasionally a non-target animal is taken. Between FY 2015 and 2019, WS-Washington killed an average of 9.2 non-target mammals per year during MDM activities, equaling 0.35% of the average lethal take of mammals in the five-year review period. The small proportion of unintentional take compared to intentional take during MDM activities shows that the proposed MDM methods and strategies are highly target specific.

Animals trapped unintentionally are released on site, and unharmed in most cases. Feral animals, such as stray dogs, may be taken to county animal control facilities. In cases where the animal does not appear able to survive or where release would be detrimental to the environment, WS-Washington would consult with the appropriate wildlife management agency about options for rehabilitation or WS-Washington personnel may euthanize the animal. Relocation of some animals is prohibited by state law or otherwise discouraged due to potential disease spread.

Table 44. Average Number of Non-Target Animals Taken During MDM Activities in Washington from FY15 – FY19.

Species	Average Killed	Average Released	Section where Population Analysis can be Found
Feral Dog	0	0.6	3.4.27.17
Feral Cat	0	2.6	3.4.27.16
Red Fox	0.2	0.2	3.4.11
Minks	0.2	0.6	3.4.25.23
Muskrats	1.8	3	3.4.16
Opossums	1.6	1.4	3.4.27.24
Pika	0.8	0	See below
River Otter	2.8	2	3.4.17
Eastern Cottontail Rabbit	0.4	0	3.4.19
Norway Rats	0.6	0	3.4.27.21
Raccoons	0.2	1.2	3.4.21
Black Rats	0.2	0	3.4.27.20
Eastern Gray Squirrels	0	0.8	3.4.27.12
Spotted Skunk	0.2	0	3.4.27.23

With the exception of pika and spotted skunk, the effect of take on species listed in Table 44, below, are provided in section 3.4, above. Pika and spotted skunk are the only species taken during MDM activities that are not also a target of MDM. WS-Washington has not been requested to assist with pika or spotted skunk damage, nor do we anticipate this activity in the future. WS-Washington has taken an average of 0.8 pika per year and 0.2 spotted skunk per year during MDM activities. Pika are not state or federally listed species, but their populations are sensitive to habitat loss (montane talus habitat) (Washington Department of Fish and Wildlife 2015c). The population of pika in Washington is currently unknown, however the take of 1 pika per year is not likely to significantly impact the population. The population of spotted skunk in Washington is currently unknown, however the take of 1 spotted skunk every 5 years is not likely to significantly impact the population.

Wolverines (*Gulo gulo*) are known to inhabit in remote, mountainous areas of Washington state, but occasionally venture out of that habitat. The remoteness of their preferred habitat generally puts them away from humans and MDM activities. The Washington population is thought to be approximately 25 individuals. WS-Washington is not proposing to target wolverines in MDM activities, nor is there likely to be any overlap in the proposed activities and wolverine habitat. In the unlikely event that a wolverine is known to venture outside of its traditional range or habitat type where WS-Washington has ongoing MDM activities, extra precautions would be taken, in coordination with WDFW, to avoid impacting them. Precautions may include removal or temporary suspension of MDM activities in the immediate vicinity. It is highly unlikely that MDM would impact the wolverine population in Washington.

3.5.1 What are the Comparative Impacts of the Alternatives on Populations of Non-Target Animals Taken?

3.5.1.1 Alternative 1. Proposed Action/No Action Alternative: WS-Washington Continues MDM Assistance in Washington

WS-Washington kills a small number of non-target animals each year. From FY15 – FY19, an average of 9.2 non-target animals were killed, and an additional 11.8 animals captured and freed unharmed or relocated. This amounts to less than 1% of the total lethal take by WS-Washington during the same time frame and supports the conclusion that the application of MDM methods by WS-Washington is highly selective for target species. Take of all mammal species was evaluated in Section 3.4 as part of the cumulative effect analysis, with the exception of pika.

Because WS-Washington's MDM activities are highly selective for target animals, WS-Washington anticipates impacts to non-target species will remain low under Alternative 1. WS-Washington would use the protective measures outlined in Section 2.4 of this EA to protect non-target species.

3.5.1.2 Alternative 2. WS-Washington Provides Lethal and Non-lethal Technical MDM Assistance and Non-lethal Operational Damage Management Assistance

Under this alternative, WS-Washington operational damage management would be limited to non-lethal methods. Washington would have less non-target take from its actions under this alternative, than under the proposed alternative (Alternative 1). Entities requesting lethal MDM assistance would have to attempt to remedy to problem themselves, or rely on WDFW, a commercial WCO or other private individual with the capabilities, approvals, and interest, if available. Other commercial, governmental, and private entities and landowners would be expected to continue to conduct MDM activities, as described in Section 2.2.1.8.

The number of animals unintentionally killed under this Alternative could be greater than, less than, or similar to the non-target take under Alternative 1. Other entities would likely increase their lethal MDM actions in proportion to the reduction of services that would normally be provided by WS-Washington. 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-Washington employees. In addition, many of the protective measures used by WS-Washington to minimize adverse effects (Section 2.4) may not be implemented by private individuals. This may result in more non-target animals being captured or killed. Conversely, fewer non-target animals may be removed in the absence of lethal operational damage management assistance from WS-Washington because there may be fewer entities readily available to help address conflicts, and because individuals experiencing damage may not take action themselves. However, WS-Washington take is already very low (less than 1% of total lethal take), so the reduction in non-target take under this alternative is unlikely to be appreciable.

Although it is not possible to anticipate exactly how many additional non-target animals would be taken by non-WS-Washington entities, it is assumed that non-target take would remain low relative to their populations. This alternative has a higher potential for non-target take by other entities than Alternative 1. However, because the mammal species in this EA are generally resilient and cumulative take is below the current annual maximum sustainable harvest level (Section 3.5), the impacts to populations of non-target animals under this alternative is expected to remain low.

3.5.1.3 Alternative 3. WS-Washington Provides MDM Lethal Assistance Only for Cases of Human/Pet Health or Safety and/or to Protect Threatened or Endangered Species

Under Alternative 3, WS-Washington would provide lethal and non-lethal MDM technical and operational damage management assistance (Appendix A), but lethal methods could only be used when responding to requests to protect human/pet health or safety or federally-listed T&E species. WS-Washington could not use lethal methods as part of MDM to protect other resources, such as livestock, agriculture, property, and natural resources. Because operational damage management actions would be limited, WS-Washington would take fewer non-target animals than Alternative 1. Other commercial, governmental, and private entities and landowners would continue to conduct MDM activities as described in Section 2.2.1.8.

When lethal assistance is necessary, requestors could request help from WDFW, a commercial WCO, or other private individual. Other entities would likely increase their lethal MDM actions, compensating for the reduction in WS-Washington activities. Take of unclassified mammals by private individuals or their agent is not required to be reported to WDFW, potentially resulting in less accurate reporting of take for some species.

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-Washington employees, increasing the risk of taking non-target animals. Therefore, this Alternative has a higher potential non-target take than Alternatives 1 and 2. However, because mammal species are generally resilient and below the current annual maximum sustainable harvest level (Section 3.5), the impacts to populations of non-target animals from all actions under this alternative are expected to remain low.

3.5.1.4 Alternative 4. No WS-Washington MDM Activities

WS-Washington would have no non-target take of individual animals under this alternative. Landowners experiencing damage or threats could only depend on assistance from commercial WCOs, WDFW, or private entities, if available. Other entities would likely increase lethal MDM actions in proportion to the reduction of services that would normally be provided by WS-Washington. 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-Washington employees, increasing the risk of taking non-target animals.

Although it is not possible to anticipate exactly how many additional non-target animals would be taken by non-WS-Washington entities, it is assumed that non-target take would remain low relative to their populations. Therefore, there is a potential for higher levels of non-target take by other entities, compared to Alternatives 1-3. However, because mammal species are generally resilient and below the current annual maximum sustainable harvest level (Section 3.5), the populations of taken non-target animals are expected to remain stable.

3.6 What are the Effects of WS-Washington MDM on Threatened and Endangered Species?

WS-Washington is responsible for ensuring its actions comply with the federal Endangered Species Act (ESA). Depending on which agency manages the species, WS-Washington consults with USFWS or NMFS on any action that has the potential to affect federally listed threatened or endangered species. WS-Washington also coordinates with WDFW to minimize impacts to state-listed species in Washington.

3.6.1 How Has WS-Washington Considered Potential Impacts on Threatened and Endangered Species?

In compliance with the Endangered Species Act, WS-Washington has completed Section 7 consultation with the USFWS and NMFS for effects from all of its activities on federally-listed T&E species. There are 3 current consultations that cover the MDM work included in this EA, including:

1) Formal Consultation with USFWS completed on July 21, 2014 (U.S. Fish and Wildlife Service 2014a), for the effect of WS-Washington's activities on Pacific Coast Distinct Population Segment (DPS) of western snowy plover (*Charadrius nivosus nivosus*), streaked horned lark (*Eremophila alpestris strigata*), the Lower 48-States and Mexico gray wolf (*Canis lupus*), and the grizzly bear (*Ursus arctos horribilis*)),
2) Informal Consultation Letter of Concurrence from USFWS, issued on July 21, 2014 (U.S. Fish and Wildlife Service 2014b)for the effect of WS-Washington activities on bull trout (*Salvelinus confluentus*), Canada lynx (*Lynx canadensis*), Columbia River DPS of Columbia white-tailed deer (*Odocoileus virginianu*s leucurus), and Columbia Basin DPS of pygmy rabbit(*Brachylagus idahoensis*).
3) Formal Consultation with NMFS, Biological Opinion issued on March 13, 2019 (National Marine Fisheries Service 2019) regarding effect of aquatic mammal damage management activities on ESA listed salmonids including; Puget Sound (PS) Chinook salmon (*Oncorhynchus tshawytscha*), Lower Columbia River (LCR) Chinook salmon, Upper Columbia River (UCR) spring-run Chinook salmon, Snake River (SR) spring/summer-run Chinook salmon, SR fall-run Chinook salmon, Columbia River (CR) chum salmon (*Oncorhynchus keta*), Hood Canal summer-run chum salmon, LCR coho salmon (*Oncorhynchus kisutch*), PS steelhead (*Oncorhynchus mykiss*), LCR steelhead, Middle Columbia River (MCR) steelhead, UCR steelhead, or Snake River Basin (SRB) steelhead, UWR spring-run Chinook salmon, Lake Ozette (LO) sockeye salmon (*Oncorhynchus nerka*), SR sockeye salmon, UWR steelhead.
4) Informal Consultation Letter of Concurrence from USFWS, issued on March 19, 2021regarding the effects of chlorophacinone (EPA Reg. No. 7173-151 Rozol Pellets1, SLN No. WA060019) use for managing mountain beaver damage to timber in Washington on the northern spotted owl (*Strix occidentalis caurina*).

WS-Washington continues to consult with the USFWS and NMFS as needed to maintain compliance with the ESA for WS-Washington activities.

3.6.2 Which T&E Species Would Not be Affected by WS-Washington MDM Activities?

WS-Washington has determined that its MDM activities would have no effect on some T&E species because WS-Washington does not conduct MDM in areas where or in a manner that would affect these species. Species that would not be affected by WS-Washington MDM activities are listed below.

- **Species of fish:** green sturgeon Southern DPS (*Acipenser medirostris*), eulachon Southern DPS (*Thaleichthys pacificus*)

- **Species of mammals:** woodland caribou (*Rangifer tarandus caribou*), Mazama pocket gopher (*Thomomys mazama*), blue whale (*Balaenoptera musculus*), false killer whale main Hawaiian islands insular DPS (Pseudorca crassidens), fin whale (*Balaenoptera physalus*), gray whale Western North Pacific DPS (*Eschrichtius robustus*), humpback whale Western North Pacific DPS (*Megaptera novaeangliae*), killer whale Southern resident DPS (*Orcinus orca*), North Pacific right whale (*Eubalaena japonica*), Sei whale (*Balaenoptera borealis*), sperm whale (*Physeter macrocephalus*), Steller sea lion Western DPS (*Eumetopias jubatus*)

- **Species of birds:** marbled murrelet (*Brachyramphus marmoratus*), short-tailed albatross (*Phoebastria (=Diomedea) albatrus*), yellow-billed cuckoo (*Coccyzus americanus*)

- **Species of invertebrates:** Taylor's checkerspot butterfly (*Euphydryas editha taylori*)

- **Species of reptiles and amphibians:** Green sea turtle (*Chelonia mydas*), Leatherback sea turtle (*Dermochelys coriacea*), Loggerhead sea turtle (*Caretta caretta*), Olive (=Pacific) ridley sea turtle (*Lepidochelys olivacea*), Oregon spotted frog (*Rana pretiosa*)

- **Species of plants:** Golden paintbrush (*Castilleja levisecta*), Umtanum desert buckwheat (*Eriogonum codium*), showy stickerseed (*Hackelia venusta*), water howellia (*Howellia aquatilis*), Bradshaw's desert parsley (*Lomatium bradshawii*), Kincaid's lupine (*Lupinus sulphureus spp. kincaidii*), white bluffs bladderpod (*Physaria douglasii ssp. tuplashensis*), Nelson's checker-mallow (*Sidalcea nelsoniana*), Wenatchee Mountains checker-mallow (*Sidalcea oregana var. calva*), Spalding's catchfly (*Silene spaldingii)*, Ute Ladies'tresses (*Spiranthes diluvialis*)

3.6.3 Which T&E Species May Be Affected by MDM Activities?

WS-Washington has determined that some animal and plant species may be affected by some aspects of MDM. The effects analyses for each of these species, based on USFWS/NMFS consultations, are summarized in Table 45.

Table 45. Federally-listed T&E Species Potentially Affected by MDM Activities in Washington

Species	Status	ESA Determination
Gray wolf	E	LAA
Streaked horned lark	T	LAA
Northern spotted owl	T	NLAA
Western snowy plover	T	LAA
Bull trout	T	NLAA
Canada lynx	T	NLAA
Columbian white-tailed deer	E	NLAA
Grizzly bear	T	LAA
Pygmy rabbit	E	NLAA
Chum Salmon Hood Canal Summer-Run	T	LAA
Sockeye Salmon Lake Ozetta	T	NLAA
Chinook Salmon Puget Sound	T	LAA
Steelhead Puget Sound	T	LAA
Steelhead Middle Columbia River	T	LAA
Chinook Salmon Snake River Fall-run	T	LAA
Chinook Salmon Snake River Spring / Summer-run	T	LAA
Sockeye Salmon Snake River	E	NLAA
Steelhead Snake River	T	LAA
Chinook Salmon Upper Columbia River Spring-run	E	LAA
Steelhead Upper Columbia River	T	LAA
Chum Salmon Columbia River	T	LAA
Chinook Salmon Lower Columbia River	T	LAA
Coho Salmon Lower Columbia River	T	LAA
Steelhead Lower Columbia River	T	LAA
Chinook Salmon Upper Willamette River	T	NLAA
Steelhead Upper Willamette River	T	NLAA

[1] T= Threatened E=Endangered [2] NLAA=Not likely to adversely affect [3] LAA=Likely to adversely affect

3.6.4 What are the Potential Effects on Threatened and Endangered Animal Species?

This section summarizes analysis conducted during Section 7 consultations with USFS and NMFS. Those consults will be made available with the EA as Supplemental Information.

3.6.4.1 Listed populations of Steelhead and Salmon

Anadromous fish (e.g. salmon and steelhead) spend one portion of their life history in freshwater habitats, spawning and early development of juveniles occurs in freshwater, once the species' early developmental period (varies by species) is complete that population migrates to the ocean to feed and develop further, and lastly the species migrates back to freshwater spawning grounds to reproduce. Steelhead can, though often do not, make the migratory journey and spawn multiple times. Washington's salmonids were considered abundant throughout the region in the waterways they currently inhabit. Habitat loss and water quality degradation from development, inputs to waterways from surrounding land uses, destruction of spawning habitats, or introduction of impassible fish barriers (any barrier that prohibits fish movement upstream) paired with historically unsustainable harvest practices have reduced the abundance and stability of listed Washington's salmonids resulting in their ESA listing.

WS-Washington has completed consultation with NOAA NMFS under Section 7 of the ESA for effects of WS-Washington's aquatic mammal damage management activities on federally-listed threatened and endangered salmonids. While beaver activity may help or hurt salmonids, depending on factors such as time of year, water levels, and location, the potential remains for WS-Washington to affect listed salmonids by removing beaver from a watershed[40]. To minimize effects on listed salmonids, WS-Washington abides by the following Terms and Conditions, as prescribed by NMFS:

1. Beaver removal at 20 sites statewide over any given 5-year period within critical habitat or other habitat occupied by ESA-listed salmonids, excluding removals in the following situations:
    a. Stream channels greater than 33 feet wide or in lakes;
    b. "Built environment" sites where it has been determined by an engineer or road supervisor that the beaver activity poses a threat to public infrastructure and safety;
    c. Habitat restoration sties, where the beavers are preventing the restoration from succeeding.
    d. Sites where beaver dams have blocked culverts or other transportation crossings to the extent that fish passage is prevented, and/or
2. A maximum of three of these beaver removal sites within any HUC6 within any given 5-year period.

[40] Beaver "removed" from a watershed includes those lethally removed and those live trapped and relocated. Beaver relocations are regulated by WDFW and may not result in a beaver being released in the same watershed from which it was captured. So while beaver removal may result in relocation, the consultation considered the "worst case scenario" of the beaver not being replaced in critical habitat.

3. Conducting monitoring sufficient to document that the proposed methods are adhered so that the terms and conditions are implemented, and that the extent of take is not exceeded.

NMFS considered the indirect effects of the proposed action by examining the number of beaver that may be removed from ESA-listed salmon habitat, the effects of beaver dams on stream ecology and salmonid habitat, the characteristics of sites where beaver removal is likely to occur, benefits of increasing water flow, and beaver relocation efforts. They concluded that the proposed removal of beaver will not have an appreciable impact on the listed salmon abundance or productivity, but that take of juvenile salmon may result from the loss of rearing habitat. Similarly, NMFS concluded that the proposed level of beaver removals in not likely to preclude or delay development of critical habitat (National Marine Fisheries Service 2019).

NMFS determined that direct effects from the proposed MDM activities would be "short-term and not likely injure, harm, or reduce the fitness of any individual salmon or steelhead or negatively impact critical habitat" (National Marine Fisheries Service 2019). Therefore, the BO concluded that the proposed action is not likely to jeopardize the continued existence of steelhead or salmon populations. WS-Washington will implement all Reasonable and Prudent Measures prescribed by NMFS in the BO, and therefore, we do not anticipate any significant effects to listed salmon and steelhead populations. WS-Washington will reinitiate consultation under Section 7 if the there is any change to the activities that could result in adverse effects to the species or if new information becomes available.

3.6.4.2 Gray Wolf

In November 2020, USFWS published the delisting of gray wolves, which goes into effect in January 2021. This delisting will be reviewed by the courts and WS-Washington will remain flexible to protect wolves under either scenario. WS-Washington is not proposing to target wolves under any circumstances, whether they are listed or delisted.

When federally-listed in Washington, the legal status of gray wolf under the Endangered Species Act depends on where the animal is physically located. Gray wolves have been federally-listed as endangered in parts of Washington that are west of the NRM DPS boundary (Figure 30). The population of wolves occurring east of this boundary has exceeded its designated recovery objectives and therefore has been removed from the federal endangered species list (75 FR 15123). This area east of the boundary was analyzed consistent with the state plan by WDFW 2011 in the action area for the USFWS Biological Opinion for gray wolf in Washington (U.S. Fish and Wildlife 2014a).

As of the end of 2019, population counts by WDFW and the Confederate Tribes of Colville Reservation estimate that the minimum population in Washington is 145 wolves composing 26 packs. This is an 11% increase over the previous year's counts and is likely an under estimation of the population (Washington Department of Fish and Wildlife 2020). Two new wolf packs were identified by WDFW in 2019, but other packs are likely to have disbanded (Washington Department of Fish and Wildlife 2020).

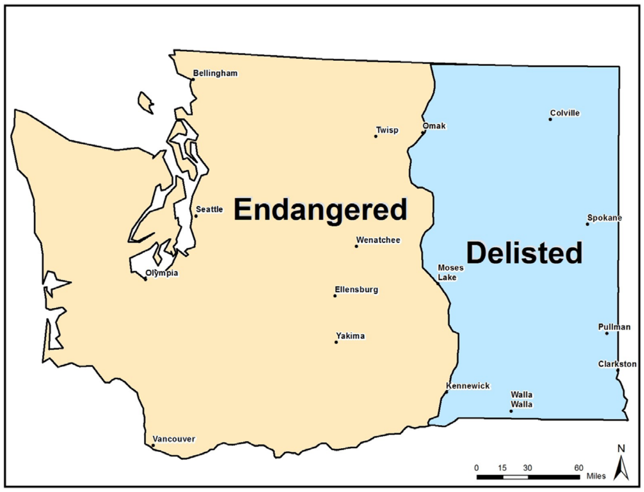

Figure 2. Federal classification of wolves in Washington State, 2019.

Should wolves be officially delisted, they would remain protected as a Washington State endangered species. WS-Washington would continue to implement protective measures to avoid capture of gray wolves. WS-Washington will continue to implement protective measures to avoid take of gray wolves, as described in the next section.

3.6.4.2.1 Protective Measures if Wolves are Federally-listed

The USFW Biological Opinion determined that the majority of WS-Washington's MDM methods are *not likely to adversely affect* (NLAA) gray wolves, and therefore a l*ikely to adversely affect* determination was made for certain methods. However, foothold traps and foot snares do have the potential to capture gray wolves. In the event that a gray wolf is captured, it would be released at the site of capture unless WDFW or USFWS direct otherwise. In compliance with the consultation, WS-Washington checks traps every 24-hours.

To minimize potential impacts of MDM to wolves and in accordance with the 2014 BO, WS-Washington implements the following conservation measures to reduce the likelihood of capturing a wolf.

1. When doing pre-trap or operational reconnaissance for federally listed wolves and for wolf sign in areas that may contain wolves, howling will be conducted to facilitate detection if it is appropriate for the surroundings.

2. While targeting coyotes and other predators, and where pre-trapping reconnaissance discovers recent sign of federally listed wolves, or pre-trapping coordination reveals recent reliable observations, WS WA may resort to non-

trapping alternatives to achieve their objectives if capture of a wolf in that area is not deemed to be desirable. When capture of a wolf is deemed desirable by WS WA and wildlife agencies, WS WA will follow appropriate protocols provided by the wildlife agencies and all conservation measures that apply in case they inadvertently capture a wolf.

When conducting MDM within federally-listed gray wolf mapped landscape areas (MLAs):

1. When controlling predators smaller than wolves, traps and equipment must be of sufficient strength to adequately restrain any wolf without equipment failure or allow the wolf to pull free from the trap. Stakes would be preferable in these situations as staking may allow a captured wolf to pull-out of the trap more easily.
2. When conducting predator control, no traps or snares would be used within 0.5 mile of occupied federally listed wolf den sites, known active rendezvous sites, or areas of recently documented pup activity from May 1 to July 15, and within 1 mile of these areas from July 15 to October 1, unless approved on a case-by-case basis by the USFWS.
3. WS-Washington does not use neck snares anywhere in Washington.

WS-Washington does not target gray wolves, has not had any incidental take of gray wolves, and continues to implement the Reasonable and Prudent Measures outlined in the consultation. If there is any change to WS-Washington's activities or if new information becomes available that would alter the analysis or conclusion of the BO, WS-Washington will reinitiate consultation under Section 7 of the ESA. Therefore, the proposed actions are not likely to result in significant effects to gray wolves in Washington.

3.6.4.2.2 Protective Measures if Wolves are Federally-delisted

Evan after federal delisting, wolves will remain state-listed as endangered. Regardless of their state classification, WS-Washington is careful to preclude the capture of gray wolves in all MDM. Site reconnaissance is a started practice used by WS-Washington personnel, and it is implemented during all trapping activities to determine if any non-target species may be present.

1. When necessary to protect wolves from MDM activities, WS-Washington will use traps and equipment must be of sufficient strength to adequately restrain any wolf without equipment failure or allow the wolf to pull free from the trap. Stakes would be preferable in these situations as staking may allow a captured wolf to pull-out of the trap more easily.
2. When practicable, WS-Washington will avoid trapping within 0.5 miles of known dens and rendezvous sites, from May 1 to October 1.
3. WS-Washington does not use neck snares anywhere in Washington.

WS-Washington concludes that the use of these methods is sufficient to preclude take or harm of wolves, and proposed MDM activities will not have a significant impact to the gray wolf population in Washington.

3.6.4.3 Canada Lynx

Populations of Canada lynx in the US are under threat from habitat loss (logging, thinning, and fire suppression), past over-harvest, range expansion by competitors such as bobcats and coyotes, and the intrusion of roads, trails, off-road vehicles, and snowmobiles.

Potential lynx habitats in Washington, such as Douglas fir (*Pseudotsuga menziesii*) and western spruce fir forests above 5,000 ft. elevation in the Cascade Mountains are isolated from occupied habitats in Washington and Idaho. WS-Washington seldom operates in areas likely to be occupied by lynx. If MDM is conducted “in or adjacent to boreal or subalpine forest within a mapped landscape area for lynx”, species specific conservation measures will be implemented in accordance with the 2014 consultation (U.S. Fish and Wildlife Service 2014a), including:

1. Initial mapped landscape areas for lynx (depicted in Appendix A) will be the Landscape Analysis Units as mapped by WDFW with recent documented occupancy (i.e., since 2003). These may change on an annual basis following review with the wildlife agencies and others.
2. Contact WDFW and USFWS to obtain most-recent lynx distribution information. Conduct pre-trapping reconnaissance to detect any potential lynx sign prior to setting traps. If recent sign or recent observations are noted, alternative methods that are more selective will be used in lieu of trapping to achieve WS WA objectives unless otherwise approved on a case-by-case basis by the USFWS after considering public safety and animal welfare. Additional conservation measures for the mapped landscape area will be implemented if trapping continues - see below.
    a. Increase pan tension.
    b. Avoid using visual attractants, such as flashers.
    c. Avoid using feline-specific scents.
    d. Avoid fresh baits.
    e. Use neck snares only as a last resort and only with prior approval from USFWS. [41]
    f. If neck snares are approved, utilize other reasonable and effective measures (e.g., increase height of neck snares [bottom of loop 18 or more inches above level of ground or snow], avoid chin sticks, set stops at sufficiently large diameter, etc.) to avoid capture of lynx.

[41] This was a stipulation of the consultation, but WS-Washington stopped using neck snared in 2019. All references to neck snares in the context of the Biological Opinion are included only to reflect the entirely of the terms and conditions prescribed at the time.

g. Change methods when feasible (e.g., to ground shooting) to decrease accidental capture.

There have been no lynx captured by WS-Washington. Based on the analysis in the consultation, USFWS concurred that potential impacts to lynx were discountable and not likely to adversely affect lynx. Therefore, the proposed action will not have significant effects on Canada lynx.

3.6.4.4 Western Snowy Plover

WS-Washington will coordinate with and follow all guidelines provided by USFWS and WDFW regarding appropriate places to drive, general types of areas to avoid, locations of nests/broods, and measures to minimize the risk of accidentally disturbing broods when conducting nest predator control on beaches.

3.6.4.5 Streaked Horned Lark

The streaked horned lark, a small ground-dwelling subspecies of the wide-ranging horned lark, is only found in the Pacific Northwest. Development of the flat bunch grass prairie habitat necessary for this species to breed has resulted in the extirpation of the species from the majority of its breeding range. Airports are maintained as open, short grass areas that provide the necessary structure and forage for larks to breed and have become some of the last areas streaked horned larks actively breed. Breeding populations are found at McChord Field at Joint Base Lewis-McChord and Olympia Regional Airport the where WS-Washington conducts IWDM activities for protecting human safety. Other areas WS-Washington conducts MDM that the lark may inhabit include portions of the Washington coast and lower Columbia River islands with dredge spoil deposition at industrial sites along the river.

MDM to reduce predation is a critical component of streaked horned lark recovery (U.S. Fish and Wildlife Service 2014a). WS-Washington may participate in efforts to reduce streaked horned lark predation at the request of landowners/managers on federal, state, tribal, or private lands. MDM activities and tools may have adverse effects on the streaked horned lark, but the risks are minimal due to the following reasons:

- WS-Washington coordinate closely with USFWS and WDFW to minimize impacts to lark occupied nest sites.
- Disturbance due to vehicles would be temporary in nature and short in duration and lark would most likely not abandon the area.
- Disturbance due to firearms would be temporary in nature and short in duration and lark would most likely not abandon the area. With positive target identification, any harm to lark from firearms is unlikely.
- Disturbance due to paintballs, spotlights, pyrotechnics, or other hazing technics would be temporary in nature and short in duration and lark would most likely not abandon the area.

- APHIS-WS will not use zinc phosphide in areas where lark are known to occur without further consultation.

Additionally, WS-Washington employs the conservation measures in accordance with the 2014 USFWS BO. These include the following:

On Beaches

1. WS WA will follow all guidelines provided by USFWS and WDFW regarding appropriate places to drive and general types of areas to avoid when conducting nest predator control on beaches.
2. WS WA will not drive through the dunes and vegetation. Driving will be constrained to the beach below the wrack line and will avoid both the swash zone and wrack line to the maximum extent possible. Additional caution will be used if driving near other debris concentrations. Driving would occur on the sands wetted by the recent tides and to the maximum extent practicable would avoid driving in older tire ruts. WS WA may park just above the high tide in a safe location.
3. WS WA will coordinate with refuge and WDFW biologists immediately prior to going into areas used by larks. WS WA will be given updated GPS locations of active nests and/or locations of broods to minimize the risk of accidentally stepping on nests or disturbing broods.

On Airports with Larks

1. WS-Washington will restrict vehicle travel to established runways, paved roads, or to specific designated tracks (located in areas without documented lark nesting) at McChord airfield, to the extent practicable.
2. WS-Washington will coordinate with lark survey crews to obtain locations of current active nests and report any nests or broods incidentally discovered.
3. WS-Washington will be given updated GPS locations of active nests and/or locations of broods to minimize the risk of accidentally stepping on nests or disturbing broods.
4. Avoid entry into nesting areas as identified by survey crew except as needed to protect nests or as necessitated for human and aircraft safety.

USFWS concluded that WS-Washington's MDM activities did not affect critical habitat and are not likely to appreciably reduce the likely of species recovery. Therefore, the proposed actions will not result in any significant effect to the streaked horned lark.

3.6.4.6 Grizzly Bear

Within grizzly bear MLAs:

- WS-Washington staff participating in trapping of large predators (cougars or black bear) will be trained in the identification of grizzly bears (particularly in distinguishing between black bears and grizzly bears) and grizzly bear sign.

- Staff participating in trapping of large predators (cougars or black bear) would be trained in implementation of techniques to avoid accidentally trapping grizzly bears.
- WS-Washington staff conducting capture of large predators (cougars or black bear) would be trained in chemical immobilization and in handling of large predators or be accompanied by WS-Washington staff that have been so trained.
- Use of foot snares and foot-hold traps for cougars or black bears would be limited.
- WS-Washington would prioritize the methods to be used with more-selective methods (e.g., shooting or aerial darting) being preferable. Generally, more-selective measures would be attempted first in an overall step-wise progression of control.
- When using formulated or commercial scents at trap sites, WS-Washington would utilize scents that are less attractive to grizzly bears (e.g., wolf urine vs. scents resembling natural bear foods).
- If foot snares are used for the capture of black bears or cougars, all snares used would be grizzly sized snares with ¼-inch steel cables anchored to fixed positions and equipped with appropriate swivels. This is to ensure that if a non-target grizzly bear is captured the snare will hold the animal (rather than breaking away from the anchor and the grizzly bear escaping with the snare remaining on the leg) until it can be safely immobilized and released.
- Neck snares would not be used.

3.6.4.7 Bull Trout

Bull trout are members of the salmon family known as char. Bull trout are native throughout the Pacific Northwest. In Washington, bull trout were historically found in major tributaries to the Columbia River on the eastside of the Cascades; major tributaries on the west side of the Cascades flowing into the Puget Sound; and major tributaries to the Olympic Mountains flowing into the Hood Canal, Strait of Juan de Fuca, and the Pacific Ocean (Washington Fish and Wildlife Office). Although still found in some these watersheds there numbers are reduced by a number of factors including reduced habitat quality and introduced non-native trout species.

Risk of adverse effects on these fish species are minimal due to the following reasons:

- Shooting with firearms is a selective tool with targets being positively identified before shooting them, and the likelihood of fish being accidentally shot is very low.
- While fish could potentially spring or activate traps, no fish have ever been captured by Washington APHIS-WS.
- Most of the conflicts with animals are in lower reaches or heavily disturbed water systems and not in bull trout habitat.

Additionally, APHIS-WS employs the minimization measures found in Section 2.4 C.

Based on the reasons describe, including the implementation of the minimization measures (Section 2.4 C), the USFWS concurred with WS-Washington's determination that such activities are not likely to adversely affect the bull trout in Washington. Therefore, there will be no significant effects to bull trout from the proposed actions.

3.6.4.8 Columbian White-tailed Deer

The Columbian white-tailed deer (CWTD) is the western-most subspecies of white-tailed deer. Habitat changes caused by humans, such as farming, logging, land development, overhunting, and poaching, have reduced populations. Currently, the remaining Columbian white-tailed deer occur in two separate populations – the lower Columbia River population in Clatsop, Columbia, and Multnomah counties in Oregon and Clark, Cowlitz, and Wahkiakum counties in Washington State. When the Columbian white-tailed deer was first listed, the number was estimated to be less than 1,000 individuals. Under the protection of the Endangered Species Act, the Douglas County population has increased to over 5,000 animals (U.S. Fish and Wildlife Service and Oregon Fish and Wildlife Office 2017). In Washington State the CWTD population remains more confined and thus smaller totaling 600 deer in 2014 (Azerrad 2016).

During consultation, WS-Washington identified risks to Columbia white-tailed deer from 2 of the proposed MDM methods: foot-hold traps and foot snares. WS-Washington very rarely conducts MDM in the Columbia white-tailed deer range, and only anticipates using doing so to reduce predation on the Columbia white-tailed deer in the future. When using those tools in Columbia white-tailed deer range, WS-Washington implements appropriate minimization measures to prevent the capture of non-target species. WS-Washington has not captured any Columbia white-tailed deer in the last 30 years. USFWS concurred that the proposed action is not likely to adversely affect the species, because potential effects are "discountable". Therefore, the proposed action will not result in any significant effects to Columbian white-tailed deer.

3.6.4.9 Columbia Basin DPS of Pygmy Rabbit

The pygmy rabbit is the smallest rabbit in North America, with adults typically weighing less than one pound. It is patchily distributed in the sagebrush-dominated areas of the Great Basin in portions of Oregon, California, Nevada, Utah, Idaho, Montana, and Wyoming.

During consultation, WS-Washington identified risks to pygmy rabbit from use of rodenticides and fumigants. WS-Washington very rarely conducts MDM near pygmy rabbit MLAs and any work conducted within MLAs is coordinated with USFWS and WDFW. All MDM work conducted by WS-Washington adheres to relevant ESA consultations, USFWS concurred during the 2014 ESA consultation (U.S. Fish and Wildlife Service 2014b) that the proposed action is not likely to adversely affect the species, because potential effects are "discountable". Therefore, the proposed action will not result in any significant effects to pygmy rabbit.

- Avoid use of chemicals such as rodenticides and rodent fumigants within the range of pygmy rabbits (depicted in Appendix B) if within or adjacent to (within 100 feet) suitable habitat (deep loamy soils and 10 percent or more cover of sagebrush that is over 20 inches tall). When WS WA is unsure whether an area meets this definition, they will contact USFWS for clarification or assistance.

Within pygmy rabbit MLAs:

1. Avoid rodenticide and fumigant use within or adjacent to (100 feet) suitable pygmy rabbit habitat.

2. Contact USFWS and WDFW prior to operating in MLAs

3.6.4.10 Northern Spotted Owl

Northern spotted owls were listed on June 26, 1990, Federal register 55 FR 26114-26194. Critical habitat occurring mostly on U.S. Forest Service lands was designated in 2008 and a revised recovery plan was published on June 30, 2011. During consultation, WS-Washington identified risks to spotted owls from use of chlorophacinone. Application of chlorophacinone occurs after a trapping regimen and in accordance with the label. All MDM work conducted by WS-Washington adheres to applicable ESA consultations. USFWS concurred that the proposed action is not likely to adversely affect the species, considering the present conditions for the northern spotted owl in the project area, and the project design and timing (U.S. Fish and Wildlife Service, 2021). Therefore, the proposed action will not have significant effects on the northern spotted owl. This determination was based on the facts that a) the action only occurs on commercial timberlands to protect forest regeneration; b) spotted owls do not target adult mountain beaver and they do infrequently consume juvenile mountain beaver which are not present during application of chlorophacinone; and c) bait packages are applied underground and are inaccessible to spotted owls.

WS-WA follows the Washington SLN label restrictions, which include the following (EA Section 2.3):

1. Application shall not occur from mid-May to mid-September when juvenile mountain beavers are present.
2. Maximum Annual Application Rate is two bait packets per burrow system per year.
3. Bait shall not be broadcast and shall not be applied by any method not specified on the label.
4. The label also states that chlorophacinone shall not be used where impact on listed threatened or endangered species is likely.

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: WS-Washington Continues MDM Assistance in Washington

This alternative is for the current activities that were assessed in Biological Opinions by NMFS and USFWS. Since at least FY 2001, WS-Washington has had no incidental take of state- or federally-listed T&E individuals while conducting MDM activities. WS-Washington follows all reasonable and prudent measures and terms and conditions required in its July 21, 2014 Biological Opinion from USFWS (2.4 C, WS Directive 2.310) and March 13th, 2019 Biological Opinion from NMFS (Section 2.4 C WS Directive 2.310). In the Biological Opinions from USFWS and NMFS made determinations that the actions proposed by WS-Washington are not likely to jeopardize any threatened or endangered species. Additionally, USFWS and NMFS concurred with the majority of WS-Washington's determination that some species (list in figure 3.7.4.1 section 3.7) that may be affected by MDM are not likely to be adversely affected based on the protective measures documented in the informal consultations and Sections 2.4 C, and WS Directive 2.310 (Section 2.4 C). In addition, some MDM activities are conducted by WS-Washington for the protection of T&E species. WS-Washington would continue to adhere to or update all Section 7 consultations as required by the ESA.

3.6.5.2 Alternative 2. WS-Washington Provide Technical MDM Assistance for Lethal and Non-Lethal Methods and Non-Lethal Operational Damage Management Assistance

Under this alternative, WS-Washington would provide non-lethal and lethal technical assistance, and non-lethal operational damage management assistance only. Other commercial, governmental, and private entities and landowners would be expected to continue to conduct MDM activities as described in Section 3.4. WS-Washington would have less impact to ESA listed species under this alternative as any impacts from lethal operational damage management assistance would not be present.

With this alternative, WS-Washington would use the APHIS-WS Decision Model for providing advice and technical assistance, as well as training on identification of species, and possibly individual animals, causing damage. Entities requesting lethal assistance would have to determine if a WDFW, commercial WCO, or other private individual with the capabilities, approvals, and interest is available, or attempt to address their MDM needs themselves (as discussed in Section 3.4).

WDFW and WCOs are available to resolve some types of mammal damage or landowners can request someone to work as their agent. There are currently no other entities besides WS-Washington and WDFW who actively work for the protection of endangered species or have the ability to conduct aerial operations for livestock damage conflicts. While other entities would likely be prohibited, WDFW may conduct work for protection of natural resources to include ESA listed species but may not have the economic or personnel resources to maintain the same level of protections that WS-Washington provides. Aerial operations for livestock damage prevention is highly target specific and under this alternative would likely be replaced by trapping from WCOs and private individuals. This shift from shooting to trapping would likely result in a higher incidence of non-target take and a higher potential to impact T&E species specifically the gray wolf.

There is a potential for other entities (as discussed in Section 3.4) to attempt to fill the need for lethal MDM activities in the absence of lethal operational damage management assistance from WS-Washington. Other entities would likely increase lethal MDM actions in proportion to the reduction of services that would normally be provided by WS-Washington. 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-Washington employees. WCOs may not have the experience or response capability with some of the species and methods if they are not already conducting activities for those particular species (Section 3.4.2). Depending on the skillset of others in minimizing non-target captures, the impacts of trapping on ESA listed species could be greater or lesser than under Alternative 1.

Only federal entities are required to complete a section 7 consultation and therefore other entities would be less likely to have fully assessed their potential impact and would not receive conservation measures to reduce those impacts. Landowners or private entities may have a larger impact than WS-Washington or WDFW would due to having less proficiency in the range of methods and being less selective with their use. In addition, many of the protective measures used by WS-Washington, especially those required in the biological opinions of USFWS and NMFS to minimize adverse effects (Section 2.4) may not be implemented by private individuals.

WS-Washington would not be available to provide lethal MDM for the protection of T&E species. Other entities may not be trained to identify T&E species and their habitats or be able to conduct lethal MDM activities to protect T&E species from predation, unless authorized by USFWS.

Since WS-Washington has not taken any T&E species, any increase in risk or take of a T&E species by other entities would be likely to have greater adverse effects on T&E species populations when compared to Alternative 1.

3.6.5.3 Alternative 3. WS-Washington Provides MDM Lethal Assistance Only for Cases of Human/Pet Health or Safety and/or to Protect Threatened or Endangered Species

Under Alternative 3, WS-Washington would provide full MDM technical and operational damage management assistance, 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-Washington could not use lethal methods as part of MDM 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 mammal species of concern would be bears, cougars, or coyotes in residential areas, disease vector species, or beaver for public safety risk due to damaging infrastructure. Any mammal species that have the potential to be threats to T&E species could also be removed. When WS-Washington responds with lethal control of mammal species under the limited circumstances allowable under this alternative, the impacts on T&E species from WS-Washington would be less than those described for Alternatives 1, 2, and 3 since fewer animals are removed under this alternative. Other commercial, governmental, and private entities and landowners would continue to conduct MDM activities as described in Section 3.4.

WS-Washington 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 WDFW, a commercial WCO, or other private individual with the capabilities, approvals, and interest is available (as discussed in Section 3.4). Aerial operations for livestock damage prevention is highly target specific and under this alternative would likely be replaced by trapping from WCOs and private individuals. This shift from shooting to trapping would result in a higher incidence of non-target take and a higher potential to impact T&E species specifically the gray wolf. Non-federal entities do not complete ESA Section 7 consultations, and it would be difficult to determine what, if any, protective measures were in place by individual landowners to minimize 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 MDM activities to protect T&E species from predation, unless authorized by USFWS.

This alternative retains WS-Washington's ability to protect T&E species and therefore adverse effects to T&E species would likely be less than effects under Alternative 2. However, WS-Washington has not taken any T&E species, 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 Alternative 1.

3.6.5.4 Alternative 4. No WS-Washington MDM Activities

WS-Washington would have no effect on T&E species under this alternative. T&E species would not benefit from MDM conducted by WS-Washington for T&E species protection. Landowners experiencing damage or threats could only depend on advice and responses from commercial WCOs, WDFW, 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). Negative impacts on T&E salmonids would be likely from reduction in water quality (siltation from flooding, and damage to habitat restoration projects) and blocking of fish passage. Aerial operations for livestock damage prevention is highly target specific and under this alternative would have to be replaced by trapping from WCOs and private individuals. This shift from shooting to trapping would result in a higher incidence of non-target take and a higher potential to impact T&E species specifically the gray wolf. Non-federal entities do not complete ESA Section 7 consultations, and it would be difficult to determine what, if any, protective measures were in place by individual landowners to minimize the take of T&E species. Additionally, T&E species would not benefit from the MDM conducted by WS-Washington 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 MDM activities to protect T&E species from predation, unless authorized by USFWS. Furthermore, other entities may not be able to conduct lethal MDM activities to protect T&E species from predation, unless authorized by USFWS.

Since WS-Washington has not taken any T&E species, 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 1-3.

3.7 What is the Potential for WS-Washington MDM Activities to result in Trophic Cascades or Affect Biodiversity and Ecosystem Resilience?

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 Washington. 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.

Similar concerns have been raised regarding the removal of beaver from natural habitats. Beaver provide numerous ecological benefits, including providing habitat for ESA-listed species. The significance of beaver to ecosystems is addressed in Section 3.7.2.1, below.

WS-Nevada does not dispute the significance of the ecological role played by these species. 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 MDM by focusing IPDM on specific individuals or localized groups.

Our analysis, however, indicates that the MDM activities evaluated in this EA are not expected to cause trophic cascades. This section will discuss why WS-Washington

MDM activities do not affect mammal populations, 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 3.4), provides the basis for WS-Washington's conclusion that proposed MDM activities are highly unlikely to cause trophic cascades or adversely affect biodiversity and ecosystem resilience in Washington.

3.7.1 Trophic Cascades

A trophic cascade is an indirect ecological effect that occurs when one trophic group is modified to an extent that is affects other trophic groups in a food web. In a simple example, predators, their herbivore prey, and plants that provide food for the herbivores are three trophic groups that interact in a food web. Predator presence potentially interacts with other trophic groups through reductions in herbivore prey populations or alteration in herbivore prey species' use of habitat that subsequently changes plant community composition, stability, and function. Depending on the nature of the impacts 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, Ripple and Beschta 2006b). In the Midwest, changes in coyote activity were documented to impact white-tailed deer activity and plant community composition (Waser et al. 2014). However, as with most ecosystems, the nature and magnitude of these types of relationships varies. For example, Maron and Pearson (2011) found no evidence that the presence of vertebrate predators fundamentally affected primary production or seed survivals in a grassland ecosystem.

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 mammals (EA Section 3.4), 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 this EA. Therefore, unlike the Yellowstone examples, Washington 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 (Appendix F.8.1; e.g., (Polis et al. 1989, Palomares et al. 1995, Litvaitis and Villafuerte 1996, Palomares et al. 1996, Arim and Marquet 2004, Finke and Denno 2005, Berger and Gese 2007, Daugherty et al. 2007);

- **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 (Appendix F.8.2; e.g., (Crooks and Soule 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) For example, the presence of coyotes in an area has been shown to limit the density of smaller predators which may prey more heavily than coyotes on songbirds, ground nesting birds such as ducks and game birds, and some rodents (Levi and Wilmers 2012, Miller et al. 2012). Carnivores such as badgers, bobcats, and fox have also been shown to increase in number when coyote populations are reduced (Robinson 1961, Nunley 1977, Crooks and Soule 1999);.

- **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 (Appendix F.9.1; e.g., (Gese et al. 1996b;a, Gese 1998;1999, Kitchen et al. 2000, Schmitz et al. 2004, Peckarsky et al. 2008, Wallach et al. 2009b, Wilson et al. 2010, Berger-Tal et al. 2011);

- **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 (Appendix F.9.2; e.g., (Polis et al. 1989, Arjo et al. 2002, Wilmers et al. 2003b, Finke and Denno 2005, Gehrt and Prange 2006, Atwood et al. 2007, Brook et al. 2012, Lendrum et al. 2014);

- **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 (Appendix F.11; (Hooper et al. 2005, Srivastava and Vellend 2005, Balvanera et al. 2006, Casula et al. 2006, Duffy et al. 2007, Cleland 2011, Ritchie et al. 2012);

- **Ecosystem services**, wherein ecosystems provide sustainable ecological services to humans, such as food, crop pollination, clean water, and clean air (Appendix F.11; e.g., (Duffy 2003, Hooper et al. 2005, Srivastava and Vellend 2005, Balvanera et al. 2006, Dobson et al. 2006, Duffy et al. 2007, Cleland 2011).

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, challenges to conducting and interpreting research of complex and dynamic ecological systems, 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.

3.7.1.1 What is the Risk that WS-Washington's Actions may Result in Trophic Cascades or Mesopredator Release?

Some individuals have expressed concerns that activities such as WS-Washington's MDM would cause disruptions to trophic cascades or irruptions in prey populations, such as rodents or rabbits, by eliminating or substantially reducing top predators (Crooks and Soule 1999, Prugh et al. 2009, Ritchie and Johnson 2009, Estes et al. 2011, Bergstrom et al. 2014). WS-Washington has reviewed these studies by for the most part they are not applicable to the types of PDM proposed for Washington, because they involve the complete absence of apex consumers from the system (e.g. Beschta and Ripple (2006b), Frank (2008), Gill et al. (2009), Estes et al. (2011), Ripple and Beschta (2012), Ripple et al. (2013)) In some instances, impacts have also been observed in cases where the predators were substantially reduced over and extended period of time (e.g. Henke (1992), Henke and Bryant (1999), Wallach et al. (2010) discussed above).

The data on the impacts of coyotes and coyote removal on prey populations are mixed. In two studies conducted in south Texas (Beasom 1974, Guthrey and Beasom 1977), intensive short-term predator removal was employed to test the response of game species to reduced coyote abundance. At the same time, rodent and lagomorph species were monitored. A marked reduction in coyote numbers had no notable effect on the populations of rabbits or rodents in either study. Similarly, Neff et al. (1985) noted that reducing coyote populations on their study area in Arizona to protect pronghorn antelope fawns had no apparent effect on rodent or rabbit populations.

Wagner and Stoddart (1972) noted that coyote predation is significant source of mortality in jackrabbit populations and may have played an important part in jackrabbit population trends. But they made no connections between PDM and jackrabbit mortality or coyote populations. Moreover, the coyote population in this study was subject to much more sustained and intensive control (coyotes were taken through use of aerial PDM, trapped for bounties and pelts, and the use of 1080 poison bait stations that were placed in fall and recovered in spring) than is expected to occur under current and projected WS-Washington MDM actions.

Wagner (1988) reviewed literature on PDM impacts on prey populations and concluded that such impacts vary by location. In some ecosystems, prey species, such as snowshoe hares, increased to the point that vegetative food sources were depleted, despite predation. In others, coyotes might limit jackrabbit density, whereas food shortages do not (Wagner 1988, Stoddart et al. 2001). Wagner and Stoddart (1972) reported that coyote predation was a major source of jackrabbit mortality in the Curlew Valley of Utah that may have caused a decline in the local jackrabbit population.

Henke (1995) reviewed literature concerning coyote-prey interactions and concluded that short-term coyote removal efforts (<6 months per year) typically did not result in increases of small mammal prey species populations. This finding is supported by Gese (2005) in which local coyote removal of up to 60% to 70% of the population for two consecutive years in a 131 mi^2 study had no observable impact on local lagomorph abundance. Some of the reason for this lack of impact may have been attributable to the fact that coyote pack size and density in the project area returned to pre-removal levels within 8 months of removal. Henke (1995) also concluded that long-term intensive coyote removal (nine months or longer per year) could, in some circumstances, result in changes to the rodent and rabbit species composition in the area where removals occurred, which could lead to changes in plant species composition and forage abundance. This conclusion was based on a previous study (Henke 1992) conducted in the rolling plains of Texas that involved one year of pretreatment and two years of treatment. Removals occurred year-round and resulted in a sustained reduction in the coyote population of approximately 48%. After the initiation of coyote removal, species richness and rodent diversity declined in treatment areas and relative abundance of badgers, bobcats, and gray foxes increased. However, sustained reduction in coyote populations (and presumably other mesopredators) after restoration of wolf populations resulted in increases in the number of voles within 3 km of wolf dens (Miller et al. 2012).

The Gunnison Sage-grouse Rangewide Steering Committee (2005) cited studies of red fox and coyote home ranges in duck breeding area of North Dakota as evidence that red fox numbers may increase if coyote numbers are reduced. Sargeant et al. (1984) reported on the effects of red fox predation on breeding ducks. Their data were collected when coyote populations were presumably suppressed by widespread use of predacides, and he notes that at the time (1968-73), "[c]oyote populations in most of the midcontinent area appear to be suppressed by man." The authors noted an inverse relationship between red fox and coyote populations and speculated that "protection of coyotes will result in expansion of local or regional populations that in turn will cause reductions in fox populations." They inferred that this would reduce predation on upland nesting ducks. Sargeant et al. (1987) reported on spatial relationships between coyotes and red foxes and showed that home ranges of fox families did not overlap the core centers of coyote home ranges on a North Dakota study site. Although none of their radio collared foxes were killed by coyotes in their study, they hypothesized that red foxes tended to avoid coyote territories, presumably because of the fear of being killed by coyotes. Thus they inferred that the red fox population would increase if the coyote population was reduced, because the removal of territorial coyotes would create vacant coyote territories that could then become occupied by red foxes.

However, other research has demonstrated that the presence of coyotes does not completely displace red foxes. Voigt and Earle (1983) verified that red fox travel through coyote areas during dispersal but did not establish. There also reported that "individual foxes and coyotes can occur in close proximity to each other along territory borders and when coyotes travel into fox areas." They also noted that "fox-coyote range overlap near borders was similar to fox-fox range overlap near borders and that coyotes do not completely displace foxes over areas." Gese et al. (1996b) reported that coyotes tolerated red foxes about half of the time when encountered in Yellowstone National Park, although they would sometimes show aggression toward and kill the foxes.

Other studies suggest that coyote territories would not remain vacant for very long after coyotes are removed. Gese (1998) noted that adjacent coyote packs adjusted territorial boundaries following social disruption in a neighboring pack, thus allowing for complete occupancy of the area despite removal of breeding coyotes. Blejwas et al. (2002) noted that a replacement pair of coyotes occupied a territory in approximately 43 days following removal of the territorial pair. Williams et al. (2003) noted that temporal genetic variation in coyote populations experiencing high turnover (due to control) indicated that "localized removal did not negatively impact population size…." Considering the level of coyote removals that WS MDM activities achieve (less than 3% of the estimated population), it is most likely that coyote populations are probably not impacted enough, even at the individual territorial level, to create the vacant territories that would theoretically allow red fox populations to increase substantially at the local level based on the North Dakota studies discussed above.

Ripple and Beschta (2007) and Beschta and Ripple (2012) examined a trophic cascade involving wolves, aspen and elk in Yellowstone National Park. The study documented the first significant growth of aspen on the northern winter range in the park (Ripple and Beschta 2007). They claimed their findings were consistent with a behaviorally-mediated and density-mediated trophic cascade. They presented data showing an increasing wolf population with a concurrent decrease in the elk population and increase in the growth rate of aspen. Additionally, as elk populations decreased, bison and beaver increased, possibly due to increased forage from grass and aspen growth Beschta and Ripple (2012). However, while Ripple and Beschta (2007), Beschta and Ripple (2012) documented population responses from bison and beaver, growth of grasses and forbs during a period of elk population decline, wolf predation may have been compensatory and not a major cause of the elk population decline. Vucetich et al. (2005) and White and Garrott (2005) analyzed the extent wolf predation contributed to elk population decline from 17,000 to 8,000 on northern range in Yellowstone National Park. They determined that the elk population declined due to legal hunting outside the park and weather. Wolf predation on elk in the park was compensatory (Vucetich et al. 2005). White and Garrott (2005) also documented the large effect legal hunting had on reducing the elk population in Yellowstone National Park. Additionally, they recommended a reduction in female elk harvest to not accelerate the decrease in elk numbers. Whereas Ripple and Beschta (2007) documented a correlation, these other studies show that is was not a demonstrative cause and effect.

An impact sustained over a period of decades was found at a site in Zion National Park which was largely avoided by cougars due to high human activity (Ripple and Beschta 2006a). The decrease in cougars resulted in increase in mule deer, and associated increases in herbivory on riparian cottonwoods. Ultimately, this resulted in decreased cottonwood regeneration in the riparian area, increases in bank erosion, and reduction in both terrestrial and aquatic species abundance. However, this is another example of dramatic and long-term population reduction, which is not analogous to WS-Washington MDM.

As discussed in this EA, WS-Washington only conducts MDM when and where it is requested. MDM's primary goal is resolving the damage so when operational damage management assistance of a depredating animal(s) is needed, deterrents or removal target the specific depredating animal or local group of animals. WS-Washington does not strive to eliminate or remove mammals from any area on a long-term basis, no mammals would be extirpated, and none would be introduced into an ecosystem. As discussed in detail in Sections 1.10.4 and 2.3.1, impacts are generally temporary and in relatively small or isolated geographic areas compared to overall population distributions. Therefore, we conclude that the impacts of WS-Washington actions are not of sufficient magnitude or scope to result in ecosystem-level shifts in trophic cascades. Most removal of mammals for MDM by WS-Washington involves removal of a small percentage of individuals of the total population from relatively isolated locations. This level of removal is not sufficient magnitude to result in substantive reductions in mammal species abundance. The only species taken by WS-Washington activities in sufficient numbers to result in substantive short-term local population reductions are coyotes.

Given the limited scope of WS-Washington MDM actions, repopulation of areas where MDM is conducted occurs relatively quickly, often within a year of the removals. As noted above in the section on biodiversity and ecosystem resilience, removals are not expected to result in long-term reductions in pack density or the number of coyotes, despite potential reductions in the age structure of the population (Gese 2005).

In the study by Gese (2005) a combination of aerial PDM and trapping removed approximately 44-61% and 51-75%, respectively, of an estimated coyote population from a 131 mi^2 project over the first and second year of a two-year study. Removals resulted in substantial reductions in coyote pack size and an associated decrease in density, but both pack size and density rebounded to pre-removal levels within 8 months. Radio collar data and shifts in age structure support the hypothesis that the coyotes colonizing the area after control were non-territorial individuals, which included yearlings from adjacent reproducing pairs of coyotes. The coyote population in the removal area had a younger age structure than the control area. Home range size did not vary for coyotes remaining after coyotes in adjacent territories were removed litter size did not differ substantially after the first year of winter and spring coyote removals but increased the second year. Average litter size was correlated to the density of coyotes entering the breeding season. Increases in available prey the second year of the removals also have influenced coyote reproductive success, with a significant positive correlation between prey per coyote and litter size. However, lagomorph (i.e. rabbits) abundance increased in both the area with coyote removal and the control area without coyote removal and likely was not the result of coyote removals. The seasonality of the coyote removal in the Gese (2005) study was similar to that which occurs in WS-Washington, but the proportion of the coyote population removed in Gese (2005) study was likely higher than typically occurs in Washington.

Similarly, red foxes are highly mobile, and MDM actions are patchy in nature. Because of strong compensatory density feedback, primarily through immigration

(Lieury et al. 2015), removals are not expected to result in long-term reductions in fox. Given the above factors, we believe it is unlikely that MDM actions by WS-Washington would result in unintended adverse impacts on ecosystems through perturbation of trophic cascades, or specifically, mesopredator release.

Most evaluations of the impacts of mammal 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 mammal species, including 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 native mammal species 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 mammal 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 cascades 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-Washington works closely with state and federal wildlife managers and landowners 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 WS-Washington MDM activities (Alternative 1) do not result in the direct or indirect loss of any wildlife species population or sustained reduction in mammal population densities.

WS-Washington's take of potential mammal species is small compared with state-wide population estimated for those species. The cumulative take of mammals in Washington (Section 3.4) is substantially below that of the annual maximum sustainable harvest level for each species. WS-Washington's take for each species is a lower proportion of the cumulative take than all non-WS take sources reported to WDFW.

Since WS-Washington does not have significant effects on target and non-target species populations (Sections 3.5, 3.6, and 3.7), there is no potential for the elimination native species, and the conditions to precipitate a trophic cascade are not produced. The limited nature of WS take of MDM species is so low that substantive long-term shifts in population age structure do not generally occur

(Section 3.5). Under Alternative 1, we anticipate similar levels of MDM and take; thus, there would be no potential for WS-Washington's actions to result in trophic cascades or mesopredator releases.

3.7.1.2 What are the Impacts of MDM on prey populations?

Rabbit and rodent populations normally fluctuate substantially in multi-year cycles. Keith (1974) concluded that: 1) during cyclic declines in prey populations, predation has a depressive effect, further decreasing prey populations and holding them for some time at relatively low densities; 2) prey populations may escape this low point when predator populations decrease in response to low prey populations; and 3) because rabbit and rodent populations increase at faster rate than predator populations, factors other than predation must initiate the decline in populations.

Wagner and Stoddart (1972) and Clark (1972) independently studied the relationship between coyote and black-tailed jackrabbit populations in northern Utah and southern Idaho. Both concluded that coyote populations respond to an abundance of jackrabbits by shifting their diet toward jackrabbits. Conversely, when a broad range of prey species is available, coyotes generally feed on all species available; therefore, coyote populations may not vary with changes in the availability of a single prey species (Knowlton 1964, Clark 1972).

Wagner (1988) reviewed the impacts of predators on prey populations and concluded that such impacts vary with the locale. In some ecosystems, prey species such as snowshoe hares increase to the point that vegetative food sources are depleted despite predation. In others (e.g. jackrabbits in the Great Basin), coyotes may limit jackrabbit density, and food shortages do not seem to limit jackrabbit abundance. Wagner and Stoddart (1972) reported that coyote predation was a major source of jackrabbit mortality and may have caused a decline in jackrabbit numbers in the Curlew Valley in Utah.

Henke (1995) reviewed literature concerning coyote-prey interactions and concluded that short term (≤6 months per year) coyote removal typically does not result in increases in small mammal prey species populations, but that longer term intensive coyote removal (9 months or longer per year) can in some circumstances result in changes in rodent and rabbit species compositions, which may lead to changes in plant species composition and forage abundance. The latter conclusion was based on one study Henke (1992) which was conducted in the rolling plains of Texas. Whether such changes would occur in all ecosystems in unknown. But even if they would, the following mitigating factors should serve to minimize these types of environmental impacts:

(1) Most MDM actions in localized areas of the State would not be year round, but would occur for short periods of damage occurs (reactive damage management operations), or for a short duration (typically less than 20 days per year) just before and during calving and lambing seasons (preventative damage management operations).

(2) WS-Washington typically conducts MDM in less than 0.97% of the land area of Washington in any year and takes only a small percentage (<0.65%) of the state's population of coyotes in any one year. Thus, any potential impacts would be small or negligible, and limited to isolated areas.

Other prey species of coyotes included T&E species (e.g. snowy plover, Columbian white-tailed deer). Coyote removals done to benefit T&E species or livestock may positively or negatively affect non-listed prey species populations, depending on whether prey populations were at or below the capacity of the habitat to support them. Because WS-Washington only conducts PDM on less than 3% of the land area of the state and takes less than 0.9% of the coyote population in any one year, it is unlikely that positive or negative effects on non-T&E prey species populations would be significant, except in isolated areas where MDM was designed to produce such results, at the request of WDFW or USFWS. If WDFW or a Tribe requested coyote removal for the purpose of enhancing T&E species or game species, an increase in local populations would be desired and considered a beneficial impact on the human environment. In those situations, it is likely that concentrated, and longer-lasting efforts of coyote removal would occur, but would end if T&E species or game species management goals were met. Even in such a scenario, it is unlikely that impacts would be significant over major portions of the state.

In general, it appears that predators prolong the low points in rodent population cycles and spread the duration of the peaks. Predators generally do not "control" rodent populations (Clark 1972, Wagner and Stoddart 1972, Keith 1974). It is more likely that prey abundance controls predator populations, especially a species such as the lynx which exhibits a classical predator-prey relationship with snowshoe hare. The U.S. Fish and Wildlife Service (1979) concluded that "[APHIS-WS] Program activities have no adverse impacts to populations of rodents and lagomorphs." WS-Washington activities directly involving prey species covered in this EA have no significant impacts (Section 3.5) and as discussed in this section and Section 3.5, WS-Washington's MDM will not significantly affect prey populations.

3.7.2 Biodiversity and Ecosystem Resilience Related to Beaver Activities

Biodiversity refers to the variety of species within an ecosystem. Ecosystem resilience refers to the magnitude of disturbance that can be absorbed before the system redefines its structure by changing the variables and processes which control behavior (Gunderson 2000). In diverse ecosystems, there is a degree of redundancy in the roles species play within the different ecological levels (e.g. apex predators, mesopredators, herbivores, plants, decomposers). In general, ecosystems that are less complex in terms of biodiversity and trophic levels, are more susceptible to adverse impacts and stressors such as climate change, disease outbreaks, introduction of invasive species, etc. In other words, such less complex ecosystems can have lower ecosystem resilience (Crooks and Soule 1999) (Beschta et al. 2013) (Ritchie and Johnson 2009) (Estes et al. 2011) (Bergstrom et al. 2014).

Beaver are known for their construction of dams which alters hydrology and creates valuable wetlands. Beaver ponds can create wetlands that provide habitat for many species of fish and wildlife (Arner and DuBose 1980, Baker and Hill 2003, White et al. 2015). Wetlands provide aesthetic and recreational opportunities for wildlife observation, nature study, hunting, fishing, trapping, wildlife photography, livestock water and environmental education[42]. The creation of standing water, edge, and plant diversity in close proximity, constitutes ideal wildlife habitat, especially for bird species (Arner and DuBose 1980, Baker and Hill 2003, White et al. 2015). The resulting wetland habitat may be beneficial to some fish (including salmonids), reptiles, amphibians, waterfowl, shorebirds, and furbearers such as muskrats, river otter, and mink (Arner and DuBose 1980, Naiman et al. 1986, Miller and Yarrow 1994). When the ponds are abandoned, they progress through successional stages which improve feeding conditions for deer (Odocoileus spp.) (Arner and DuBose 1980). The USFWS estimates that up to 43% of the T&E species rely directly or indirectly on wetlands for their survival (U.S. Environmental Protection Agency 1995).

Beaver dams have the potential to impact local hydrology, ecology, and nutrient cycles (e.g. groundwater seepage and infiltration, water temperature, water turbidity, water nutrient composition, water chemical composition; diversity and abundance of associated vegetative and faunal communities; and soil nutrient composition). Beaver dams streams have been shown to increase diversity, abundance, nutrient content, dissolved oxygen content, and surface water infiltration, while lowering water temperature and turbidity. Beaver ponds may also improve soil quality and provide improved habitat for some fish and invertebrates. The anaerobic conditions in beaver impoundments caused by saturated soil increase the size of the organic layer of saturated soils which was shown to increase soils retention of nitrogen and carbon as well as increase downstream contributions of those nutrients (Naiman et al. 1994). Arner et al. (1967) found that the bottom soils of beaver ponds in Mississippi were generally higher in phosphate, potash, and organic matter than the bottom soils of feeder streams.

Beavers contribute to biodiversity and ecosystem resilience by diversifying the environments they inhabit. The building and rebuilding of beavers dams over seasons and years creates a mosaic of different-aged ponds in a watershed (Pollock et al. 2015). Beaver ponds contained greater amounts of invertebrates and healthier fish than were found in the streams feeding those ponds in Mississippi (Arner and DuBose 1980). Research has also shown that beaver activity benefits salmonids by increasing edge habitat, improving water quality, and connecting floodplains with side channels (Pollock et al. 2007, Pollock et al. 2015, Bouwes et al. 2016, Weber et al. 2017, Wathen et al. 2019). These wetland ecosystems filter

[42] These activities added an estimated $59.5 million to the national economy in 1991 U.S. Environmental Protection Agency. 1995. Wetlands Fact Sheets. O. o. W. U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds, . EPA843-F-95-001.

nutrients and reduce sedimentation, which maintains the quality of water systems (Wade and Ramsey 1986, Arner and Hepp 1989). Aquatic and early successional plants may become established in the newly deposited sediment allowing conditions to become favorable for the stabilization of a flood plain by more permanent woody vegetation (Pollock et al. 2007, Pollock et al. 2015).

3.7.2.1.1 Impacts of Beaver Removal on Biodiversity and Ecosystem Resilience

Removal of beaver from an ecosystem can lead to the degradation and/or eventual failure of a beaver dam or other water blockage. Without beaver present, the blockage may naturally degrade, or it may be removed by a non-WS entity, such as a road department or private landowner.

The potential for adverse effects from MDM activities on natural habitats, wetlands, and streams is low because WS-Washington only responds to request for assistance where there is damage associated with human-wildlife conflict. Human-wildlife conflicts generally occur in built environments, such as roadways, irrigation structures, or residential areas, where natural habitats are limited by surrounding land uses. The landowner or manager requesting assistance from WS-Washington determines what course of action is taken to alleviate the damage and meet their management goals. In general, built environments are unlikely to be allowed to return to a natural ecosystem. Therefore, lethal removal of beaver from built environments is not likely to have a significant impact on biodiversity[43].

Only a small portion of WS-Washington's beaver removal is likely to occur in natural areas there is a potential to affect ecosystem resilience and biodiversity. WS-Washington has completed consultation with USFWS and NMFS to ensure there are no significant effects to any federally-listed species or critical habitat. As described in Section 3.6.4, WS-Washington follows the Terms and Conditions prescribed by NMFS in the 2018 Biological Opinion to protect habitat and ecosystems that sensitive species rely on. Therefore, there is unlikely to be a significant effect on ecosystem resilience and biodiversity from proposed MDM activities.

3.7.2.1.2 Impacts of Other MDM on Biodiversity and Ecosystem Resilience

WS-Washington MDM activities would occur in localized areas and immigration may replace removed individuals with individuals not likely to cause damage reducing long term impacts as previously discussed (Section 2.3.1). Most evaluations of the impacts of mammal removal or loss on biodiversity involve the complete removal of a species from the ecosystem for multiple years (e.g. Berger et al. (2001), Beschta and Ripple (2006a), Frank (2008), Gill et al. (2009). WS-Washington's actions will not result in long-term extirpation or eradication of any wildlife species, so findings of most of these studies are not relevant to the proposed action. WS-Washington operates in accordance with international, federal, and state laws and

[43] WS-Washington does not conduct beaver dam or debris removal from waterways. Those actions may be performed by the land manager under their discretion and required permits.

The number of mammals taken annually by WS-Washington and other entities is a small percentage of the sustainable harvest levels and estimated populations of those species in the state. The analysis in this EA and in GAO (1990) indicate that the impacts of the current WS-Washington activities on biodiversity are not significant statewide or nationally. Any reduction of a local population or groups would be temporary because natural immigration from adjacent areas or reproduction from remaining animals would replace the animals removed, unless actions are taken by landowner/manager to make the site unattractive to the target species. The limited nature of proposed WS-Washington take for species listed in this EA is low and therefore shifts in population age structure are not anticipated (Section 3.4). Based on that analysis, we conclude that the impacts of the proposed WS-Washington MDM activities are not of sufficient scale or to significantly impact biodiversity or ecosystem resilience.

3.7.3 What are the Comparative Impacts of the Alternatives on Biodiversity, Ecosystem Resilience, Trophic Cascades?

3.7.3.1 Alternative 1. Proposed Action/No Action Alternative: WS-Washington Continues MDM Assistance in Washington

APHIS-WS continues to acknowledge that important ecological role played by predators, beavers, and other mammalian species. However, due to the targeted nature of MDM, including the short duration of activities, small geographic scope, and low level of take compared to the populations, the localized MDM anticipated proposed in this alternative are not expected to alter any existing ecosystems or their processes.

The effects of WS-Washington's activities are temporary, localized, and of low magnitude. Negative population-level effects on mammals from the proposed activities are very unlikely because mammal populations are stable under the current and projected levels of cumulative take. Therefore, under Alternative 1, it is highly unlikely that WS-Washington's current and projected direct or cumulative take is contributing to any trophic cascades, mesopredator releases, or any resulting adverse ecological effects on biodiversity, ecosystem resilience, or ecosystem services.

3.7.3.2 Alternative 2. WS-Washington Provides Technical MDM Assistance for Lethal and Non-Lethal Methods and Non-lethal Operational Damage Management Assistance

Under this alternative, WS-Washington would provide non-lethal and lethal technical assistance, but only non-lethal operational damage management assistance. Other commercial, governmental, and private entities and landowners would be expected to continue to conduct MDM activities as described in Section 2.3.2. WS-Washington would have no lethal take under this alternative.

With this alternative, WS-Washington would use the APHIS-WS Decision Model for providing advice and technical assistance, as well as training on identification of species, and possibly individual animals, causing damage. 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 MDM needs themselves (as discussed in Section 3.3). WCOs are not authorized to conduct big game damage management unless under authorities of a landowner's damage management agreement with WDFW, 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-Washington employees. WCOs may not have the experience or response capability with some of the species and methods if they are not already conducting MDM activities for those particular species (Section 3.3.2).

There is a potential for other entities (as discussed in Section 3.3) to conduct increased lethal MDM activities in the absence of lethal operational damage management assistance from WS-Washington. Other entities would likely increase lethal MDM actions in proportion to the reduction of services that would normally be provided by WS-Washington. Depending on the readiness and interest of other entities to conduct MDM activities, the cumulative number of mammal removals could be greater than, less than, or similar to the cumulative take under Alternative 1. It is possible that more animals could be taken by other entities, as a result of less selective removals effort. Conversely, fewer animals may be removed in the absence of lethal operational damage management assistance from WS-Washington because there may be fewer entities readily available to help address conflicts, and because individuals experiencing damage may not take action themselves. Lastly, there is the potential for mammals to be removed by other entities at a similar level to WS-Washington's lethal take under Alternative 1.

Under Alternative 2, other entities would be expected to have a higher level of take compared to Alternative 1. Take of unclassified mammals by private individuals or their agent is not required to be reported to WDFW, potentially resulting in underreporting, compared to WS-Washington's reporting under Alternative 1. However, take by other entities would not be expected to near annual maximum sustainable harvest levels established for the mammal species, despite any reasonably foreseeable levels of increased take by other entities.

Therefore, under Alternative 2, there is no potential for WS-Washington's actions to initiate a trophic cascade. Additionally, it is highly unlikely that take by other entities will contribute to any ecologically-forced trophic cascades, mesopredator releases, and any resulting adverse ecological effects on biodiversity, ecosystem resilience, or ecosystem services.

3.7.3.3 Alternative 3. WS-Washington Provides MDM Lethal Assistance Only for Cases of Human/Pet Health or Safety and/or to Protect Threatened or Endangered Species

Under Alternative 3, WS-Washington would provide full MDM technical and operational damage management 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-Washington could not use lethal methods as part of IPMDM 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 mammal species of concern would be bears, cougars, or coyotes in residential areas, disease vector species, and beavers for damage to infrastructure. Any mammal species have the potential to be threats to T&E species. When WS-Washington responds with lethal control under the limited circumstances allowable under this alternative, the impacts on mammal populations from WS-Washington would be less than those described for Alternatives 1 but greater than Alternative 2, since fewer mammals are removed under this alternative. Other commercial, governmental, and private entities and landowners would continue to conduct MDM activities as described in Section 3.4. Other entities would likely increase MDM actions in proportion to the reduction of services that would normally be provided by WS-Washington.

However, WS-Washington 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 2.3.3). 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-Washington employees. Take of unclassified mammals by private individuals or their agent is not required to be reported to WDFW, potentially resulting in underreporting, compared to WS-Washington's reporting under Alternative 1.

Under Alternative 3, mammal populations are expected to remain stable with higher levels of take by other entities compared to Alternative 1. Take of unclassified mammals by private individuals or their agent is not required to be reported to WDFW, potentially resulting in underreporting, compared to WS-Washington's reporting under Alternative 1. However, cumulative take would not be expected to near annual maximum sustainable harvest levels established for the mammal species, despite any reasonably foreseeable levels of increased take by other entities.

Therefore, under Alternative 3, there is no potential for WS-Washington 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.

3.7.3.4 Alternative 4. No WS-Washington MDM Activities

Under this alternative, WS-Washington would have no effect on mammal populations or the potential to initiate a trophic cascade. Landowners experiencing damage or threats could only depend on advice and responses from commercial WCOs, WDFW, 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. Other entities would likely increase MDM actions in proportion to the reduction of services that would normally be provided by WS-Washington.

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-Washington employees. Take of unclassified mammals by private individuals or their agent is not required to be reported to WDFW, potentially resulting in underreporting, compared to WS-Washington's reporting under Alternative 1. However, while take by other entities would be higher than under Alternatives 1, cumulative take would not be expected to near annual maximum sustainable harvest levels established for the mammal species, despite any reasonably foreseeable levels of increased take by other entities.

Therefore, under Alternative 4, there is no potential for WS-Washington to initiate a trophic cascade or impact biodiversity and ecosystem resilience. 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 How Do Wildlife Professionals and Others Consider Ethics and Humaneness in Mammal Damage Management?

WS-Washington 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 (1993), Vucetich and Nelson (2007), Sneddon et al. (2014). WS-Washington field personnel strive to undertake these activities as ethically and humanely as possible under field conditions.

3.8.1 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).

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-Washington employees through the use of the WS Decision model to select methods that are effective and appropriate for the given location. WS-Washington 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 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-Washington 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-Washington MDM activities 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 MDM 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 minimize 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).

3.8.2 How are Euthanasia and Humane Killing Defined?

APHIS-WS policy and operations comply with the guidelines of the American Veterinary Medical Association (American Veterinary Medical Association 2020), which states "... euthanasia is the act of inducing humane death in an animal" and that "...that if an animal's life is to be taken, it is done with the highest degree of respect, and with an emphasis on making the death as painless and distress free as possible". This typically involves unconsciousness followed by cardiac or respiratory arrest, leading to loss of brain function, with minimized 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.

3.8.3 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, Gruver et al. 1996, Engeman et al. 1997, International Organization for Standardization 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 (California Department of Fish and Game 1991, American Veterinary Medical Association 2020). The AVMA defines pain as being, "that sensation (perception) that results from nerve impulses reaching the cerebral cortex via ascending neural pathways" (AVMA 2007). 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 2007). It is the goal of professional MDM to minimize 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 four and eight 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 minimize that risk and treat the animal with respect (Kreeger et al. 1990, Iossa et al. 2007, Sneddon et al. 2014).

3.8.4 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 and Gruver 1996, Engeman et al. 1997, International Organization for Standardization 1999). The Association of Fish and Wildlife Agencies (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(Association of Fish and Wildlife Agencies 2005). This program 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. These BMPs are updated as new information, traps, and practices are developed, with the most recent BMPs updated in 2020. 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 (Association of Fish and Wildlife Agencies 2019c).

The Furbearer Conservation Technical Working Group of the AFWA has developed BMPs for each species (Association of Fish and Wildlife Agencies 2019c). 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 Washington for mammals (as updated):

- Badger BMPs (Association of Fish and Wildlife Agencies 2019a) (Updated 2019)
- Beaver BMPs (Association of Fish and Wildlife Agencies 2016) (Updated 2016)
- Bobcat BMPs (Association of Fish and Wildlife Agencies 2019b) (Updated 2019)
- Coyote in western US BMPs (Association of Fish and Wildlife Agencies 2020a) (Updated 2020)
- Red fox BMPs (Association of Fish and Wildlife Agencies 2019d) (Updated 2019)
- Mink (Association of Fish and Wildlife Agencies) (Produced 2006)
- Muskrat (Association of Fish and Wildlife Agencies 2014b) (Updated 2014)
- Nutria (Association of Fish and Wildlife Agencies 2020b) (Updated 2020)
- Opossum BMPs (Association of Fish and Wildlife Agencies 2020c) (Updated 2020)
- Raccoon (Association of Fish and Wildlife Agencies 2020d) (Updated 2020)
- River Otter (Association of Fish and Wildlife Agencies;2014d) (Updated 2014)
- Striped skunk (Association of Fish and Wildlife Agencies) (Produced 2006)
- Weasels (Association of Fish and Wildlife Agencies 2006c) (Produced 2006)

Humaneness of trapped animals is improved by using traps types and design, and trapping practices that minimize 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.

3.8.5 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 MDM.

Wildlife Services employees are concerned about animal welfare. APHIS-WS is aware that some members of the public believe that some MDM 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 (Association of Fish and Wildlife Agencies 2006a, The Wildlife Society 2015). 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 minimize pain.

When implementing MDM 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) 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. Washington state laws also regulate the use of traps, snares, and capture devices (Section 2.4). 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-Washington continues to use and implement BMP tools and practices as they become available and when appropriate for MDM. 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.

3.8.5.1 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 3.11. 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).

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, Association of Fish and Wildlife Agencies 2006, White et al. 2015, White et al. 2021). Humane traps should be practical and equally effective at capturing target animals and avoiding capturing non-target animals (Andelt et al. 1999). Seasonality and timing of the use of physical capture devices is an important consideration for humaneness.

Any physical live capture method must be carefully evaluated for potential for hypothermia, hyperthermia, and stress caused by disturbance of trapped individuals. WS-Washington employees consider environmental conditions of trap sites that will occur prior to their next 24-hour trap check to minimize any heat or cold stress on trapped individuals. If unfavorable weather conditions occur during trapping efforts or if weather conditions may inhibit the ability of WS-Washington employees to check traps within 24 hours, traps will be made inactive or removed. Trap sites are typically selected to avoid disturbance for the purposes of enhancing animal capture rates, but WS-Washington staff evaluate the potential for human disturbance and predator disturbance that may cause excessive stress to animals once trapped.

3.8.5.1.1 Box, Cage, and Corral Traps

Animals captured in box and cage traps for smaller mammals, and culvert-type traps for large mammals may have fewer physical and behavioral traumas than those captured in foot snares and foothold traps. Although injury rates in cage traps are lower than cables and foot 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, cage traps are used for smaller animals such as bobcats, opossums, and raccoons that will be euthanized on-site, areas that are high risk for non-target species (cage traps allow for non-targets to be safely released), and in uncommon situations with MDM animals that are intended to be released (e.g. bears released off-site, with WDFW approval). Canids or other trap wise animals appear to be truly reluctant to enter cage traps (Way et al. 2002, Shivik et al. 2005).

Corral traps are used to live-capture feral swine or other large ungulates. They are made of panels with a door that can be closed manually or a passive system using one-way doors (revolving or swinging door) that allow animals into the trap but not out of an enclosure. Because they typically do not have triggers and rely on manual operations of doors or use passive one-way door systems there is little chance of injury to trapped animals. Their target specific design of short walls, open top, and sometimes access restricting door systems reduces effects to non-target species.

APHIS-WS completed a formal risk assessment on the use of all types of cage traps included in this EA in 2017 (USDA Wildlife Services 2017c). This assessment concluded:

> *"Cage traps offer a comparatively low risk to human health and the environment compared to other trapping methods, but their use is specific to those animals where aversion to entering a trap can be minimized. Advancements in the design of cage traps and the response time to handling caged animals have resulted in more effective and humane trapping of target animals while dramatically reducing the potential for nontarget captures."*

3.8.5.1.2 Suitcase Traps

Suitcase traps are special design of cage trap used to live-capture animals, constructed of a metal frame covered in heavy-gauged wire that is hinged with springs. The trap is set open, flat, and partially submerged. An animal climbs into the trap, trips a trigger mechanism in the center and the trap closes quickly like a suitcase around the trapped animal. Suitcase traps are typically used by WS-Washington to live trap beaver, muskrat, or otter. Since suitcase traps are set partially submerged potential for drowning is a concern and must be mitigated.

Traps are set so that the top of the trap will not be submerged when closed and traps are anchored to the shore to keep the trap from moving deeper into the water once activated or being moved by trapped animals. As mentioned earlier in Section 3.9.2.5.1 WS-Washington staff consider environmental conditions when setting suitcase traps. Beaver, muskrat, and otter are active throughout and adapted for winter conditions which are typically milder in western Washington when most beaver damage occurs during the wetter winter months. Because suitcase traps are half submerged in water, changing water levels and notable weather events are considered to reduce stress and potential hypothermia in trapped animals. Cage traps are 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). In addition to these risks the moving panels and quick closing action of the trap add the risk of pinching body parts and light superficial wounds to trapped animals though the position of the triggering mechanism ensures the animal is as close to the center of the trap and way from the edges as possible.

Suitcase traps were also evaluated as a type of cage trap in the Risk Assessment on cage traps, previously referenced (USDA Wildlife Services 2017c).

3.8.5.1.3 Leg-hold Snares

WS-Washington uses foot snares most often for bears and occasionally for cougar, but rarely for smaller mammals. Leg-hold snares are highly portable and can be readily adapted by the field biologist for use in the field for many situations. Under normal conditions, injuries may include swelling and abrasions. However, if the snare becomes entangled or the animal struggles energetically, severe injuries can result.

Effectiveness of foot 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 (Onderka et al. 1990, Skinner and Todd 1990). WS-Washington's use of foot snares is highly selective to minimize non-target captures (Section 3.6, 3.7, Table 3.6.1). Turnbull et al. (2011) found recent models of traps and snares to be about equally effective with low levels of apparent injury and trauma. Leg-hold 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, Association of Fish and Wildlife Agencies 2019d).

Increased size of the cable for foot 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. Leg-hold snares are also effective in a variety of weather but use in cold weather should be avoided to minimize risk of limb freezing.

3.8.5.1.4 Foothold Traps

BMPs for the mammal species in this EA identify key designs or modifications to foothold traps to reduce. 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 minimize 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. 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.

Some people are concerned about the humaneness of drowning beaver and muskrats captured in submersion foothold traps. Death by drowning in the classical sense is caused by inhalation of fluid into the lungs and is referred to as wet drowning (Gilbert and Gofton 1982, Noonan 1998). Gilbert and Gofton (1982) reported that all submerged beaver do not die from wet drowning, but die of CO_2 induced narcosis. Concern centers around whether drowning animals are rendered unconscious by high levels of carbon dioxide (CO_2) and thus insensitive to distress and pain (Ludders et al. 1999). Ludders et al. (1999) showed death during drowning is from hypoxia and anoxia, and thus animals experience hypoxemia. CO_2 causes death in animals by hypoxemia (AVMA 2021). Even though these animals are distressed, the AVMA states this death is an acceptable form of euthanasia (AVMA 2021).

AVMA (2020) reports that with some techniques that induce hypoxia, some animals have reflex motor activity followed by unconsciousness that is not perceived by the animal.

When beaver are captured using submersion set foothold traps, beaver are exhibiting a flight response. Gracely and Sternberg (1999) reported that there is stress-induced analgesia resulting in reduced pain sensitivity during fight and flight responses. Environmental stressors that animals experience during flight or fight activate the same stress-induced analgesia (Gracely and Sternberg 1999). Given the short time period of a drowning event, possible analgesic effect of CO_2 buildup to beaver, the minimum, if any, pain or distress on drowning animals, the AVMA's acceptance of hypoxemia as euthanasia and a minimum of pain and distress during euthanasia, acceptance of catching and drowning muskrats approved by International Humane Trapping Standards (Fur Institute of Canada 2019), the conclusion has been drawn that submersions sets are acceptable. However, some people will disagree and remain un-swayed.

White et al. (2021) published data from the more recent BMP testing and BMPs for available species are reference above in Section 3.8.7.   Updates to the performance tables and figured presented in White et al. (2021) will be updated by the authors and made available on the Association of Fish and Wildlife Agencies website.

3.8.5.1.5 Quick kill and Snap Traps

Conibear traps, typically used for beaver removals, are a quick kill body-gripping trap that have adjustable triggers allowing animals to swim between them. Adjusting the triggers for the target species reduces the chance of non-target capture.   Traps may also be set within other structures (e.g. culverts or buckets) that limit the size of the animal that can approach them. Similarly, bars, funnels, or other restrictive devices may be placed in front of the trap to prevent non-targets from accessing it. Traps are set so that when triggered the trap closes on the animals neck causing death through asphyxiation. Other quick kill traps have a similar process though may have different mechanisms to activate the traps moving parts. Humaneness concerns with quick kill traps typically comes from misapplication or non-target take of animals. Site reconnaissance, trap selection, trap set adjustments, and limiting the timeframe of trapping efforts are all implemented by WS-Washington employees to reduce non-target take potential. WS-Washington staff are trained and proficient in the use of these traps to ensure traps are set appropriately to ensure a humane death for trapped animals.

Common rat and mouse traps operate in a similar measure to other quick-kill traps by closing on the animal's body, typically on the neck or head, resulting in an irreversible loss of consciousness. Death from common rat and mouse traps are typically from asphyxiation, cervical dislocation, or destruction of the brain, all methods approved by the AMVA (American Veterinary Medical Association 2020).

3.8.5.2 What are the Considerations for Humaneness for Different Chemical Methods?

Chemical methods may be used for lethal take, such as gas cartridges, 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 3.11.3.

3.8.5.2.1 Gas Cartridge for Burrowing Animals

WS-Washington uses the Large Gas Cartridge (EPA Reg. No. 56228-21 and APHIS-Only applications EPA Reg. No. 56228-21) and Small Gas Cartridge (EPA Reg. No. 56228-61 and APHIS-Only applications EPA Reg. No. 56228-2) in rangelands, crop, and non-crop areas to remove yellow-bellied marmots, woodchucks, ground squirrels, coyotes, red foxes, and skunks in burrows. The registered gas cartridge product contains the active ingredients sodium nitrate and charcoal, and two 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 (2020) 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 (2020) and APHIS-WS consider CO a humane euthanasia method.

3.8.5.2.2 Zinc Phosphide

WS-Washington uses zinc phosphide on wheat (EPA Reg. No. 56228-3), zinc phosphide on oats (EPA Reg. No. 56228-14), zinc phosphide concentrate (EPA Reg. No. 56228-6) in areas consistent with their respective labels (e.g. areas further than 100 ft from an occupied building in underground burrow systems located in non-crop areas, crop areas, or orchards) on species consistent with their respective labels (e.g. yellow-bellied marmots, voles, mice, and woodchucks). WS-Washington is not used on floating mats for muskrat and nutria although this is allowed under the label. Zinc phosphide once is absorbed from the respiratory tract and gastrointestinal tract where it toxicity effects the heart, liver, and kidneys. Death results from cardiac, respiratory, or kidney failure within 24 hours, sub-lethal effects are minimal and mostly shown to be behavioral avoidance of food and lethargy, limited to no chronic toxicity effects (zinc phosphide does not accumulate in bodily tissues) (USDA Wildlife Services 2019c). Rodents that received lethal doses were symptomatic between 1-30 minutes after exposure and usually die within 2 hours with little lasting harm to subjects exposed to non-fatal levels (Mason and Littin 2003). With use by trained and experienced personnel APHIS-WS consider zinc phosphide a humane euthanasia method.

3.8.5.2.3 Aluminum Phosphide

WS-Washington uses aluminum phosphide (EPA Reg. No. 72959-1) in areas consistent with its label (e.g. non-crop areas, airports, pasture/rangelands, tree plantations) on species consistent with its label (e.g. ground squirrels, moles, voles, mice, yellow-bellied marmots, and woodchucks). The active part of both zinc and aluminum phosphide is the phosphine gas and thus toxic effects are similar if not the same. Aluminum phosphide once is absorbed from the respiratory tract and gastrointestinal tract where it toxicity effects the heart, liver, and kidneys. Death results from cardiac, respiratory, or kidney failure within 24 hours, sub-lethal effects are minimal and mostly shown to be behavioral avoidance of food and lethargy, limited to no chronic toxicity effects (aluminum phosphide does not accumulate in bodily tissues) (USDA Wildlife Services 2019b). Rodents that received lethal doses were symptomatic between 1-30 minutes after exposure and usually die within 2 hours with little lasting harm to subjects exposed to non-fatal levels (Mason and Littin 2003). With use by trained and experienced personnel APHIS-WS consider aluminum phosphide a humane euthanasia method.

3.8.5.2.4 Chlorophacinone

WS-Washington uses chlorophacinone (EPA Reg. No. 7173-151) in areas consistent with its label (e.g. forest plantations in Western Washington) on species consistent with its label (mountain beaver). WS-Washington's use of chlorophacinone will be done in compliance with all applicable laws and ESA consultations (Section 2.3). Chlorophacinone is the only anticoagulant used by WS-Washington and is subject to an extensive list of restrictions on the label including a restricted period of application and limits to underground application to limit secondary effects. WS-Washington only applies chlorophacinone once per year from late September to early May when juvenile mountain beaver are not present and only in private forestry lands in western Washington. Chlorophacinone bait packages are placed an arms-length (label requires greater than 12 inches) inside of active target burrows.

As a 1st generation anticoagulant, chlorophacinone typically requires multiple feedings to achieve a lethal dose. Accumulation of the toxicant can take up to 4 days but does not bioaccumulate to greater than a single lethal dose, as it is readily metabolized and eliminated from the body (Vein et al. 2013). As with most anticoagulants, lethal effects are produced via blocking the epoxide reductase enzyme inhibiting recycling of vitamin K. Without sufficient vitamin K, blood clotting is inhibited and death results from blood loss (Arjo et al. 2004). Sub-lethal effects of chlorophacinone (e.g. bruising, hematomas, and anemia) are typically short lived but can compound with other factors (e.g. disease, previous injuries) to result in death. Without continued consumption of chlorophacinone, vitamin K levels return to normal and blood clotting resumes following the metabolization and elimination of chlorophacinone from the body. Chlorophacinone has been shown to be 100% effective at achieving lethality under the label's application regimen (Arjo et al. 2004). With use by trained and experienced personnel APHIS-WS considers chlorophacinone a humane method.

3.8.5.2.5 Strychnine

WS-Washington uses strychnine oats (EPA Reg. No. 56228-20) and strychnine milo (EPA Reg. No. 56228-19) in areas consistent with their respective labels (e.g. rangelands, croplands, forests, non-agricultural areas) on species consistent with their respective labels (e.g. northern pocket gophers). Provisions are included on the label to exclude use in areas with ESA species including the Mazama pocket gopher. Subsurface applications of strychnine can be made by either hand baiting or by using a mechanical burrow builder. Baiting by hand is done either by digging a hole into the gopher burrow or using a hollow probe that deposits the measured amount of bait into a burrow. The mechanical burrow builder is towed behind a tractor and digs an artificial burrow for the treated bait to be placed. Once consumed the strychnine is a neurotoxin that quickly disrupts the processes of the nervous system to include breathing, death typically occurs from asphyxia or cardiac arrest within one hour (U.S. Environmental Protection Agency - Office of Prevention - Pesticides and Toxic Substances 1996).

Pocket gophers rarely die above ground due to the quick acting effects of the toxicant, other primary exposed non-target small mammals may. Rapid decay of carcasses due to insect activity typically excludes scavengers from finding available carcasses. Concentrations of strychnine in insects during the study were not enough to exceed harmful levels in the most sensitive species of insectivores (avian, mammalian, or amphibian) documented (Arjo et al. 2006). With use by trained and experienced personnel APHIS-WS considers strychnine a humane euthanasia method.

3.8.5.2.6 What Field Immobilizations Methods are Humane?

Immobilization drugs are used infrequently by WS-Washington, primarily when needed to release an captured non-target 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.

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 minimize sight, sound, and touch to minimize 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 cougars (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-Oregon prefers to use Telazol™ for most of the species that are immobilized.

Propiopromazine HCL is the immobilization drug used in Tranquilizer Trap Device (TTD). TTDs were developed by APHIS-WS NWRC as a means of sedating animals captured in foothold traps to reduce the potential for self-inflicted injuries. TTDs are small rubber nipples fastened to the trap jaw filled with Propiopromazine HCL. When captured, mammals instinctively bite the trap tab, ingest the immobilizing drug, and are sedated. Used properly, the sedative Propiopromazine HCL (Investigational New Animal Drug #9528) does not render the animal unconscious. Due to animal welfare concerns (Section 3.9.2.5), TTDs are not currently used by WS-Washington.

3.8.5.2.7 What Field Methods are Used for Humane Killing (Euthanasia)?

During MDM 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.

DeNicola et al. (2019) assessed humaneness of shooting on deer depopulation under field conditions and found that shooting can be an 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.

3.8.5.3 Conclusion

From FY2015 through FY2019, firearms, padded foothold traps, body gripping traps, and cage traps were the most consistently used for lethal take of many target mammal species. Methods implemented for lethal take are; firearms (55% of take through ground shooting, 14% aerial shooting), padded footholds (13% of mammal take), body gripping traps (5% of mammal take), and cage traps (8% of mammal take). Cage traps are also commonly used for smaller mammals and in areas where non-target species are more difficult to exclude from traps. Black bears are mostly caught with foot snares and shot with firearms and, more rarely, caught with culvert traps. Cougars are mostly taken with foot snares and shot with firearms. Chemical euthanasia and immobilizing drugs are rarely used in the field by WS-Washington.

These methods are highly selective for target animals, with low non-target takes of mammal species during WS-Washington MDM activities (Section 3.5). WS-Washington personnel are highly trained in the proper use of these methods, follow applicable policies, and utilize best practices to undertake these activities as ethically and humanely as possible under field conditions.

3.8.6 What are the Comparative Impacts of the Alternatives on Humaneness?

3.8.6.1 Alternative 1. Proposed Action/No Action Alternative: WS-Washington Continues MDM Assistance in Washington

All WS-Washington 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-Washington 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 foot snares used by WS-Washington 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-Washington follows state laws and regulations regarding the frequency of trap checks (Section 2.4). When warranted, WS-Washington employees may check traps more often than required, but not less often than state regulations.

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-Washington complies with applicable federal, state, and local laws and regulations. WS-Washington continues to use and implement BMP tools and practices as they become available and when appropriate for managing wildlife damage. Therefore, WS-Washington 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 2015 through 2019, the firearms, padded foothold traps, and body gripping traps were the most consistently used for lethal take of many target mammal species. Components used for lethal take ranked from highest to lowest take numbers are; ground shooting, aerial shooting, foothold traps, body-gripping traps, followed by cage traps. Cage traps are commonly used for smaller mammals, or in areas with higher chance of non-target capture to ensure a non-target species' safe release. Chemical euthanasia, and immobilizing drugs are rarely used in the field by WS-Washington (Table 2.1 and Table E.1). These methods are highly selective for target animals, with low non-target take of mammal species during WS-Washington MDM activities (Table 3.18). Therefore, WS-Washington would continue to practice and uphold high standards of humaneness and ethics under Alternative 1.

3.8.6.2 Alternative 2. WS-Washington Provides Technical MDM Assistance for Lethal and Non-Lethal Methods and only Non-Lethal Operational Damage Management Assistance

Under this alternative, WS-Washington would provide non-lethal and lethal technical assistance, and non-lethal operational damage management assistance only. Other commercial, governmental, and private entities and landowners will continue to conduct MDM activities as described in Section 3.4.

With this alternative, WS-Washington would use the APHIS-WS Decision Model for providing advice and technical assistance, as well as training on identification of species, and possibly individual animals, causing damage. WS-Washington would continue to practice and uphold high standards of humaneness and ethics, as described under Alternative 1.

However, in the absence of lethal assistance from WS-Washington, 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 MDM needs themselves (as discussed in Section 3.4). WCO's unless specifically authorized by permits are not permitted to respond to big game species damage management requests, but landowners can request someone to work as their agent with the applicable authorizations. 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-Washington employees. WCOs may not have the experience or response capability with some of the species and methods if they are not already conducting MDM 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 MDM activities in the absence of lethal operational damage management assistance from WS-Washington. WDFW currently responds to a requests for damage management from big game species (e.g. bear, cougar, deer, and elk). For instances not involving big game species, WDFW may not have the personnel or funding to respond to a majority of requests for MDM assistance in a timely manner, leaving landowners to either resolve the matter themselves or to seek assistance from other entities. Other entities would likely increase lethal MDM actions in proportion to the reduction of services that would normally be provided by WS-Washington. Depending on the skillset of others, it is possible that more non-target animals could be taken or less humanely by other entities, as a result of less selective and less proficient removal efforts. It is unlawful to trap wildlife on the property of another for a fee or other consideration without a current and valid WCO certification (WAC 220-440-110). While WCOs are trained in BMPs (Washington Department of Fish and Wildlife), other private entities are not required to follow BMP guidelines. Therefore, other private entities may have less ethical or less humane lethal MDM actions. While WS-Washington 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 2, there are likely to be less humane and ethical practices by other entities compared to Alternative 1.

3.8.6.3 Alternative 3. WS-Washington Provides MDM Lethal Assistance Only for Cases of Human/Pet Health or Safety and/or to Protect Threatened or Endangered Species

Under Alternative 3, WS-Washington would provide full MDM technical and operational damage management 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-Washington could not use lethal methods as part of MDM 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 mammal species of concern would be beaver (flooding and undercutting roads, rails, and bridges), marmots (destruction of dikes and dams), coyotes (direct conflicts with humans), Northern pocket gophers (destruction of dikes and dams, and Columbian ground squirrels (destruction of dikes and dams). Any mammal species have the potential to be threats to T&E species. WS-Washington would continue to practice and uphold high standards of humaneness and ethics, as described under Alternative 1. Other commercial, governmental, and private entities and landowners would continue to conduct MDM activities as described in Section 3.4. Other entities would likely increase MDM actions in proportion to the reduction of services that would normally be provided by WS-Washington.

However, in the absence of lethal assistance from WS-Washington 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 MDM needs themselves (as discussed in Section 3.4). WCO's unless specifically authorized by permits are not permitted to respond to big game species damage management requests, but landowners can request someone to work as their agent with the applicable authorizations. 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-Washington employees. WCOs may not have the experience or response capability with some of the species and methods if they are not already conducting MDM 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 MDM activities in the absence of lethal operational damage management assistance from WS-Washington. WDFW currently responds to a requests for damage management from big game species such as bear, cougar, deer, and elk. For MDM instances not involving big game species WDFW may not have the resources to respond to requests for MDM assistance for non-big game species in a timely manner, leaving landowners to either resolve the matter themselves or to seek assistance from other entities. Other entities would likely increase lethal MDM actions in proportion to the reduction of services that would normally be provided by WS-Washington. Depending on the skillset of others, it is possible that more non-target animals could be taken or less humanely by other entities, as a result of less selective and less proficient removal efforts. It is unlawful to trap wildlife on the property of another for a fee or other consideration without a current and valid WCO certification (WAC 220-440-110). While WCOs are trained in BMPs (Washington Department of Fish and Wildlife), other private entities are not required to follow BMP guidelines. Therefore, other private entities may have less ethical or less humane lethal MDM actions. While WS-Washington 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 Alternative 1 but more so than Alternative 2.

3.8.6.4 Alternative 4. No WS-Washington MDM Activities

WS-Washington MDM would have no effect on humaneness or ethics. Landowners experiencing damage or threats could only depend on advice and responses from commercial WCOs, WDFW, or other entities. WDFW currently responds to a requests for damage management from big game species such as bear, cougar, deer, and elk. For instances not involving big game species, WDFW may not have the resources to respond to requests for MDM assistance for non-big game species in a timely manner, leaving landowners to either resolve the matter themselves or to seek assistance from other entities. Landowners 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 MDM actions in proportion to the reduction of services that would normally be provided by WS-Washington.

Depending on the skillset of others, it is possible that more non-target animals could be taken or less humanely by other entities, as a result of less selective and less proficient removal efforts. It is unlawful to trap wildlife on the property of another for a fee or other consideration without a current and valid WCO certification (WAC 220-440-110). While WCOs are trained in BMPs (Washington Department of Fish and Wildlife), other private entities are not required to follow BMP guidelines. Therefore, other private entities may have less ethical or less humane lethal MDM actions.

Therefore, under Alternative 4, there are likely to be less humane and ethical practices by other entities compared to Alternatives 1-3.

3.9 How do WS-Washington's MDM Activities Relate to Sociocultural Wildlife Values or Wildlife Related Recreation?

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)).

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.

3.9.1 What are the concerns and Native American cultural values of wildlife as they relate to WS-Washington's MDM Activities?

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 Washington 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.

MDM conducted for big game animals has historically presented the greatest chance of interfacing with tribal interests. For example, elk may present a hazard to aviation in areas culturally significant to tribes. Proposed damage management activities are discussed and coordinated with tribes that have an interest. WS-Washington works to develop a site specific solution that suits all entities, while meeting the need for action to respond to requests for assistance. In some cases, management actions may be conducted by tribal personnel, animals may be donated to tribes for meat, or other damage management solutions may be developed cooperatively.

WS-Washington also works closely with tribes on beaver damage management issues. As stewards of the land and natural resources, tribes offer unique opportunities for beaver relocation. WS-Washington may live trap and transfer custody of beaver to tribes to further salmon habitat and wetland restoration efforts. The involvement of tribes in Washington has enabled WS-Washington to contribute to restoration efforts and we anticipate these activities continuing and expanding in the future.

All USDA-APHIS programs, including APHIS-WS, engage Native American Tribes to protect agriculture and cultural resources through government-to-government consultation. APHIS Directive 1040.3 defines the consultation process. Any tribal government may initiate the consultation process on APHIS projects, programs, and activities. During consultation, tribal views, information, rights, and interests are taken into consideration in assessing APHIS' impacts to better serve tribal communities.

WS-Washington is committed to respecting tribal heritage and cultural values when planning and initiating wildlife damage management activities. Consultation and coordination with tribal governments is conducted consistent with EO 13175 and APHIS-WS' plan implementing the executive order. WS-Washington has offered opportunities for formal government-to-government consultation on its proposed activities to federally-recognized tribes in Washington and has requested their involvement for this EA through direct invitations (September 13th, 2019). A draft of this EA was provided to all of the federally recognized tribes in Washington on October 16, 2020 by certified mail. WS-Washington received several phone calls from tribes expressing interest in the proposal, however, no formal comments have been received. WS-Washington is available to engage in government-to-government consultation with any tribe, as requested. What are the Effects of WS-Washington MDM Activities on Wildlife Related Recreational Activities?

Some individuals may believe their recreational experiences on public lands are impaired by knowing that any lethal MDM actions are occurring on these lands. Others feel that they are being deprived of the aesthetic experience of viewing or hearing beaver, coyotes, or other mammals covered under this EA because of WS-Washington's MDM actions. Occasionally, individuals may have formed an attachment to a specific individual or group of individual animals. Removal of these animals can be a cause of distress and sorrow for these individuals. Some commenters have stated that witnessing aerial shooting operations or encountering WS-Washington warning signs for MDM 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 shooting operations 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 non-lethal 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. Fladry may also have impacts on the aesthetic nature of areas when implemented.

Opinions regarding the impact of MDM on recreation and aesthetic values vary among individuals. An impact associated with MDM actions, such as the use of foothold traps, may be perceived by one individual as a negative and conflict with their own personal values towards wildlife while may have significantly different impact on someone who's personal experiences or values toward wildlife align with the MDM method being implemented or MDM as a whole.

Another issue that is occasionally raised is the purported impact that MDM would have on sportsmen and wildlife viewing. Game and non-game wildlife populations are not significantly impacted by WS MDM take (Section 3.4), therefore there is little chance impacts to recreational hunting or wildlife watching activities. WS-Washington MDM is highly directed to target individuals and species in a given area, mostly on private lands and lands with limited access by the general public (e.g. airports, military lands, etc.). WS-Washington works only until damage is reduced to an acceptable level.

3.9.2 What are the Comparative Impacts of the Alternatives on Sociocultural Wildlife Values?

3.9.2.1 Alternative 1. Proposed Action/No Action Alternative: WS-Washington Continues MDM Assistance in Washington

3.9.2.1.1 Likelihood of WS- Washington MDM Activities Reducing Wildlife Encounters for the Public

WS-Washington actively works on only a small portion of all the available properties it is authorized to work at any given time. Of those properties, MDM activities are conducted on only a fraction of the total area which the property encompasses. WS-Washington only conducts MDM on a small portion of Washington (3.5% of the state). 61% of WS-Washington take occurs in areas inaccessible to the public such as; private lands, military lands, airfields, dams (MIS 2020). Where WS-Washington conducts lethal MDM, any reduction in wildlife presence is generally insignificant and temporary. Section 3.4 determined that proposed take by WS-Washington will not have a significant effect on any wildlife population. Unclassified wildlife populations are widespread and numerous enough within their range that removal by WS-Washington's MDM actions will only have marginal impact on wildlife viewing in small localized areas.

Predator viewing is often considered a high value recreational encounter. In localized areas where WS-Washington does remove some portion of a 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-Washington's MDM 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-Washington MDM 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-Washington take is a small fraction of those taken by other harvest methods (Section 3.4).

Consequently, for most species, the presence or absence of impacts of WS-Washington MDM activities may not be discernable from impacts from other sources. Overall impacts on mammal populations would be relatively low, and opportunities to view, hear, or see evidence of them would still remain. The potential minor reduction in local opportunity to view mammals must be considered with all potential impacts, including the potential emotional harm suffered by resource owners or others affected by mammal damage, if management activities were not implemented.

3.9.2.1.2 Impacts to Wildlife that May Affect Recreational or Cultural Uses

Game and non-game wildlife populations are not significantly impacted by WS-Washington's MDM activities (Sections 3.4 and 3.5) 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 Washington that are suitable for seeing abundant wildlife. WS-Washington activities do not significantly impact animal populations and it does not remove a significant number of any one species. There may be a marginal decrease in recreational mammal hunting, trapping, and viewing opportunities, however, impacts that may occur are expected to be minimal, due to their limited duration or limited spatial scale, and are not likely to significantly impact recreational activities.

Procedures and policies designed to reduce WS-Washington impacts on recreation are in described in Section 2.4, and throughout Chapter 1. As discussed in Chapter 1 61% of WS-Washington take occurs in areas inaccessible to the public such as; private lands, military lands, airfields, and hydroelectric facilities (MIS 2020). On private lands, the cooperators or landowners are aware that MDM 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-Washington personnel post signs in prominent places to alert the public (on both private and public lands) that MDM tools are set in an area, in accordance with USDA-WS Directive 2.450.

On public lands, WS-Washington coordinates with the public land management agencies through work plans or other means and designates different work areas using GPS maps to reduce potential problems. If MDM is proposed on public lands that are also used by recreationalists, WS-Washington will coordinate with the land management agency to either avoid public recreation or prevent recreational activities during MDM activities. This could result in some limitation on recreational activities, but they would be short-term, usually no more than day at a time. There has only ever been 1 public land closure for WS-Washington MDM, which was for removal of feral swine in eastern Washington. WDM activities will not be conducted unless WS-Washington has a written agreement signed by the landowner or manager having management authority for that area. High use recreation and other sensitive areas are identified by the landowner/manager prior to the start of any MDM.

3.9.2.1.3 Impacts to Native American Cultural Uses and Concerns

WS-Washington 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 mammals due to the effects on their population, but on the manipulation of the natural ecosystem in general. 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%). Predicting impacts and establishing ways to meet agency objectives for 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. WS-Washington recognizes that the agency has unique government to-government obligations to the tribes as established in treaties.

Depending on the activity, potential impacts from MDM on cultural values could include increased or decreased quality of interactions with wildlife for future consumptive and non-consumptive uses. WS-Washington has low or negligible impacts on mammal species populations, non-target species populations, trophic cascades, humaneness, the environment, humans, or domestic animals from proposed MDM activities. Due to the low or negligible impacts described, and the protective measures described in Section 2.4, WS-Washington would have minimal effects on Cultural uses of wildlife resources.

3.9.2.2 Alternative 2. WS-Washington Provides Technical MDM Assistance for Lethal and Non-Lethal Methods and only Non-Lethal Operational Damage Management Assistance

Under this alternative, WS-Washington would provide non-lethal and lethal technical assistance, but only non-lethal operational damage management assistance. Other commercial, governmental, and private entities and landowners would be expected to continue to conduct MDM activities as described in Section 2.3.2. WS-Washington would have no lethal take under this alternative.

WS-Washington would use the APHIS-WS Decision Model for providing advice and technical assistance, as well as training on identification of species, and possibly individual animals, causing damage. Entities requesting lethal assistance would have to determine if WDFW, a commercial WCO, or other private individual with the capabilities, approvals, and interest is available, or attempt to address their MDM needs themselves (as discussed in Section 3.3). WCOs are not authorized to conduct big game damage management unless under authorities of a landowner's damage management agreement with WDFW, 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-Washington employees. WCOs may not have the experience or response capability with some of the species and methods if they are not already conducting MDM activities for those particular species (Section 3.3.2).

There is a potential for other entities (as discussed in Section 3.3) to conduct increased lethal MDM activities in the absence of lethal operational damage management assistance from WS-Washington. Other entities would likely increase lethal MDM actions in proportion to the reduction of services that would normally be provided by WS-Washington. Activities by private individuals are not required to and may not be coordinated with other land management agencies, tribes, and with WDFW to reduce exposure to the public viewing or recreational activities aside from restriction defined in Washington State laws. Therefore, other private entities may have more potential effects to cultural resources. While WS-Washington 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 2. there are likely to be more impacts to consumptive, non-consumptive uses, aesthetics, and Native American cultural uses as compared to Alternatives 1.

3.9.2.3 Alternative 3. WS-Washington Provides MDM Lethal Assistance Only for Cases of Human/Pet Health or Safety and/or to Protect Threatened or Endangered Species

Under Alternative 3, WS-Washington would provide full MDM 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-Washington could not use lethal methods as part of MDM 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 species involved would be mountain lions, coyotes, beaver, or black bears, or disease vector species. WS-Washington would continue to implement MDM 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 MDM activities as described in Section 3.4. Other entities would likely increase MDM actions in proportion to the reduction of services that would normally be provided by WS-Washington.

However, in the absence of lethal assistance from WS-Washington for non-T&E species protection requests, some people choose to take lethal action to protect publicly or privately owned resources, if necessary. Entities requesting lethal assistance would have to determine if WDFW, a commercial WCO, or other private individual with the capabilities, approvals, and interest is available, or attempt to address their MDM needs themselves (as discussed in Section 3.4). WCO's unless specifically authorized by permits are not permitted to respond to big game species damage management requests, but landowners can request someone to work as their agent with the applicable authorizations. 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-Washington employees. WCOs may not have the experience or response capability with some of the species and methods if they are not already conducting MPM 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 MDM activities in the absence of lethal operational damage management assistance from WS-Washington. WDFW currently responds to a request for damage management from big game species such as bear, cougar, deer, and elk. For MDM instances not involving big game species WDFW may not have the resources to respond to requests for MDM assistance for non-big game species in a timely manner, leaving landowners to either resolve the matter themselves or to seek assistance from other entities. Other entities would likely increase lethal MDM actions in proportion to the reduction of services that would normally be provided by WS-Washington. Depending on the skillset of others, it is possible that more non-target animals could be taken as a result of less selective and less proficient removal efforts. It is unlawful to trap wildlife on the property of another for a fee or other consideration without a current and valid WCO certification (WAC 220-440-110).

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.

3.9.2.4 Alternative 4. No WS-Washington MDM Activities

Under this alternative, WS-Washington would not be available to provide any MDM activities. WDFW currently responds to a requests for damage management from big game species such as bear, cougar, deer, and elk. For instances not involving big game species, WDFW may not have the resources to respond to requests for MDM assistance for non-big game species in a timely manner, leaving landowners to either resolve the matter themselves or to seek assistance from other entities. Landowners experiencing damage or threats could only depend on advice and responses from WS-Washington, commercial WCOs, WDFW, or other entities. Entities requesting lethal assistance would have to determine if WDFW, 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 MDM actions in proportion to the reduction of services that would normally be provided by WS-Washington.

Depending on the skillset of others, it is possible that more non-target animals could be taken 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 WDFW to reduce exposure to the public viewing or recreational activities aside from restrictions defined in Washington State laws.

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 1-3.

3.10 What are the Potential Impacts of WS-Washington MDM Methods on the Environment, Risks to Human/Pet Health and Safety?

This section evaluates the potential impacts and risks associated with mechanical and chemical MDM methods used by WS-Washington 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, hunters, and WS-Washington employees.

The analysis of each mechanical and chemical method is based on a thorough national risk assessment of each APHIS-WS method (USDA Wildlife Services 2017a) with additional information included from WS-Washington activities and the literature where available.[44] 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 MDM (Section 1.12)
- Impacts on mammal populations, including federally-listed threatened and endangered species from non-target take (Sections 3.5- 3.7)
- Humaneness of methods (Section 3.8)

[44] Refer to Section 3.4 for information regarding assumptions about lethal actions others might take to address mammal damage in the absence of WS-Washington or if WS-Washington lethal activities are restricted.

APHIS-WS Directives and policies for the use of MDM methods are described in Section 2.4.1 through 2.4.3 and the associated state of Washington laws and regulations are included in Section 2.4.4.

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, foot snare, foothold traps, and quick-kill/body grip traps. Additionally, the use of firearms, aerial shooting, and trained animals but also are often used in conjunction with physical capture devices. The impacts and risks associated with lead ammunition associated with these mechanical/physical will be discussed in Section 3.11.2.

3.10.1.1 What are the Potential Impacts and Risks Associated with Physical Capture Devices?

WS-Washington uses four primary types of physical capture devices during MDM activities – cage traps, foot snare, foothold traps, and quick-kill/body grip traps. Descriptions of these methods are found in Appendix A. Risks related to the use of mechanical/physical capture devices by APHIS-WS are examined in detail in several *USDA, APHIS, WS Risk Assessments*.

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 foot 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-Washington 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-Washington 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 Hunters, and Domestic Animals?

WS-Washington follows APHIS-WS Directive 2.450, which states that capture devices should be set to minimize the visibility of captured animals to the public (Section 2.4). 64% of WS-Washington's total mammal take occurs on lands inaccessible to the general public (e.g. airports, military bases, dams, private lands) and WS Directive 2.450 requires APHIS-WS employees to make reasonable efforts to obtain approval from adjacent landowners when setting traps or foot snares under fence lines to avoid capture of domestic animals (Section 2.4). Most MDM 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).

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. Live traps, culvert traps, and foot 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 and, if used in areas with bears damaging campgrounds, development dumpsters or other areas where the public frequents, signs are placed on each end of the culvert trap to warn people away (Section 2.4).

Use of traps and foot snares are restricted in public safety zones designated in USFS or BLM Annual Work Plans for MDM on federal 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. MDM conducted on federal 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 MDM activities in the public safety zone for another type of identified need through coordinated with the managing agency. Depending on the situation and applicable laws and regulations, federal permittees could request either WS-Washington or others to conduct MDM activities. However, when WS-Washington conducts the activities, it notifies the land management agencies of MDM activities that involve methods of possible concern, such as firearms, 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 MDM work conducted by other entities or individuals.

WS-Washington had no unintentional lethal take of livestock or domestics from FY 2015 through FY 2019, four dogs were returned to owners after getting loose on airfields from FY 2015 through FY2019. In the same five-year period, eighteen feral cats and four feral dogs were captured and freed unharmed (Table 3.18).

APHIS-WS completed formal risk assessments on the use of all types of capture devices included in this EA (USDA Wildlife Services 2019d, 2019e, 2019f, 2017c). These risk assessments were peer reviewed and concluded that the proposed methods pose little risk because APHIS-WS implements site specific minimization measures that are designed to reduce human interactions and non-target animals. Therefore, the potential for the public, recreationists, hunters, landowners, and domestic animals to encounter and be captured or killed by a trap or foot snare set by WS-Washington and/or any other person/entity is very low on private lands and highly unlikely on public lands.

3.10.2 What are the Potential Risks of Using Physical Capture Devices to WS-Washington Employees?

WS-Washington 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 foot snares. Most injuries occur while setting or placing suitcase traps. Setting traps also involves bending, kneeling, and pounding and pulling stakes, which could potentially lead to back strains. When using foot 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 foot 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 periodic firearms training (WS Directive 2.615, Section 2.4.1.3), which is important when firearms are used to euthanize captured animals.

WS-Washington has taken specific precautions to minimize the risk of employees being bitten by a diseased animal. The bite from a wild mammal 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 foot 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 and culvert traps, the risk to employees from captured animals is minimal. The animal is entirely enclosed in the trap and can be readily moved (if captured in a public area) and released 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, bears are immobilized inside the trap using a pole syringe before being euthanized outside the trap; 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 minimize 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.

Nationwide, from FY 2008 through FY 2012, APHIS-WS field personnel were bitten 14 times (one bear, one coyote, two feral cats, three feral dogs, two bats, one pelican, and four unknowns). Since 2013, an average of only 2.3 animal bites were recorded nationwide, with two 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. From 2014-2018, WS-Washington only one hand injury from a suitcase trap occurred, although minor injuries have occurred.

Between FY 2014 and FY 2018, there were sixteen field-related injuries reported by WS-Washington field employees through workman's compensation processes. All of these injuries were considered minor and none of which are related to trapping. The pet dog owned by the landowner caused the only animal bite reported.

Skilled WS-Washington 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-Washington field employees is considered very low. The risk to non-WS-Washington entities depends on their proficiency and experience with the equipment and its placement.

3.10.2.1 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-Washington field employees to lethally take or euthanize wildlife during IWDM activities.[45] Firearms are 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).

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), 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 APHIS-WS 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 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 three 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.[46] All firearms are safely carried and stored per WS Directive 2.615 (Section 2.4).

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[45] The humaneness of using firearms for removing or euthanizing animals is discussed in Section 3.9.2. The use of firearms during aerial activities is discussed in Section 3.11.1.3. APHIS-WS policy for use of firearms is found in WS Directive 2.615 (Section 2.4).

[46] The risks to human health and safety and the environmental impacts and fate for lead used in ammunition are found in Section 3.11.2. In addition, further detail on risks associated with the use of firearms and lead ammunition maybe found in *USDA, APHIS, WS Risk Assessment, Chapter VI: The Use of*

APHIS-WS field personnel select firearms appropriate to an intended use, and which include rifles, shotguns, air rifles, or pistols. For example, WS-Washington personnel may use a larger caliber rifle to take large mammals (e.g. deer or bear) or a smaller caliber rifle for smaller mammals (e.g. raccoons or opossums). Field employees base the selection of weapon 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 in aerial shooting teams.

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 mammal (Section 3.9.2). 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 bears 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 mammals.

In addition to euthanasia, WS-Washington uses firearms to lethally remove about 69% of total target mammal take during the FY2015-FY2019 reporting period, of the take with firearms; 25% were coyotes, 25% were nutria, 23% were yellow-bellied marmots, 8% eastern cottontails, and 5% were beaver. Firearms are highly selective; WS-Washington employees have not taken any non-target species with this method in at least the last decade (Table 3.6.1).

Nationwide, only one federally-listed threatened or endangered species has been inadvertently lethally removed by an APHIS-WS employee using firearms during FY 2004- FY 2016. In that incident, a Mexican wolf pup was mistaken for a coyote in FY 2013 in New Mexico. Another incident occurring in the 1990s in North Dakota

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Firearms in Wildlife Damage Management and *Chapter XII: The Use of Lead in Wildlife Damage Management*, respectively (Appendix G).

during aerial shooting operations, when an unknown wolf, likely from the Great Lakes region, was mistakenly identified as a coyote. No WS-Washington employee has lethally removed a non-target federally-listed threatened or endangered species with a firearm.

APHIS-WS completed a formal risk assessment on the use of firearms and firearm-like devices included in this EA in 2019 (USDA Wildlife Services 2019g). This risk assessment was peer reviewed and concluded that the firearms posed little risk to WS personnel, the public, non-target species, and the environment.

3.10.2.1.1 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-Washington 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 (USDA Wildlife Services 2019g).

3.10.2.1.2 What is the Accident Risk of WS-Washington's Use of Firearms to the Public, Including Recreationists, Hunters, and Domestic Animals?

APHIS-WS and WS-Washington 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.[47]

Dogs have been known to eat paintballs, which may cause toxicosis. However, with veterinary treatment, they typically recover within 24 hours (Donaldson 2003). WS-Washington is not aware of any dog having eaten a paintball it has used in MDM. WS-Washington anticipates rarely using paintball firearms for mammal harassment outside of airfields.

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 (USDA Wildlife Services 2019g).

3.10.2.1.3 What are the Potential Risks to WS-Washington Field Employees from Using Firearms?

The risk to WS-Washington 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 minimize hearing loss and monitor employees subjected to frequent noise based on the applicable Occupational Safety and Health Administration Hearing Conservation guidelines (Occupational Safety and Health Administration 2002). 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

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[47] 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. In addition, further detail on risks associated with the use of firearms and lead ammunition maybe found in *USDA, APHIS, WS Risk Assessment, Chapter VI: The Use of Firearms in Wildlife Damage Management* and *Chapter XII: The Use of Lead in Wildlife Damage Management*, respectively (Appendix G).

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-Washington employees are highly familiar with the firearms they use, which ensures accuracy and safety. Nationwide, APHIS-WS employees have had 55 accidents with uses of all firearms between 2011 and 2015, average of 10.2 per year, typically by firearm and ammunition malfunctions (Table 3.19). Incidents due to operator error were minimal.

No accidents or incidents were recorded by WS-Washington involving firearms between FY 2011 and FY 2018, and an average of 10 were recorded nationwide in APHIS-WS. Although not identified specifically due to firearms, WS-Washington field employee accidents and resultant injuries overall are minimal.

Lastly, since APHIS-WS 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 46. The annual average number of accidents and incidents with firearms and firearm-like devices used by WS in WDM for FY11 thru FY15

Method	Injury	Pers. Error	Mechanical	Ammunition	Mishaps	Thefts
Shotgun (ground)	0.2#	1.0	1.0	0.8	-	
Shotgun (aerial)[1]	-	-	-	-	-	
Rifle	0.2#	0.8	1.2	0.8	-	
Rifle with Suppressor	-	-	2.0	0.2	-	
Pistol	0.2^	0.6	0.2	-	-	
Pneumatics (air rifles)	0.2^	0.6	-	-	0.2	
Pyrotechnic (pistol launcher)[1]	-	-	-	0.4	-	
Pyrotechnic (12 ga. cracker shell)[1]	-	-	-	0.4	-	
Paint Balls, Rubber Bullets, Dart & Net Guns	-	-	-	-	-	
Thefts[2]						1.2
TOTAL BY CATEGORY	**0.8**	**3.0**	**4.4**	**2.6**	**0.2**	**1.2**
TOTAL OF ACCIDENTS/INCIDENTS		10.2				

No accidents were recorded due to use of dart guns or other non-lethal projectiles

1=Addressed in Firearms Risk Assessment

2= Thefts often involve a variety of firearms (including one that stole an entire safety box that was bolted to vehicle while employee was in immediate area responding to a damage request)

#=Injury associated with an ammunition failure

^=Injury resulting from personal error

3.10.2.2 What are the Potential Impacts and Risks from the Use of Aircraft and Aerial Shooting?

WS-Washington uses or contracts for fixed-wing aircraft and helicopters for aerial shooting of target coyotes (70% of coyote take and 14% of total MDM lethal take from FY 2015 through FY 2019) on areas under agreement. In Washington, these activities occur primarily in late winter and early spring, during lambing and calving seasons, and the most commonly used aircraft are fixed-wing aircraft. WS-Washington 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-Washington 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 (WS-Washington 2014 BA and USFWS concurrence letter). In addition, no non-target take by WS-Washington has occurred between 2011 and 2019 during aerial shooting activities, and no humans on the ground have been injured as a result of a crash or during aerial shooting.[48]

3.10.2.2.1 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 waterfowl
- Conomy et al. (1998): only 2% of wintering American black ducks, American widgeon, 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

[48] Risks related to these activities are discussed in detail in *USDA, APHIS, WS Risk Assessment, Chapter V: The Use of Aircraft in Wildlife Damage Management* (Appendix G).

- 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): five species of hawks, two 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): three 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 Hyngstrom (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): two 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 IWDM activities only in areas under agreement and concentrates 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 two seconds per acre), on properties under agreement. WS avoids non-target wildlife such as elk, deer, and wolves. Impacts on wolves from WS-Washington overflights were covered under 2014 BO from USFWS. 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 (USDA Wildlife Services 2019a).[49]

3.10.2.2.2 What Are the Potential Impacts of Aircraft Sound on the Public, Including Recreationists and Hunters?

WS-Washington aerial shooting occurs mostly over private land where landowners would notify WS of ongoing recreational uses, resulting in very little exposure to recreationists on public lands. WS-Washington does not anticipate increasing

[49] Risk assessment details are available in *USDA, APHIS, WS Risk Assessment, Chapter V: The Use of Aircraft in Wildlife Damage Management*.

aerial shooting activities on public lands, however, should a request for assistance be received, WS-Washington may conduct limited aerial activities on public lands. When on public lands, WS-Washington coordinates with public land managers, during annual planning meetings and at other times, to avoid areas with high potential for recreational use.

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.

Hunters wearing Hunter Orange/Pink for safety would likely be visible to aerial crews and could thereby be avoided to reduce all forms of risk including from noise. In addition, WS-Washington 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.

FAA rules require pilots to stay a safe distance from people or 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-Washington conducts aerial shooting are sparsely vegetated and people are likely to be seen. In rare instances, people in the vicinity of aerial MDM activities are startled but have not been within minimum safe distances.

3.10.2.2.3 What are the Potential Risks to the Health and Safety of WS-Washington Employees during Aerial Activities?

Between 2000 and 2015, APHIS-WS recorded seven incidents nationwide involving firearms causing damage to the aircraft during aerial shooting (directly shooting parts of the aircraft and shot ricochet from rocks on the ground), with the last incident occurring in 2010. WS-Washington has not recorded any accidents or incidents related directly to aerial shooting since 2000 (USDA, APHIS, WS Risk Assessment, Chapter V: The Use of Aircraft in Wildlife Damage Management).

WS-Washington determined that the risk of accidents related to aerial shooting is minimal and less than that for general aviation. WS-Washington has not experienced any accidents or mishaps to date.[50]

[50] Details of evaluation of risk from aerial activities to WS employees are in the *USDA, APHIS, WS Risk Assessment, Chapter V: The Use of Aircraft in Wildlife Damage Management*.

3.10.2.2.4 What is the Potential for Hazardous Spills from an APHIS-WS Aircraft Crash?

The risk of fire or hazardous spills related to WS-Washington's aerial shooting activities 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-Washington aerial operations (USDA, APHIS, WS Risk Assessment, Chapter V: The Use of Aircraft in Wildlife Damage Management).[51]

3.10.2.2.5 What is the Potential for Compromised Physical Security of APHIS-WS Aircraft and Related Facilities?

WS-Washington 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-Washington has ever been stolen and the potential for such occurrences is considered negligible under all alternatives considered here.[52]

3.10.2.3 What are the Comparative Impacts of the Alternatives from the Use of Physical/Mechanical Methods?

3.10.2.3.1 Alternative 1. Proposed Action/ No Action Alternative: WS-Washington Continues MDM Assistance in Washington

The analysis for impacts on soil, water, and terrestrial and aquatic species indicates little to no effect on the environment from WS-Washington's use of any physical capture devices, shooting, aerial shooting, or trained animals. The effects of lead ammunition will be discussed in Section 3.11.2.

Risks to human health and safety, including recreationists, hunters, and domestic animals from WS-Washington'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 MDM activities occurring in a particular area and protective measures as described in Section 2.4. WS-Washington employees have a high level of proficiency and are routinely trained in the use of mechanical/physical methods.

WS-Washington 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 MDM activities, based on historical records (Table 46). Reported injuries to WS-Washington employees over the last five years average approximately four per year, mostly related to conducting

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[51] Details on the evaluation of related risk can be found in *USDA, APHIS, WS Risk Assessment, Chapter V: The Use of Aircraft in Wildlife Damage Management*.
[52] Details on how these risks were evaluated and addressed can be found in *USDA, APHIS, WS Risk Assessment, Chapter V: The Use of Aircraft in Wildlife Damage Management*.

operations in the outdoors, but only one incident was related to the use of the equipment. Therefore, the risk to humans and domestic animals from WS-Washington's use of mechanical/physical methods is very low on private lands and highly unlikely on public lands.

3.10.2.3.2 Alternative 2. WS-Washington Provides Technical MDM Assistance for Lethal and Non-Lethal Methods and only Non-Lethal Operational Damage Management Assistance.

Under this alternative, WS-Washington would provide non-lethal and lethal technical assistance, and non-lethal operational damage management assistance only. Other commercial, governmental, and private entities and landowners will continue to conduct MDM activities as described in Section 3.4. With this alternative, WS-Washington would use the APHIS-WS Decision Model for providing advice and technical assistance, as well as training on identification of species, and possibly individual animals, causing damage. 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 MDM needs themselves (as discussed in Section 3.4).

WCO's cannot conduct damage management on big game mammals, but landowners can get permits from WDFW and a WCO could work under those permits or a landowner could request someone to work as their agent under those permits. For damage management not involving big game mammals, WCO's are available and landowners could request someone work as their agent without a permit for select species. 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-Washington employees. WCOs may not have the experience or response capability with some of the species and methods if they are not already conducting MDM activities 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-Washington implements for its employees. The consistent use of PPE by private entities is likely to be lower than that used by WS-Washington 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. WDFW is the only entity other than WS-Washington who has been authorized by WDFW to conduct aerial shooting, thus impacts to safety and the environment would been less under this alternative.

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 Alternative 1. It is possible that the environment, humans, and domestic animals may have fewer exposures to MDM methods in the absence of lethal operational damage management assistance from WS-Washington 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 MDM methods and activities by other entities as a result of increased and less selective MDM efforts. While WS-Washington 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-Washington's effects on the environment, humans, and domestic animals from the use of mechanical/physical methods would be less than Alternative 1. 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 Alternative 1.

3.10.2.3.3 Alternative 3. WS-Washington Provides MDM Lethal Assistance Only for Cases of Human/Pet Health or Safety and/or to Protect Threatened or Endangered Species

Under Alternative 3, WS-Washington would provide full MDM technical and operational damage management 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-Washington could not use lethal methods as part of MDM 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 species of concern would be beavers, coyotes, yellow-bellied marmots, nutria, Columbian ground squirrels, bears, cougars, or disease vector species. Any mammal 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 MDM 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 MDM actions in proportion to the reduction of services that would normally be provided by WS-Washington. 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-Washington employees. This lack of training and experience will likely increase adverse effects on the environment, humans, and domestic animals.

Because operational damage management lethal actions would be limited and not available to manage damage to other resources, WS-Washington effects on the environment, humans, and domestic animals from the use of mechanical/physical methods would be less than Alternative 1 and slightly greater than Alternative 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 Alternative 1 and lesser effects than Alternative 2.

3.10.2.3.4 Alternative 4. No WS-Washington MDM Activities

WS-Washington 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, WDFW, 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 MDM actions in proportion to the reduction of services that would normally be provided by WS-Washington. 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-Washington employees.

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 1-3.

3.10.3 What are the Potential Impacts and Risks from the Use of Lead Ammunition?

WS-Washington uses non-lead ammunition in the majority of its MDM activities, including aerial shooting activities. WS-Washington will also use non-lead ammunition when required by land management policies and as required by federal and state laws, and when and where required by ESA Section 7 consultations. Some ground shooting activities may still be conducted with lead ammunition, but WS-Washington personnel recover and dispose of carcasses when practicable, greatly reducing the chance of exposure to wildlife. Additional analysis of lead use can be found in Appendix C. However, WS-Washington, through the implementation of the strategies above, has minimized the amount of lead that may be available to avian or mammalian scavengers, other predators, or humans in the environment.

3.10.3.1 What are the Comparative Impacts of the Alternatives from Lead Used in Ammunition?

3.10.3.1.1 Alternative 1. Proposed Action/No Action Alternative: WS-Washington Continues WS-Washington MDM Assistance

Impacts of lead to soils, water, plants, aquatic species, and invertebrates from WS-Washington sources of lead from MDM activities are negligible. Impacts of lead to birds and terrestrial mammals from WS-Washington sources are low. 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. WS-Washington uses non-lead ammunition for all aerial damage management operations because retrieval of carcasses is more difficult. In management operations other than aerial activities WS-Washington also retrieves and disposes of nearly all carcasses which further reduces the exposure of wildlife to lead. Additionally, WS-Washington will exclusively use non-lead ammunition for an agreement anytime a cooperator requests and funds its use.

WS-Washington selects ammunition for each project based on site specific conditions and concerns. Manufacturers continue to make improvements in the performance of non-lead ammunition and WS-Washington evaluates them for operational needs. However, ammunition does not perform universally, even across firearms of the same make and caliber and reliability is necessary for safe and effective MDM. The extent to which WS-Washington can incorporate the use of non-lead ammunition is contingent upon the project specific performance. WS-Washington abides by federal and state laws related to lead ammunition and continues to use non-lead ammunition in wildlife damage management where feasible and effective. WS-Washington remains committed to working with other federal and state agencies to proactively manage lead exposure to fish and wildlife.

The primary contribution of lead is related to ingestion of leaded ammunition by individual animals and humans from eating meat (or gutpiles 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 gutpiles. 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-Washington use non-leaded ammunition when in accordance with federal and state law and when available, cost-effective, and effective for MDM purposes.

WS-Washington 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 gutpiles 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 gutpiles left by WS-Washington 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-Washington through carcass disposal in the field is extremely low in comparison to that deposited from industrial sources and hunters.

Risks to human health and safety, including recreationists, hunters and domestic animals, from WS-Washington sources of lead is very low. WS-Washington 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 MDM activities as described in Section 3.4.

As humans are very unlikely to eat carcasses discarded in the field by WS-Washington, the risk of ingesting lead from WS-Washington activities is negligible. Lead from ammunition would be more likely to be ingested by humans from meat obtained by recreational hunting. Meat donated by WS-Washington is removed using non-lead ammunition only. Meat donated by WS-Washington is primarily from deer shot during activities to aircraft and crew operations on airport property. Therefore, the risk to humans and domestic animals from WS-Washington's use of lead is very low.

3.10.3.1.2 Alternative 2. WS-Washington Provides Technical MDM Assistance for Lethal and Non-Lethal Methods and Non-lethal Operational Damage Management Assistance

Under this alternative, WS-Washington would provide non-lethal and lethal technical assistance, and non-lethal operational damage management assistance only. Other commercial, governmental, and private entities and landowners would be expected to continue to conduct MDM activities as described in Section 2.3.2. WS-Washington would have no take under this alternative.

With this alternative, WS-Washington would use the APHIS-WS Decision Model for providing advice and technical assistance, as well as training on identification of species, and possibly individual animals, causing damage. 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 MDM needs themselves (as discussed in Section 3.4). WCOs are not authorized to conduct big game damage management unless under the authority of landowners in a damage management agreement with WDFW, 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-Washington employees. WCOs may not have the experience or response capability with some of the species and methods if they are not already conducting MDM 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 MDM activities in the absence of lethal operational damage management assistance from WS-Washington. Other entities would likely increase lethal MDM actions in proportion to the reduction of services that would normally be provided by WS-Washington. Depending on the readiness and interest of other entities to conduct MDM activities, the impacts of lead could be greater than, less than, or similar to the cumulative take under Alternative 1. It is possible for greater impacts of lead from other entities, as a result of less selective removals effort. Conversely, less lead may be used as fewer animals may be removed in the absence of lethal operational damage management assistance from WS-Washington because there may be fewer entities readily available to help address conflicts, and because individuals experiencing damage may not take action themselves. Lastly, there is the potential lead impacts from other entities would be similar WS-Washington's levels under Alternative 1.

Under Alternative 2, other entities would be expected to have a higher levels of lead take than Alternative 1. Take of unclassified mammals by private individuals or their agent is not required to be reported to WDFW, potentially resulting in underreporting, compared to WS-Washington's reporting under Alternative 1. However, take by other entities would not be expected to near annual maximum sustainable harvest levels established for the mammal species, despite any reasonably foreseeable levels of increased take by other entities.

WS-Washington's use of lead would have no effect on the environment, humans, and domestic animals. 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 Alternative 1.

3.10.3.1.3 Alternative 3. WS-Washington Provides MDM Lethal Assistance Only for Cases of Human/Pet Health or Safety and/or to Protect Threatened or Endangered Species

Under Alternative 3, WS-Washington would provide full MDM technical and operational damage management 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-Washington could not use lethal methods as part of MDM 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 mammal species of concern would be bears, cougars, or coyotes in residential areas, disease vector species, and beaver from damage to infrastructure. Any mammal 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 MDM 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 MDM actions in proportion to the reduction of services that would normally be provided by WS-Washington. 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, taking more shots per animal, and improperly dispose of carcasses.

Effects on the environment, humans, and domestic animals from WS-Washington's use of lead would be less than Alternatives 1 but greater than Alternative 2. Other entities would be expected to have greater effects on the environment, humans, and domestic animals from the use of lead compared to Alternative 1 and similar effects to Alternative 2.

3.10.3.1.4 Alternative 4. No WS-Washington MDM activities

WS-Washington 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 commercial WCOs, WDFW, 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 MDM actions in proportion to the reduction of services that would normally be provided by WS-Washington. 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, taking more shots per animal, and improperly disposing of carcasses.

Therefore, effects on the environment, humans, and domestic animals by the use of lead by other entities would be expected to be higher than under Alternatives 1-3.

3.10.4 What are the Potential Impacts and Risks from the Use of Chemical Methods?

In accordance with WS Directives 2.401 and 2.401 (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-Washington personnel must be registered with EPA and WSDA. 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 of 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.

3.10.4.1 What are the Impacts and Risks of Sodium Nitrate as Used in Gas Cartridges?

Gas cartridges are pyrotechnic fumigants used to target animals that live in burrows or dens, such as coyotes, skunks, marmots, and ground squirrels. 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 2020) recommends the use of CO for euthanasia because it quickly induces unconsciousness without pain, and death occurs rapidly (Section 3.9.5.3.2).

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 (U.S. Environmental Protection Agency and United States Department of Transportation 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 (Agency for Toxic Substances and Disease Registry 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 (U.S. Environmental Protection Agency 2009).

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-Washington uses gas cartridges sparingly during MDM activities, mostly limited to coyote, with limited use on red fox dens and possible use on striped skunks (Table 2.1, Table E.1). Burrows of target mammals 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 burrow is very low, non-target species rarely co-habitat with target species. 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 target species is very low.

Further detail on risks associated with the use of carbon monoxide in gas cartridges and forced gas fumigation systems are available in the peer-reviewed Risk Assessment on carbon monoxide (USDA Wildlife Services 2019h).

3.10.4.2 What are the Impacts and Risks of Zinc Phosphide?

Zinc phosphide is a restricted-use toxicant that requires certified applicators or persons under their direct supervision to be applied. Aluminum phosphide and magnesium phosphide fumigants have similar modes of action, aluminum phosphide is discussed in Section 3.11.3.3. Zinc phosphide is a heavy, finely ground gray-black powder that is practically insoluble in water and alcohol. When exposed to acid, it breaks down by hydrolysis and releases phosphine gas (PH3). Zinc phosphide concentrate is a stable material when kept dry and hermetically sealed. Zinc phosphide is a toxicant WS-Washington used to remove damaging ground squirrels, voles, northern pocket gophers, Columbian ground squirrels, and Californian ground squirrels. Although zinc phosphide baits have a strong, pungent, phosphorous-like odor (garlic like), this characteristic seems to attract rodents, particularly rats, and apparently makes the bait unattractive to some other animals.

For many uses of zinc phosphide formulated on grain or gain-based baits, pre-baiting is recommended or necessary for achieving good bait acceptance (Timm 1994). The use of zinc phosphide on various types of fruit, vegetable or cereal baits (apples, carrots, sweet potatoes, oats, barley) has proven to be effective at suppressing a local population. Toxicity from zinc phosphide occurs from reaction with acids in the stomach creating phosphine gas that is absorbed into the respiratory system typically resulting in death from asphyxia overnight, for those individuals that consumed a lethal dose and do not succumb to asphyxia liver damage results in death in the next few days.

Specific bait applications are designed to minimize non-target hazards (Evans 1970). Zinc phosphide presents low secondary hazard to predators and scavengers as it breaks down into harmless phosphates in the bodies of animals that ingested it directly. Zinc phosphide also causes an emetic response in most non-rodents and for those animals that directly ingest and don't regurgitate a sub-lethal dose make a full recovery after 3 days. Monitoring during the pre-baiting period helps to determine the presence of non-target wildlife and appropriate measures to prevent zinc phosphide exposure to non-target wildlife will be implemented to include not treating with zinc phosphide. Zinc phosphide is not applied in locations where it can enter aquatic environments through direct contact or in runoff as detailed by the label.

In the soil, zinc phosphide rapidly creates phosphine when exposed to soil moisture which is released into the atmosphere or is converted into phosphate and zinc complexes (USDA Wildlife Services 2019c). In the air and soil, zinc phosphide hydrolyzes quickly with a half-life of less than one week in moist soils less than one day in the air (USDA Wildlife Services 2019c).

There have been no reports human deaths the United States from exposure to zinc phosphide, but non-severe poisonings include occupational exposures at four veterinary hospitals (two in Michigan, one in Iowa, and one in Washington) when veterinary staff breathed in phosphine gases from dogs accidentally poisoned by consuming rodenticides containing zinc phosphide (USDA Wildlife Services 2019c). Direct exposure to zinc phosphide from WS-Washington applications is unlikely due to its use typically being on private lands or land inaccessible to the general public (e.g. airports, dike, and dams). Applications near residential areas is also prohibited by the label. Although carcasses are not often retrieved by WS-Washington, fossorial rodents are the primary target species for zinc phosphide so carcasses are often left underground. Additionally, the hypophosphite excreted through urine and dissolved phosphines that are produces once the phosphine gas has hydrolyzed are inert and pose very low risk to humans, pets, and wildlife.

Risks to WS-Washington employees are low because WS-Washington employee's implement all appropriate PPE as consistent with the label during application. WS-Washington uses zinc phosphide sparingly (0.16% of responses during the reporting period) through either hand-baiting or ground broadcast baiting. As consistent with the label, any residual zinc phosphide or treated carcasses are handled with waterproof gloves.

3.10.4.3 What are the Impacts and Risks of Aluminum Phosphide?

Aluminum phosphide was first registered as a pesticide in 1958. Aluminum phosphide is frequently prepared in rounded pellets/tablets as a fumigant used to control insects and rodents. Aluminum phosphide concentrate is a stable material when kept dry and hermetically sealed. When applied to a burrow, entrances are sealed, and aluminum phosphide exposed to moisture in the burrow reacts with the tablets and releases phosphine gas (PH3). Concentrations of phosphine reach their peak in 48-60 hours (USDA Wildlife Services 2019b). It is understood that any animals within the burrow, target or non-target, will inhale the phosphine which enters the bloodstream via the lungs, and for those individuals receiving a lethal dose, death is typically overnight due to asphyxia or within 3 days due to liver damage.

As aluminum phosphide is typically used to treat the burrows of fossorial rodents USDA-WS identify burrows of target and non-target mammals and birds based on tracks, observed activity, and presence of scat. Non-target vertebrate species do rarely co-habitat with target species but typically have identifiable burrow structures (including entrances) that if observed treatment of those burrows do not occur. Thus, the risk of taking non-target birds and mammal species is low. Toxicity from aluminum phosphide comes from phosphine gas which breaks down readily in the atmosphere through reaction with hydroxyl radicals in the atmosphere degrading in 5 hours (USDA Wildlife Services 2019b). Aluminum phosphide presents minimal secondary hazard to predators and scavengers. Toxicity results from inhalation of phosphine gas which has been fully absorbed and converted to hypophosphite in urine or dissolved phosphines which have no toxic effect on predators and scavengers (USDA Wildlife Services 2019b). Additionally, phosphine gas is an emetic, forcing animals that ate a prey animal still containing phosphine gas in their lungs or stomach to regurgitate the prey animal, leaving the predator/scavenger unharmed.

Risks to the public during application are reduced by WS-Washington following the label's instructions on application. Some safety precautions on the label limiting risks to the public are applications being prohibited in residential areas and within 100ft of buildings occupied by humans or domestic animals. WS-Washington does not apply aluminum phosphide to food commodities and does not use it anywhere that may contaminate drinking water. Direct exposure to aluminum phosphide from WS-Washington applications is unlikely due to its use typically being on private lands or land inaccessible to the general public (e.g. airports, dike, and dams). Although carcasses are not often retrieved by WS-Washington, fossorial rodents are the primary target species for aluminum phosphide applications, so carcasses are often left underground. Additionally, the hypophosphite excreted through urine and dissolved phosphines that are produces once the phosphine gas has hydrolyzed are inert and pose very low risk to humans, pets, and wildlife.

Risks to WS-Washington employees are low because WS-Washington employee's implement all appropriate PPE as consistent with the label during application. WS-Washington uses aluminum phosphide sparingly (0.01% of responses during the reporting period) through either hand-baiting or through a probe directly into closed burrow systems.

3.10.4.4 What are the Impacts and Risks of Chlorophacinone?

Chlorophacinone in only used to manage damaged caused by mountain beaver and per the label is only applied underground. A special local need label has been issued for Washington State to use of chlorophacinone on mountain beaver. Unlike many of the other toxicants in this EA, pre-baiting is not used as it has the potential to increase non-target take by attracting other species to the easy access food source (Arjo and Nolte 2004). WS-Washington's use of chlorophacinone will be implemented in accordance with all relevant laws and ESA consultations. As burrows dug by mountain beaver are readily identifiable, chlorophacinone is applied directly inside the burrow either at the entrance or into the runway of an active tunnel. Chlorophacinone is only applied for management of mountain beaver damage to forest plantations in western Washington and is not authorized for use in eastern Washington. Chlorophacinone is an anticoagulant that causes fatal hemorrhaging in individuals that receiving a lethal dose.

Only one baiting is implemented per year which further reduces primary exposure to non-target species that frequent mountain beaver burrows such as rabbits, weasels, and skunks. Primary exposure of birds, amphibians, and larger mammals is unlikely due to lack of interest in the bait or the lack of accessibility to the bait placed underground. Mountain beavers cache food and would likely bring bait packets back into their burrow to their food cache further reducing access to species outside of the burrow. As dispersing mountain beavers move into unoccupied burrows the cached bait stores extend the effectiveness of a treatment to reduce mountain beaver populations throughout the year. Mountain beaver do not frequently co-habitat with other species as other residents may feed on the mountain beaver food caches. There is a possibility for non-target fossorial rodent species reoccupying burrows and consuming the cached bait after target mountain beaver have been removed. This is one of the reasons that baiting is only conducted once per year.

The issues of secondary toxicity for anticoagulant toxicants, including chlorophacinone is well documented (Arjo and Nolte 2004, Riley et al. 2007, Salmon et al. 2007, Van de Brenk et al. 2018). The special label for its use in Washington State implements mitigation measures to reduce the impacts of secondary effects. Non-target take is reduced by restricting use to between October and February when juvenile mountain beaver are not present to limit secondary toxicity. The combination of underground applications (on a fossorial rodent species) and limiting applications to once per year on a site limits treated carcass access and availability to predators/scavengers. This short time period and reduced availability of treated mountain beaver carcasses limits exposure and the chances of harmful accumulation of chlorophacinone in predator/scavenger species. In Arjo et al. (2004) the highest chlorophacinone residuals in a mountain beaver carcass (0.354 ppm) was used to calculate an EPA method to derive a risk quotient for mink and red-tailed hawk LD_{50} values and average daily mass of food consumed by the assessed species. Mink's risk quotient (0.1) and red-tailed hawks (.003) was lower than the EPA's acceptable level of concern for restricted-use pesticides potential impacts to ESA listed species (0.2).

Risks to the public during application are reduced by WS-Washington following the label's instructions on application. Direct exposure of the public to chlorophacinone from WS-Washington applications is unlikely due to its use only underground on private timber lands. Although carcasses are not often retrieved by WS-Washington, mountain beaver are fossorial and the majority of mountain beaver that consumed a lethal dose of chlorophacinone die underground (Arjo et al. 2009) so carcasses are often left underground.

Risks to WS-Washington employees are low because WS-Washington employee's implement all appropriate PPE as consistent with the label during application. Baits are contained in packets that prevent direct exposure to the bait and do not require opening when being applied. WS-Washington uses only hand-baiting bait directly into burrow systems.

Risks to the environment are minimal as chlorophacinone has low water solubility, low soil mobility, and while moderately persistent in the soil (half-life is 70 days) toxicity is no longer present once degraded (Liphatech).

3.10.4.5 What are the Impacts and Risks of Strychnine?

Strychnine is a poison that has been used to control rats as well as other mammalian and avian pests since the 17th century. In the United States it is registered for below-ground use only to manage damage caused by pocket gophers. Provisions are included on the label to exclude use in areas with ESA species including the Mazama pocket gopher. Subsurface applications of strychnine can be made by either hand baiting or by using a mechanical burrow builder. Baiting by hand is done either by digging a hole into the gopher burrow or using a hollow probe that deposits the measured amount of bait into a burrow. The mechanical burrow builder is towed behind a tractor and digs an artificial burrow for the treated bait to be placed. Once consumed the strychnine is a neurotoxin that quickly disrupts the processes of the nervous system to include breathing, death typically occurs from asphyxia.

Acute toxicity from direct consumption and not cumulative effects are the primary concern of risk to non-target species and the public in general. Secondary and tertiary toxicity was assessed on scavenging birds and insectivores. Though pocket gophers rarely die above ground, other primary exposed non-target small mammals may. Rapid decay of carcasses due to insect activity typically excludes scavengers from finding available carcasses. Concentrations of strychnine in insects during the study were not enough to exceed harmful levels in the most sensitive species of insectivores (avian, mammalian, or amphibian) documented (Arjo et al. 2006).

Data exists from a few studies on dietary LC_{50} on larger mammals that indicate carnivores might be sensitive to direct consumption of bait (Durkin and Syracuse Environmental Research Associates 2010). The impacts on avian species directly consuming treated bait follows the same response as mammal species and dosages are lethal in similar qualities. Strychnine does not accumulate from multiple non-lethal doses in the body of exposed individual and negative impacts of the non-lethal dose subside after a short time period. So long as no other significant stresses are experienced by the individual during the recovery period (Durkin and Syracuse Environmental Research Associates 2010), a full recovery would be expected from a non-lethal dosing. Non-target species that use the same burrow systems as pocket gophers are potentially impacted depending on the season specifically Muridae and Microtus species. All applications are made underground and sufficiently sealed so exposures to members of the general public, secondary toxicity for avian species, and other scavengers are minimal. Non-target impacts are expected to occur with mice, mole, and vole species that occupy the burrow systems with the pocket gophers though this level of take is expected to be limited as pre-baiting will restrict the amount of Strychnine applied to the amount that will be consumed during the treatment. Monitoring during the pre-baiting period also helps identify any non-target species that may be affected and measures (so long as their consistent with the label) can then be taken to limit or prevent non-target species take.

Risks to the public during application are reduced by WS-Washington following the label's instructions on application. Some safety precautions on the label limiting risks to the public are applications being prohibited in residential areas and within 100ft of buildings occupied by humans or domestic animals. Direct exposure of the public to strychnine from WS-Washington applications is unlikely due to its use being prohibited in residential areas and primarily on private lands or land inaccessible to the general public (e.g. airports, dike, and dams). Although carcasses are not often retrieved by WS-Washington, fossorial rodents are the primary target species for strychnine applications, so carcasses are often left underground. The rapid decay of carcasses due to insect activity discussed above also reduces the public's exposure to treated individuals.

Risks to WS-Washington employees are low because WS-Washington employee's implement all appropriate PPE as consistent with the label during application. WS-Washington uses strychnine more than other toxicants, but it is still used sparingly

(1.07% of responses during the reporting period) through either hand-baiting into burrow entrances or through a probe directly into closed burrow systems.

3.10.4.6 What are the Impacts and Risks of Direct Injection Chemical Euthanasia and Euthanasia with CO_2?

Immobilization and euthanasia (I&E) chemicals are described in Appendix A and evaluated for humaneness in Section 3.8.2.

WS Directives 2.505 and 2.430 (Section 2.4) provide guidance for euthanizing and immobilizing animals. All WS-Washington 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.[53]

Immobilization drugs are metabolized and broken down by wildlife through natural metabolic processes over time. Some animals, such as a bear, could be immobilized just prior to or during a hunting season. In the event that WS-Washington is requested by WDFW to immobilize a bear during a period of time where the drug withdrawal period (chemical metabolic breakdown) could overlap with a regulated harvest season, WS-Washington would either euthanize the bear or mark the animal with ear tags labeled with a "do not eat" warning prior to the bear's release. This measure minimizes the risk of human exposure to residual immobilization drugs in the low likelihood that they consume game meat from a recently immobilized animal (Section 2.4.3.1).

WS Directive 2.515 (Section 2.4) 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-Washington uses very few I&E drugs. 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

[53] Further detail on risks associated with the use of immobilization and euthanasia (humane killing) drugs are available in *USDA, APHIS, WS Risk Assessment, Chapter XIX: The Use of Immobilization and Euthanasia Drugs in Wildlife Damage Management* (Appendix G).

area with high visibility, both of which are rare. Use of immobilization drugs also requires the direction and approval of WDFW because all wildlife relocated in the state must be approved by WDFW prior to relocation). Immobilization would occur primarily for bear and cougar 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).

As only small amounts of I&E drugs are used by WS-Washington 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-Washington field employees is negligible. Only WDFW would be expected to use I&E drugs.

3.10.4.7 What are the Comparative Impacts of the Alternatives from the Use of Chemical Methods?

3.10.4.7.1 Alternative 1. Proposed Action/ No Action Alternative: WS-Washington Continues MDM Assistance in Washington

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-Washington employee has been injured by using gas cartridges, and the use of these cartridges by WS-Washington field personnel is infrequent.

Zinc phosphide: The risk of impacts on the environment, humans, and domestic animals from zinc phosphide is negligible because primary exposure is limited by underground application to reduce access and secondary toxicity is significantly limited due to the limited residence time phosphine (the active toxicant) has both in the environment and within treated individuals. No member of the public has been injured by the use of zinc phosphide by WS-Washington and precautions taken by WS-Washington in accordance with the label keep the risk to the public low. No APHIS-WS or WS-Washington employee has been injured by using zinc phosphide, and the use of these cartridges by WS-Washington field personnel is infrequent.

Aluminum phosphide: The risk of impacts on the environment, humans, and domestic animals from aluminum phosphide is negligible because primary exposure is limited by underground application to reduce access and secondary toxicity is significantly limited due to the limited residence time phosphine (the active toxicant) has both in the environment and within treated individuals. No member of the public has been injured by the use of aluminum phosphide by WS-Washington and precautions taken by WS-Washington in accordance with the label keep the risk to the public low. No APHIS-WS or WS-Washington employee has been injured by using aluminum phosphide, and it's use by WS-Washington field personnel is infrequent.

Chlorophacinone: The risk of impacts on the environment, humans, and domestic animals from chlorophacinone is negligible due to the number of precautions taken to minimize the primary and secondary non-target effects. Maximum of one application per site per year, underground application, the typically low density of mountain beaver (when compared to many other fossorial rodents), application only on timber land, and the timing of application limited to when no juvenile or dispersing mountain beaver are present reduce chlorophacinone application's effects on non-target species, the environment, and the public. No member of the public has been injured by the use of chlorophacinone by WS-Washington and precautions taken by WS-Washington in accordance with the label keep the risk to the public low. No APHIS-WS or WS-Washington employee has been injured by using chlorophacinone, and it's by WS-Washington field personnel is infrequent.

Strychnine: The risk of impacts on the environment, humans, and domestic animals from strychnine is negligible because primary and secondary exposure is limited by underground application to reduce access and availability of treated carcasses to scavengers. No member of the public has been injured by the use of Strychnine by WS-Washington and precautions taken by WS-Washington in accordance with the label keep the risk to the public low. No APHIS-WS or WS-Washington employee has been injured by using Strychnine, and it's use by WS-Washington field personnel is infrequent.

I&E Drugs: Only small amounts of I&E drugs are used by WS-Washington in a year, 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-Washington field employees is negligible.

Therefore, based on detailed risk assessments (Appendix G) and 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-Washington's use of chemical methods. Additionally, risks to humans and domestic animals from WS-Washington's use of chemical methods are very low to negligible due to protective measures (Section 2.4).

3.10.4.7.2 Alternative 2. WS-Washington Provides Technical MDM Assistance for Lethal and Non-Lethal Methods and only Non-Lethal Operational Damage Management Assistance.

Under this alternative, WS-Washington would provide non-lethal and lethal technical assistance, and non-lethal operational damage management assistance only. Other commercial, governmental, and private entities and landowners will continue to conduct MDM activities as described in Section 3.4. WS-Washington would use the APHIS-WS Decision Model for providing advice and technical assistance, as well as training on identification of species, and possibly individual animals, causing damage. WS-Washington would only be able to use immobilization drugs under this alternative.

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 MDM needs themselves (as discussed in Section 3.4). Relatively few WCOs are not authorized to conduct big game damage management without being covered under a landowner's cooperative damage agreement and a WDFW issued damage take permit. Landowners can request WDFW or 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 MDM activities in the absence of lethal operational damage management assistance from WS-Washington. However few individuals would have the training and authorization to utilize chemicals that WS-Washington could use under Alternative 1. 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. WDFW, 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-Washington) to minimize effects on the environment, humans, and domestic animals. Sodium nitrate in large gas cartridges isn't a restricted-use pesticide and could be used by private individuals and or public agencies; however, it is not currently registered in Washington for use other than for WS-Washington. If it is registered, applicators would be 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-Washington's use of chemical methods would be less than Alternative 1 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 Alternative 1 and 3.

3.10.4.7.3 Alternative 3. WS-Washington Provides MDM Lethal Assistance Only for Cases of Human/Pet Health or Safety and/or to Protect Threatened or Endangered Species

Under Alternative 3, WS-Washington would provide full MDM technical and operational damage management 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-Washington could not use lethal methods as part of MDM 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 mammal species of concern would be bears, cougars, or coyotes in residential areas, disease vector species, or beaver for damage to infrastructure. Any mammal species have the potential to be threats to T&E species. Other commercial, governmental, and private entities and landowners would continue to conduct MDM activities as described in Section 3.4.

During (or instead of) WS-Washington's limited lethal assistance, landowners could still choose to address the problem by implementing MDM methods themselves. Landowners could use trained and experienced WCOs or may implement lethal methods themselves. Other entities would likely increase lethal MDM actions in proportion to the reduction of services that would normally be provided by WS-Washington.

However few individuals would have the training and authorization to utilize chemicals that WS-Washington could use under Alternative 1. 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. WDFW, 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-Washington) to minimize effects on the environment, humans, and domestic animals. Sodium nitrate in large gas cartridges isn't a restricted-use pesticide and could be used by private individuals and or public agencies; however, it is not currently registered in Washington for use other than for WS-Washington. If it is registered, applicators would be 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-Washington's use of chemical methods would be less than Alternatives 1. 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.

3.10.4.7.4 Alternative 4. No WS-Washington MDM Activities

WS-Washington 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 commercial WCOs, WDFW, 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, or attempt to address their MDM needs themselves (as discussed in Section 3.4). WCOs are not authorized to manage big game damage unless under the authority of a landowner's damage management agreement with WDFW, 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 MDM activities in the absence of lethal operational damage management assistance from WS-Washington. However few individuals would have the training and authorization to utilize chemicals that WS-Washington could use under Alternative 1. 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. WDFW, 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-Washington) to minimize effects on the environment, humans, and domestic animals. Sodium nitrate in large gas cartridges isn't a restricted-use pesticide and could be used by private individuals and or public agencies; however, it is not currently registered in Washington for use other than for WS-Washington. If it is registered, applicators would be 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 than under Alternative 1.

3.11 How does this EA Address WS-Washington's Stated Goal and Objectives?

Section 1.5.1 states the goals and objectives of WS-Washington MDM 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 and Current Action, Alternative 1, 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-Washington MDM activities meet the goal and objectives.

APHIS-WS responds to requests for assistance from private and public entities, tribes and other federal, state, and local governmental agencies (APHIS-WS Directive 1.201 and 3.101).

The goal of WS-Washington is to 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 (APHIS-WS Decision Model, APHIS-WS Directive 2.201, Section 2.2.1.2) to evaluate, formulate, and implement or recommend the most effective strategy. The recommended strategy is designed to reduce or eliminate damage and risks caused by the offending animal(s) and to resolve conflicts with humans and their valued resources, health, and safety.

The WS-Washington objectives are to:

- Professionally and proficiently respond to all requests for assistance using integrated MDM and applying the APHIS-WS Decision Model (APHIS-WS

Directive 2.201; Section 2.2.1.2). MDM must be consistent with all APHIS-WS policies and directives, cooperative agreements, MOUs, and other requirements as provided in any decision resulting from this EA.

- Implement MDM so that cumulative effects do not negatively affect the viability of any native wildlife populations.

- Ensure that actions conducted within the IWDM 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.

- Minimize non-target effects by using the APHIS-WS Decision Model (APHIS-WS Directive 2.201; Section 2.2.1.2) to select the most effective, target-specific, and humane remedies available, given legal, environmental, and other constraints.

- Incorporate the use of appropriate and effective new and existing lethal and non-lethal technologies, where appropriate, into technical and direct assistance strategies.

APHIS-WS' activities are also conducted in accordance with the directives found in the WS Program Policy Manual. These documents establish the need for requested work, legal authorities allowing the requested work, and the respective responsibilities of APHIS-WS and its cooperators.

Section 1.5.1 states the goals and objectives of WS-Washington MDM 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 and Current Action, Alternative 1, 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-Washington MDM activities meet the goal and objectives.

Objectives:

Each objective listed below (Section 1.5.1) is addressed in the following sections of the EA:

1. Professionally and proficiently respond to all reported and verified losses or threats due to mammals, using the MDM approach using the APHIS-WS Decision Model. MDM 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 1.7: WDFW authorities and objectives for managing wildlife
- Section 1.8: Description of how WS-Washington works with WDFW and state agencies, including cooperative agreements
- Section 1.9: MOUs between APHIS-WS and USFS, USFWS, and BLM
- Section 2.2.1.2: Description of APHIS-WS Decision Model
- Section 2.4: APHIS-WS relevant Directives and policies and WDFW relevant laws and regulations for integrated predator damage management
- Section 2.4: Use of APHIS-WS relevant Directives and WDFW relevant laws and regulations in integrated predator damage management

2. Implement MDM so that cumulative effects do not negatively affect the viability of any native or game managed populations.
    - Section 3.5: Cumulative effects analysis for target mammal populations
    - Section 3.6 and 3.7: Cumulative effects analysis for non-target mammal populations
    - Section 3.8: Cumulative impact analysis for impacts to biodiversity and ecosystem resilience

3. Ensure that actions conducted within the MDM 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 1.7: WDFW management authorities and objectives for managing wildlife
    - Section 3.12: WDFW, USFS, and BLM objectives and management of mammal damage in special management areas
    - Section 3.5: Take of target mammal species either under WDFW authorization or reported to WDFW per state law and regulations

4. Minimize 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 1.13: Effectiveness of mammal damage management
    - Section 2.2.1.2: Description of APHIS-WS Decision Model
    - Section 2.4: APHIS-WS relevant Directives and policies and WDFW relevant laws and regulations for predator damage management
    - Section 3.5: Impacts of MDM involving all known target mammal species and reported lethal takes of native mammals
    - Section 3.6 and 3.7: Impacts of MDM involving all known non-target WS-Washington take of mammals and impacts to ESA-listed species
    - Section 3.9: Analysis of the ethics and humaneness impacts of MDM methods used by WS-Washington

- Section 3.10: Analysis of impacts sociocultural values and wildlife related recreation
- Section 3.11: Analysis of the impacts of MDM 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 MDM activities
- Section 2.3.1 and Appendix A: Description of WS-Washington MDM activities, including methods
- Section 3.9: Analysis of the ethics and humaneness impacts of MDM methods used by WS-Washington

Table 47. Comparison of alternatives in meeting the objectives to support WS-Washington's goal to meet the APHIS-WS mission of professionally supporting the coexistence of humans and wildlife.

<u>Alternative 1</u> Proposed Action/No Action-Continue WS-Washington MDM Activities	<u>Alternative 2</u> Technical MDM Assistance and Non-lethal Operational Damage Management Activities	<u>Alternative 4</u> Lethal MDM Assistance Only for Human/Pet Safety or to Protect T&E Species	<u>Alternative 5</u> No WS-Washington MDM Activities
Objective 1. Professionally and proficiently respond to all reported and verified losses or threats due to mammals, using the MDM approach using the APHIS-WS Decision Model. MDM 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.			
Meets objective.	Does not meet Objective.	Does not meet objective	Does not meet objective
Objective 2. Implement MDM so that cumulative effects do not negatively affect the viability of any native mammal populations.			
Meets objective.	Meets objective	Meets objective	Meets objective.
Objective 3. Ensure that actions conducted within the MDM 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.	Meets objective.	Meets objective	Does not meet objective.
Objective 4. Minimize 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.	Does not meet objective.	Does not meet objective.	Does not meet objective.
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.	Does not meet objective.	Does not meet objective	Does not meet objective.

Table 48. Summary of the Environmental Effects of Each Alternative by Issue

Issues	Alternative 1 Proposed Action/No Action-Continue WS-Washington MDM Assistance	Alternative 2 Technical MDM Assistance and Non-lethal Operational Damage Management Assistance	Alternative 3 Lethal MDM Assistance Only for Human/Pet Safety or to Protect T&E Species	Alternative 4 No WS-Washington MDM Activities
Effects on mammal 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 mammal species populations are stable as determined by WDFW. WS-Washington is not and would not adversely impact any native or managed mammal populations.	WS-Washington would have no effect on mammal species populations. Other entities would be expected to fill the need for lethal operational damage management assistance to some degree and have a level of take similar to the cumulative take under Alternative 1. Take by other sources would not be expected to near the maximum sustainable harvest levels. Mammal populations are expected to be stable.	WS-Washington would have less effects on mammal species populations compared to Alternatives 1 but greater than Alternative 2. Other entities would be expected to fill the need for lethal MDM to protect other resources to some degree and have a level of take similar to the cumulative take under Alternative 1. Cumulative take would not be expected to near the maximum sustainable harvest levels. Mammal populations are expected to be stable.	WS-Washington would have no effect on mammal species populations. Other entities would be expected to fill the need for lethal operational damage management assistance to some degree. Without WS-Washington technical or non-lethal operational damage management assistance, other entities may be less efficient and effective, and therefore effects on mammal species populations would likely be higher than under Alternatives 1-3. Mammal populations are expected to be stable.
Effects on threatened and endangered species	WS-Mammal has had no take of T&E species since at least FY 2001 and has completed appropriate ESA consultations with USFWS and NMFS on potential effects to T&E species. WS-Washington is not likely to adversely	WS-Washington would have less effects on T&E species compared to Alternative 1. T&E species would not benefit from lethal MDM conducted by WS-Washington for T&E species protection. Other entities would be expected	WS-Washington would have the same beneficial impacts on T&E species and a lower potential for negative impacts on T&E species from MDM for other resources compared to Alternative 1. Other entities would be expected	WS-Washington would have no effect on T&E species. T&E species would not benefit from all IMDM conducted by WS-Washington for T&E species protection. Other entities would be expected to fill the need for lethal

Issues	<u>Alternative 1</u> Proposed Action/No Action-Continue WS-Washington MDM Assistance	<u>Alternative 2</u> Technical MDM Assistance and Non-lethal Operational Damage Management Assistance	<u>Alternative 3</u> Lethal MDM Assistance Only for Human/Pet Safety or to Protect T&E Species	<u>Alternative 4</u> No WS-Washington MDM Activities
	affect the majority of T&E species or would have no effect. Effects are expected to continue to be minimal. WS-Washington would continue to conduct MDM to protect T&E species.	to fill the need for lethal operational damage management assistance to some degree, potentially resulting in higher risks to T&E species than under Alternative 1.	to fill the need for lethal operational damage management assistance to some degree, potentially resulting in higher risks to T&E species, than under Alternative 1. WS-Washington would continue to conduct to protect T&E species.	operational damage management assistance to some degree, potentially resulting in higher risks to T&E species. Without WS-Washington technical or non-lethal operational damage management assistance, other entities may be less efficient and effective, and therefore adverse effects on T&E species would be expected to be higher than under Alternatives 1-3.
Effects on non-target species	WS-Washington's IMDM activities lethally take very few non-target animals and activities are highly selective for specific mammal species. WS-Washington's non-target take is expected to remain negligible.	WS-Washington would likely take fewer individual non-target animals compared to Alternative 1. Other entities would be expected to fill the need for lethal operational damage management assistance to some degree and potentially have a higher level of non-target take compared to Alternative 1.	WS-Washington would likely take fewer individual non-target animals compared to Alternative 1 and due to increase in IMDM activities potentially greater take of non-target animals compared to Alternative 2. Other entities would be expected to fill the need for lethal operational damage management assistance to some degree and	WS-Washington would have no non-target take of individual animals. Other entities would be expected to fill the need for lethal operational damage management assistance to some degree, potentially resulting in higher non-target take. Without WS-Washington technical or non-lethal operational damage management assistance, other entities may be less efficient and

Issues	Alternative 1 Proposed Action/No Action-Continue WS-Washington MDM Assistance	Alternative 2 Technical MDM Assistance and Non-lethal Operational Damage Management Assistance	Alternative 3 Lethal MDM Assistance Only for Human/Pet Safety or to Protect T&E Species	Alternative 4 No WS-Washington MDM Activities
			potentially have a higher level of take compared to Alternative 1.	effective, and therefore effects on non-target species taken would be expected to be higher than under Alternatives 1 and 3.
Effects on biodiversity and ecosystem resilience	The effects of WS-Washington IMDM activities on mammal species populations are temporary, localized, and of low magnitude. It is highly unlikely that WS-Washington's current and projected direct and cumulative take will contribute to any changes in ecosystem resilience to include trophic cascades or changes to biodiversity. Effects are expected to continue to be minima to target and non-target species leaving effects to biodiversity minimal.	WS-Washington would have no take. Other entities would be expected to fill the need for lethal operational damage management 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 changes in ecosystem resilience to include trophic cascades or changes to biodiversity.	WS-Washington would have less take compared to Alternatives 1 and more than Alternative 2. Other entities would be expected to fill the need for lethal operational damage management assistance to some degree and potentially have a higher level of take compared to Alternative 1 but similar to Alternative 2. It is highly unlikely that cumulative take will contribute to any changes in ecosystem resilience to include trophic cascades or changes to biodiversity.	WS-Washington would have no take. Other entities would be expected to fill the need for lethal operational damage management assistance to some degree, potentially resulting in a higher level of take. Without WS-Washington technical or non-lethal operational management assistance, other entities may be less efficient and effective, and therefore take would be expected to be higher than under Alternatives 1-3. However, it is highly unlikely that take by other entities will contribute to any changes in biodiversity to include trophic cascades or changes to biodiversity.

Issues	Alternative 1 Proposed Action/No Action-Continue WS-Washington MDM Assistance	Alternative 2 Technical MDM Assistance and Non-lethal Operational Damage Management Assistance	Alternative 3 Lethal MDM Assistance Only for Human/Pet Safety or to Protect T&E Species	Alternative 4 No WS-Washington MDM Activities
Effects on Humaneness and Ethics	All WS-Washington 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-Washington 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 foot snares used by WS-Washington are updated as often as funding allows, and field personnel trained in their use. APHIS-WS NWRC actively works to develop new	WS-Washington 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. For requests to conduct MDM actions there is a potential for other entities (as discussed in Section 3.4) to attempt to fill the need for lethal IMDM activities in the absence of lethal operational damage management assistance from WS-Washington. Depending on the skillset of others, it is possible that more non-target animals could be taken or less humanely by other entities, as a result of less selective and less proficient removal efforts. While WCOs are trained in BMPs, other private entities are not required to follow BMP guidelines. Therefore, other	WS-Washington would be able to respond for instance involving human health and safety and T&E species protection. For requests to conduct MDM for other resources there is a potential for other entities (as discussed in Section 3.4) to attempt to fill the need for lethal MDM activities in the absence of lethal operational damage management assistance from WS-Washington. Depending on the skillset of others, it is possible that more non-target animals could be taken or less humanely by other entities, as a result of less selective and less proficient removal efforts. While WCOs are trained in BMPs, other private entities are not required to follow BMP guidelines. Therefore, other private entities may have less ethical or less humane lethal MDM actions. While WS-Washington would still be	WS-Washington MDM would have no effect on humaneness or ethics. Landowners experiencing damage or threats could only depend on advice and responses from commercial WCOs, WDFW, or other entities. Other entities may not have the resources or skillset to respond to requests for MDM assistance in a timely manner, leaving landowners to either resolve the matter themselves. Landowners 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 MDM actions in proportion to the reduction of services that would normally be

Issues	Alternative 1 Proposed Action/No Action-Continue WS-Washington MDM Assistance	Alternative 2 Technical MDM Assistance and Non-lethal Operational Damage Management Assistance	Alternative 3 Lethal MDM Assistance Only for Human/Pet Safety or to Protect T&E Species	Alternative 4 No WS-Washington MDM Activities
	methods and trap modifications to improve effectiveness, selectivity, and humaneness.	private entities may have less ethical or less humane lethal MDM actions. While Therefore, under Alternative 2, there are likely to be less humane and ethical practices by other entities compared to Alternative 1.	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 Alternative 1 but more so than Alternative 2.	provided by WS-Washington. Therefore, under Alternative 4, there are likely to be less humane and ethical practices by other entities compared to Alternatives 1-3.
Effects on Sociocultural wildlife values or wildlife related recreation	WS-Washington's MDM actions will not significantly affect any wildlife populations in Washington state and thus will only have a marginal impact on wildlife viewing and access to game species in small localized areas, many areas are not accessible to public. WS-Washington's MDM actions would have minimal effects on cultural uses of wildlife resources because impacts on	WS-Washington's effects on the sociocultural wildlife values or wildlife related recreation would be less under Alternative 1. Other entities would be expected to fill the need for lethal operational MDM to some degree, potentially resulting in greater impacts to on the sociocultural wildlife values or wildlife related recreation compared to Alternative 1.	WS-Washington's effects on the sociocultural wildlife values or wildlife related recreation would be less under Alternative 1 and greater than Alternative 2. Other entities would be expected to fill the need for lethal operational MDM to some degree, potentially resulting in greater impacts to on the sociocultural wildlife values or wildlife related	WS-Washington would have no effect on the sociocultural wildlife values or wildlife related recreation. Other entities would be expected to fill the need for lethal operational damage management assistance to some degree, potentially resulting in greater impacts to the environment and managed species. Without WS-Washington technical or non-lethal operational

Issues	<u>Alternative 1</u> Proposed Action/No Action-Continue WS-Washington MDM Assistance	<u>Alternative 2</u> Technical MDM Assistance and Non-lethal Operational Damage Management Assistance	<u>Alternative 3</u> Lethal MDM Assistance Only for Human/Pet Safety or to Protect T&E Species	<u>Alternative 4</u> No WS-Washington MDM Activities
	species from MDM actions are low or negligible.		recreation compared to Alternative 1.	damage management assistance, effects on sociocultural wildlife values or wildlife related recreation would be greater compared to Alternatives 1-3.
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-Washington's use of mechanical/physical methods. Risks to humans and domestic animals from WS-Washington's use of mechanical/physical methods are very low on private lands and highly unlikely on public lands due to short duration and protective measures.	WS-Washington's effects on the environment, humans, and domestic animals would be less than Alternative 1. Other entities would be expected to fill the need for lethal operational MDM to some degree, potentially resulting in greater risks to the environment, humans, and domestic animals compared to Alternative 1.	WS-Washington's effects on the environment, humans, and domestic animals would be less than Alternative 1 and greater than Alternative 2. Other entities would be expected to fill the need for lethal operational MDM to some degree, potentially resulting in greater risks to the environment, humans, and domestic animals compared to Alternative 1.	WS-Washington would have no effect on the environment, humans, and domestic animals. Other entities would be expected to fill the need for lethal operational damage management assistance to some degree, potentially resulting in greater risks to the environment, humans, and domestic animals. Without WS-Washington technical or non-lethal operational damage management assistance, effects on the environment, humans, and domestic animals would be expected to be higher than under Alternatives 1-3.

Issues	Alternative 1 Proposed Action/No Action-Continue WS-Washington MDM Assistance	Alternative 2 Technical MDM Assistance and Non-lethal Operational Damage Management Assistance	Alternative 3 Lethal MDM Assistance Only for Human/Pet Safety or to Protect T&E Species	Alternative 4 No WS-Washington MDM Activities
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-Washington sources of lead is negligible. Impacts of lead on birds and terrestrial mammals from WS-Washington sources are low. Risks to humans and domestic animals from WS-Washington sources of lead are very low.	WS-Washington's use of lead would have no effect on the environment, humans, and domestic animals. Other entities would be expected to fill the need for lethal operational MDM to some degree, potentially resulting in greater risks to the environment, humans, and domestic animals compared to Alternative 1.	WS-Washington's effects on the environment, humans, and domestic animals would be less than Alternatives 1 and greater than Alternative 2. Other entities would be expected to fill the need for lethal operational MDM to some degree, potentially resulting in greater risks to the environment, humans, and domestic animals compared to Alternative 1.	WS-Washington's use of lead would have no effect on the environment, humans, and domestic animals. Other entities would be expected to fill the need for lethal operational damage management assistance to some degree, potentially resulting in greater risks to the environment, humans, and domestic animals. Without WS-Washington technical or non-lethal operational damage management assistance, effects on the environment, humans, and domestic animals would be expected to be higher than under Alternatives 1-3.

Issues	Alternative 1 Proposed Action/No Action-Continue WS-Washington MDM Assistance	Alternative 2 Technical MDM Assistance and Non-lethal Operational Damage Management Assistance	Alternative 3 Lethal MDM Assistance Only for Human/Pet Safety or to Protect T&E Species	Alternative 4 No WS-Washington MDM Activities
Effects on the environment, humans, and domestic animal health and safety from the use of chemical 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-Washington's use of chemical methods. Risks to humans and domestic animals from WS-Washington's use of chemical methods are very low to negligible due to protective measures.	WS-Washington's effects on the environment, humans, and domestic animals would be less than Alternative 1. Other entities would be expected to fill the need for lethal operational MDM 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.	WS-Washington's effects on the environment, humans, and domestic animals would be less than Alternative 1 and slightly greater than Alternative 2. Other entities would be expected to fill the need for lethal operational MDM 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.	WS-Washington would have no effect on the environment, humans, and domestic animals. Other entities would be expected to fill the need for lethal operational damage management assistance 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.

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6 Responses to Comments

In January 2021, WS-Washington published the Draft EA on Regulations.gov for 31 days to allow the public to review and comment on the draft. During that period we received 993 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, were 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 substantive 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).

1. Outside the Scope of the EA

We received comments which are categorically outside the scope of the EA. Comments on topics outside the scope of the EA include mammal or predator management by other state or federal programs, lethal wolf management and the ecological effects of lethal wolf removal, the effects and economics of livestock grazing on public lands, and the use of M-44s, Compound 1080, and neck snares

This EA covers MDM conducted by WS-Washington within the State of Washington, as stated in Sections 1.2 and 1.9.2. All other wildlife management actions, especially those conducted by other agencies, are outside the scope of the EA.

All species included in the activities are listed in Table 1 of the EA. This does not include wolves. WS-Washington is not proposing any operational involvement in wolf damage management activities in the state of Washington. WS-Washington did provide $10,000 in non-lethal wolf damage management tools (fladry) to WDFW in 2020, and will continue to support those efforts as funding allows.

WS-Washington is not proposing to use M-44s, Compound 1080, or neck snares under any alternative. In the past, WS-Washington occasionally used neck snares for the protection of human safety on military airfields, but it ceased using this method in July 2019. All comments about these methods are outside the scope of the EA.

WS-Washington 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-Washington only addresses mammal damage upon request.

2. Need for Action

Some comments questioned the need for MDM in the state. One commenter insisted that there was no evidence that human expansion into more rural areas increase conflicts. Another commenter feels that the Purpose and Need are not adequately described because the EA does not detail everywhere that WS-Washington works and anticipates working.

WS-Washington 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 mammal damage in some capacity is not necessary.

WS-Washington cannot predict where we may be requested to provide MDM, but the EA explains how WS-Washington has predicted the level of MDM that may be necessary and how each conflict is evaluated in Section 2.2.1.6. WS-Washington applies the Decision Model and programmatic and site-specific protective measures to each request for assistance. The analysis indicated that these measures have been effective at preventing adverse impacts and will continue to minimize or prevent impacts. WS-Washington 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.

3. Environmental Baseline

We received 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-Washington 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-Washington's current MDM activities, which have been conducted in Washington for decades, along with MDM, hunting, and trapping 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 2.2.1.

4. Cumulative Effects

General assertions were made that the proposed action would have cumulative environmental effects to mammal populations and biodiversity. Commenters were also concerned that the EA did not consider cumulative take of the proposed action along with take by non-WS entities.

We disagree with the assertion that the EA does not take a hard look at the cumulative effects of the proposed action. We addressed cumulative effects to mammal species in Section 3.4 of the EA for each species. This section documents and analyzes take by WS-Washington along with known hunter, trapper, WCO, and other harvest, as documented by the State of Washington. Section 3.5 of the EA described anticipated cumulative effects to non-target species while Section 3.7 described cumulative effects for federally listed species. Commenters provided no additional information that alters the cumulative effects analysis in the EA.

We addressed cumulative effects of trophic cascades and biodiversity in Section 3.7 of the EA. This analysis looked at WS-Washington's proposed activities and the cumulative take of species and determined that there would be no significant impacts as a result. Commenters did not provide any additional information to alter this conclusion.

5. Ecologically Sensitive Areas

One commenter requested that WS-Washington conduct additional analysis on work in ecologically sensitive areas, such as Wilderness Areas and Wilderness Study Areas.

WS-Washington has not and is not proposing to conduct any MDM in Wilderness Areas, Wilderness Study Areas, Wild and Scenic Rivers, Areas of Critical Environmental Concern, National Recreational Areas, National Conservation Areas, or National Monuments. A complete list of areas excluded from the analysis can be found in Appendix D. WS-Washington has never been requested to work in any of these areas and does not anticipate requests to work in these areas in the future.

6. Economic Issues

We received a few comments related to economic issues, including the purported NEPA requirement of a cost-benefit analysis, potential impacts of MDM on outdoor recreation and tourism industries in Washington, 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 MDM assistance. The costs and benefits associated with WS-Washington's services are unique to each entity that requests assistance. WS-Washington responds to requests for assistance on a case-by-case basis, and its recommendations are based on WS Directives and science. Implementation of some methods may have no monetary cost to the cooperator, such as technical assistance (advice). When WS-Washington 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-Washington's fencing recommendation is cost-effective under the circumstances; another producer may reach the opposite conclusion and choose not to engage WS-Washington's assistance. Either way, WS-Washington recommends all effective and available methods as solutions for human-mammal conflict.

Economics alone are not an environmental effect that necessitate the preparation of an EIS (40 CFR 1508.14[54]). 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

[54] The APHIS-WS program prepared this analysis in compliance with the 1978 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. This EA was prepared in accordance with the 1978 CEQ regulations.

important to a decision (40 CFR1502.23). 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 of the EA.

Regarding potential impacts to outdoor recreation and tourism industries, the EA analyzed effects on recreation and aesthetic values of the environment in Section 3.9 and determined that WS-Washington's activities were unlikely to have any significant adverse effect on recreation. We based this determination on several factors, including:

- WS-Washington coordinates with land management agencies to deconflict MDM with recreational uses and minimize impacts to recreation;
- During peak times of MDM, recreationists do not extensively use land allotments designated for grazing livestock, further reducing the likelihood of a recreationist being limited by or encountering MDM activities; and
- WS-Washington is proposing very low levels of lethal removal of target species, (EA Section 3.4) and we do not expect the public will experience a noticeable decrease in wildlife encounters (EA Section 3.9.1, 3..2.1.1, 3.9.2.1.2).

Additionally, data contained in the Section 3.4 (Table 43) makes clear that the number of mammals taken by WS-Washington will not have a significant impact on target mammal populations, preserving an abundance of mammals for future viewing enjoyment.

A commenter stated that WS-Washington does not demonstrate that losses to livestock producers are sufficient enough to warrant MDM assistance and WS-Washington should set a threshold for providing MDM. The comment implies that a requestor would need to experience a certain amount of economic losses before receiving assistance.

We discussed the idea of setting an economic threshold before providing assistance in Sections 1.4.4 and 2.4.8 of the EA. WS-Washington's responsibility is to provide assistance to those who request it, whether that is a larger cattle producer or a family with a backyard farm. Moreover, loss of livestock is not only quantified in terms of economic loss; loss of livestock can be emotionally devastating, especially if animals are viewed as pets or they suffer, which may be just as impactful, or more so, than an economic loss. Our goal is to alleviate conflicts upon request with an integrated approach, using lethal and non-lethal techniques, regardless of the economics of the situation.

We do not anticipate any adverse effects to tourism or recreation opportunities from the proposed activities.

7. Efficacy of PDM

We received numerous comments questioning the efficacy of lethal MDM. Many commenters felt that the individual methods were not effective while some felt that lethal control on the whole was not effective.

Efficacy of MDM was discussed in Section 1.12 of the EA. During public comment in 2021, commenters asked WS-Washington to consider additional literature. The following studies on efficacy were presented for our consideration however, commenters did not say what about each study they felt was relevant to the analysis. We reviewed each study and determined that the studies either did not present new information for analysis or involved matters outside the scope of the analysis. For example, studies regarding wolf and African lion conflicts are outside the scope of the EA, as management of those species is not included in the analysis.

Table 49. **Literature Provided to and Reviewed by WS-Washington Regarding Efficacy**

Citation	Title
Lennox et al 2018	Evaluating the efficacy of predator removal in a conflict-prone world
Miller et al 2016	Effectiveness of Contemporary Techniques for reducing livestock depredations by large carnivores
van Eeden et al 2018	Managing conflict between large carnivores and livestock
Radford et al. 2020	Artificial eyespots on cattle reduce predation by large carnivores
Ohrens et al 2019	Non-lethal defense of livestock against predators: flashing lights deter puma attacks in Chile
Davidson-Nelson et al 2010	Testing fladry as a nonlethal management tool for wolves and coyotes in Michigan
Gehring et al 2010	Utility of livestock-protecting 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
Khorozyan and Waltert 2019	How long do anti-predator interventions remain effective? Patterns, thresholds and uncertainty

Some questions about the efficacy suggests a misunderstanding of the intent of MDM by asking "if MDM was effective, then why does WS-Washington still receive requests for assistance?"

The goal of MDM 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 MDM. If population reduction were the goal, WS-Washington 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 and to target the offending mammals. Claims that MDM could result in long-term reductions to the target populations were addressed in Section 3.4 of the EA.

The issue of compensatory reproduction was also raised, with one commenter stating that killing coyotes results in more coyotes so lethal MDM can't be effective.

There are claims that MDM results in increased predator populations through compensatory reproduction, specific to coyotes. This would mean lethal MDM leads to increased predator populations. WS-Washington discussed compensatory reproduction in Section 3.4.18.3 of the EA. The commenter's suggestion that WS-Washington's actions may result in an increase in the coyote population through compensatory reproduction supports the conclusion in Section 3.4.18 of the EA that the proposed action is not likely to adversely affect coyote populations. WS-Washington has also not seen drastic increases in requests for assistance over the years of conducting MDM as might be expected had the ongoing MDM activities caused a significant increase in depredation of livestock.

8. EIS Required

Several commenters demanded WS-Washington 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-Washington'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 1.10.1 of the EA defines how WS-Washington analyzed significance and cumulatively significant impacts.

9. Ethics and Humaneness

We received numerous comments stating that proposed MDM methods are inhumane. One commenter also claimed that WS-Washington does not report activities accurately.

WS-Washington takes ethics and humaneness seriously. The science of wildlife biology and management, including WDM 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 (1993), Vucetich and Nelson (2007), Sneddon et al. (2014). WS-Washington field personnel strive to undertake these activities as ethically and humanely as possible under field conditions.

The EA discussed and analyzed ethics and humaneness in depth in Sections 3.2.4 and 3.8. The wide range of public opinions on wildlife and wildlife management was discussed in Section 1.4.3 of the EA and we understand that people have strong emotions related to wildlife management. WS-Washington recognizes that many people feel MDM methods are inhumane, cruel, and/or unacceptable. However, other people feel that people, lambs, sheep, calves, or pets being injured or eaten by predators is equally inhumane, cruel, and/or unacceptable.

WS-Washington personnel are skilled professionals who abide by applicable laws and regulations for trap use. Additionally, WS-Washington personnel abide by the species-specific AFWA Trapping BMPs, which were most recently updated in 2020. EA Section 1.5.4 "How does APHIS-WS ensure the implementation of professional WDM Practices?" addressed the accusations regarding APHIS-WS's ethics. Additionally, Section 3.8 explains how APHIS-WS approaches ethics and animal welfare.

No new information was provided that altered the analysis presented.

A commenter questioned the humaneness of enclosed foothold traps.

One commenter stated that we did not adequately consider the humanness of enclosed foot-hold traps, also called EGG traps, citing Hubert et al 1996. We evaluated enclosed foot-hold traps in the Risk Assessment for foothold traps and the 2020 update to the AFWA BMPS, both reviewed and cited in the EA. We added a description of the method and the relevant citations to Appendix A for clarification.

We also reviewed Hubert et al (1996), which found the EGG trap ™ to be more humane than coil spring traps. It also reduced the severity of trap-related injuries and self-mutilation. The study also cited the Proulx et al (1993) conclusion that the EGG trap was humane. We feel these citations support the analysis and the inclusion of this method in the proposed integrated MDM program.

One commenter stated that the EA fails to consider sublethal CO dose in burrows.

WS-Washington applies gas cartridges in accordance with label directions which were developed under the direction and certification of the EPA to be humane and safe. The use of carbon monoxide was analyzed in the Risk Assessment (USDA 2019g), which was part of the analysis for the EA.

A commenter wants to know how often WS-Washington repairs and inspects padded foot traps.

Traps are inspected and repaired every time they are set and re-evaluated during the daily trap checks.

A commented suggested that WS-Washington use trap monitors to increase humaneness.

WS-Washington is using trap monitors where they are practical and where there is cell coverage. We are also developing telemetry-based monitoring devices, in conjunction with NWRC, and will continue to explore the uses of these devices to increase effectiveness and humaneness of MDM activities.

We received a request to obtain and release the testing scores from the development of the BMPs.

These scores are available to the public in:

White, H.B., Batcheller, G.R., Boggess, E.K., Brown, C.L., Butfiloski, J.W., Decker, T.A., Erb, J.D., Fall, M.W., Hamilton, D.A., Hiller, T.L., Hubert, G.F., Jr., Lovallo, M.J., Olson, J.F. and Roberts, N.M. (2021), Best Management Practices for Trapping Furbearers in the United States. Wild. Mon., 207: 3-59. https://doi.org/10.1002/wmon.1057

One commenter claimed that WS-Washington ignored the findings of an OIG audit in 2018.

This is an incorrect statement, as there was no OIG audit of APHIS-WS in 2018. There is an OIG Final Action Verification Report released September 2018 that was a follow up to the 2015 audit. OIG found stated:

We determined that APHIS provided sufficient documentation to OCFO to close the seven recommendations we made in our September 8, 2015 audit report, APHIS Wildlife Services—Wildlife Damage Management. The following table summarizes the action APHIS took with respect to each recommendation.

This report is not "new information" nor does it contain revelations of agency failings, as claimed by the commenter. The report can be viewed at https://www.usda.gov/sites/default/files/33026-0001-41.pdf

10. Modern Wildlife Biology

Commenters asked that WS-Washington consider additional literature 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.

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-Washington reviewed and cited the best available science in the preparation of this EA, with extensive literature citations provided in the Section 5, and Appendix F. These citations include relevant studies from the papers that the commenters provided during public comment. The following studies were provided to WS-Washington, were reviewed, and were included in the analysis in the Final EA:

Table 50. Literature Cited by Commenters And Included in the Final EA

Citation	Title
Thompson et al 2021	Ecosystem services provided by beavers
Bouwes et al 2016	Ecosystem experiment reveals benefits of natural and simulated beaver dams
Naiman et al 1986	Ecosystem alternation of boreal forest streams by beaver
Pollock et al 2015	The Beaver Restoration Guidebook
Snodgrass et al 1998	Influence of beavers on stream fish assemblages
Henke and Bryant 1999	Effects of Coyote removal on the faunal community in western Texas
Phillips 1996	Evaluation of 3 types of snares for capturing coyotes
Craighead and Bedrosian 2008	Blood lead levels of common ravens with access to big-game offal
Treves et al. 2016	Predator Control should not be a shot in the dark
NAHMS 2015	Death Loss in US cattle and Calves due to predator and Nonpredator causes
Bergstrom et al 2014	License to Kill: Reforming Federal Wildlife Control to Restore Biodiversity and Ecosystem Function
Manfredo et al 2018	American's Wildlife Values: Washington State Report
Crooks and Soule 1999	Mesopredator release and avifaunal extinctions in a fragmented system

Estes et al. 2011	Trophic Downgrading of Planet Earth
Mezquida et al 2006	Sage grouse and indirect interaction: potential implications of coyote control on sage-grouse populations
Prugh et al. 2009	The Rise of the Mesopredator
Ripple and Beschta 2012	Trophic cascades in Yellowstone: the first 15 years after wolf reintroduction
Winnie and Creel 2017	The Many Effects of Carnivores on their Prey and Their Implications for Trophic Cascades, and Ecosystem Structure and Function
Berger and Gese 2007	Does interference competition with wolves limit the distribution and abundance of coyotes?
Poudyal et al 2016	Wolf lethal control and depredations
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
Wilmers et al 2003	Resource Dispersion and Consumer Dominance
Beschta and Ripple 2006	River Channel Dynamics Following Extirpation of Wolves in Northwestern Yellowstone National Park
Ripple et al 2014	Status and ecological effects of the world's largest carnivores
Sacks et al 1999	Relative vulnerability of coyotes to removal methods on a northern California ranch

The following studies either were not within the scope of the analysis (e.g. Santiago-Avila et al 2018) or did not add meaningfully to the existing analysis. For example, Neill et al 2007 evaluated the use of older trap monitor technology, which WS-Washington already uses where feasible. WS-Washington is also working with NWRC to develop new telemetry-based trap monitor technology. The Pepper et al 2003 publication was used in the development of the USDA Risk Assessment on APHIS-WS' aircraft use that cited in the EA.

Table 51. Literature Provided to WS-Washington but not Incorporated into the Final EA

Citation	Title
Santiago-Avila et al 2018	Killing wolves to prevent predation on livestock may protect one farm but harm neighbors
Proulx et al 2015	Humaneness and Selectivity of Killing Neck Snares Used to Capture Canids in Canada: A Review
Rochlitz et al. 2010	The impact of snares on Animal Welfare
Andreasen et al 2018	Survival of cougars caught in non-target foothold traps and snares
Neill et al 2007	Minimizing foot trapping trauma for otters with mobile phone technology
Pepper et al 2003	A review of the effects of aircraft noise on wildlife and humans, current control mechanisms, and the need for further study.

Over 110 additional citations were provided and reviewed by WS-Washington; however, they did not add to or alter the analysis in the EA. In the Stakeholder Notice of Public Availability, we stated "Comments, information, and analyses provided should be as specific as possible and an explanation of why the information is important to the analysis should be included." No explanation accompanied that additional citations to explain why they warranted further consideration.

11. Lead

WS received comments opposing the use of lead ammunition and claims that the EA failed to properly analyze the use of lead.

We disagree that the use of lead ammunition in MDM activities were not adequately analyzed in the EA. As described in Section 3.10.3, WS-Washington only uses lead ammunition in cases where the carcass can be recovered and meat will not be donated, preventing lead for remaining in the environment or threatening human safety. This means there is very little chance any lead will be introduced to the environment as a result of proposed MDM activities. The analyses further indicated that the risk to humans of lead exposure from WS-Washington activity is low.

Section 3.10.3 and Appendix C discuss the potential impacts of lead on birds, mammals, amphibians and reptiles, fish, and soils and water. APHIS-WS conducted a formal, peer reviewed Risk Assessment on lead use, which also found little risk to the environment from the agency's limited use of lead ammunition (USDA Wildlife Services 2017b). Nationwide, APHIS-WS contributes less than 0.01% of the amount of lead being introduced into the environment from hunting, fishing, and industrial activities (Appendix C). That contribution is negligible, and no cumulative effects are anticipated. Commenters provided no new information that alters the analysis of effects provided in the EA, and we feel the analysis is comprehensive and sufficient.

12. Unintentional Take

Many commenters expressed concern for animals likely to be taken inadvertently in the course of MDM. MDM methods were characterized in comments as "being indiscriminate and often kill unintended victims". Commenters asserted that MDM 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.

We disagree with these assertions. The potential for Alternative 1 to impact non-target species populations, including threatened and endangered species, is discussed and analyzed throughout In Section 3.5, and 3.6. WS-Washington rarely takes non-target species during MDM, averaging only 9.2 non-target animals per year (Section 3.5). The reliability of APHIS-WS's data reporting was verified by the 2015 OIG Audit (Section 1.12.2.1).

WS-Washington personnel are skilled at employing MDM methods so they are extremely selective for the target species (0.35% of the average lethal take of mammals in the five-year review period, EA Section 3.5). WS Directives and species-specific trapping BMPs help ensure target selectivity. Precautions for federally listed species are included in Section 3.6.4, and were formulated as part of Section 7 ESA consultation with USFWS and NMFS.

Based on these facts and the analysis in the EA, we determined that Alternative 1 was unlikely to have significant impact on non-target species populations, including threatened and endangered species.

One commenter provided a recent study on mortality of mountain lions unintentionally trapped in bobcat traps.

WS-Washington reviewed the study titled "Survival of cougars caught in non-target foothold traps and snares" by Andresean et al 2018. The study followed mountain lions that were unintentionally captured in bobcat traps then released, and determined they had a shorter life expectancy than untrapped individuals. WS-Washington has not taken any mountain lions unintentionally and, based on the protective measures employed and the track record, it is unlikely that trend will change. WS-Washington's exceptionally low non-target capture rate (EA Section 3.5)shows that even if there were to be adverse effects on some individuals from being released from a trap that it would be less than 10 animals per year, and not amount to a significant impact on any species' population.

One commenter claimed that APHIS-WS takes more animals than it admits and has inaccurate record keeping.

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).

13. Mesopredator Release

The potential for mesopredator release due to WS-Washington's proposed actions was raised by one commenter.

Mesopredator release is discussed in Section 3.7.1 and Appendix F. We determined there was no risk of the proposed action contributing to mesopredator release.

14. Opposition to Human Interference

A few commenters indicated they would prefer that humans have no role in managing wildlife.

While WS-Washington cannot limit other entities from MDM, Alternative 4 analyzed what would happen in the absence of federal WS-Washington's involvement in MDM. Alternative 4 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.

15. Opposition to Lethal PDM/Prefers Non-Lethal Methods

We received numerous comments regarding the use of non-lethal MDM. 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 MDM.

WS-Washington is aware that some people oppose lethal MDM. Section 1.4.3 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-Washington considered one alternative that contained an alternative with no lethal MDM (Alternative 2), one that considered an almost entirely non-lethal MDM program, with exceptions for human and pet health and safety (Alternative 3), and no WS-Washington involvement in MDM (Alternative 4).

16. Use of Taxpayer Funds and Government Compensation

Government compensation was commented on in several ways, most often expressing displeasure at the use of tax fund for lethal MDM. Commenters also felt that livestock producers should accept losses because they receive compensation from the government, that tax dollars should not be used to help the livestock industry, and that producers should receive compensation for their losses instead of using APHIS-WS.

Public attitudes about wildlife and the use of taxes to fund management were acknowledged and discussed in Section 1.4.3. Compensation programs and economic aspects of depredation on livestock were addressed in detail in the following Sections:

1.13.2.1	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
1.13.2.2	Compensation for Losses or Damage Should Replace APHIS-WS MDM
1.13.2.3	Livestock Producers Should Pay All Costs of MDM
1.13.2.4	A Program Subsidizing Non-lethal Methods Implemented by Resource Owners Should Replace APHIS-WS MDM
1.13.2.5	Incorporate the Environmental Costs of Livestock Grazing on Public Lands into Cost Analyses
1.13.2.6	No Federal Funds Should be Used to Kill Predators to Protect Game Species

WS-Washington also discussed other MDM alternatives related to compensation that were not considered for comparative analysis, in Section 2.4. We feel these discussions thoroughly examined and analyzed potential alternatives to Federal MDM and address the comments provided to the agency.

One commenter pointed out that APHIS-WS received $1.38 million for non-lethal livestock protection efforts and asked WS-Washington to use those funds for more non-lethal efforts.

APHIS-WS received a one-time increase of $1.38M in the program's FY20 budget to conduct nonlethal livestock protection activities, intended to decrease livestock depredations by large carnivore predators. The funds were distributed to 12 APHIS-WS state programs (AZ, CA, CO, ID, MI, MN, MT, NM, OR, WA, WI, WY), two research units at WS' National Wildlife Research Center (NWRC), and WS Operational Support Staff (OSS) to meet the intent of the initiative. WS-Washington received only $10,000 of that $1.38M. The money was used to purchase fladry for WDFW to use in wolf damage management activities. WS-Washington does very little livestock protection work (4.2% of all activities proposed in the EA, Section 1.11.7.5), and WDFW is the entity responsible for wolf management.

17. Public and Pet Safety

Some commenters felt that the proposed activates are a threat to humans and pets, specifically on public lands, and that the analysis in the EA was not sufficient.

Potential impacts to human and pet safety under the Alternatives were analyzed in Section 3.10 and Alternative 1 was determined not to result in any significant impact to human or pet health or safety in this Section. WS-Washington has not captured or killed any pets, as reported in the non-target analysis in Section 3.5. We feel the protective measures outlined in the EA and the analysis are sufficient and the conclusion that there is little to the public or pets from proposed MDM activities is accurate.

18. 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. This audit occurred and the process was concluded over a decade ago. This has no bearing on the analysis in the EA.

19. Public Trust

Commenter stated that killing wildlife on public lands for the benefit of livestock producers "fails the government's public trust obligations".

WS-Washington 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-Washington continues to act under that authority and in good faith with state and federal natural resource management partners. See EA Section 1.5.1.

The Public Trust Doctrine is the foundation of State and Federal wildlife management programs in North America. The basis for the doctrine in the United States was established by the Supreme Court in 1842 (*Martin v. Waddell)* and subsequently supported by other case law rulings during the 19th through the 20th centuries. The Doctrine establishes that wildlife is a natural resource that belongs to the public and that should be maintained through government programs in trust for the people, including future generations. APHIS-WS conducts wildlife damage management according to the Public Trust Doctrine and its underlying public stewardship principles, not to generate revenue and profit for the Government. The Doctrine guides the relationship between natural resources that are publicly owned, and the Government wildlife management programs that provide stewardship to maintain the resources for the benefit of the public and future generations.

20. Alternatives

Commenters requested WA-Washington analyze 5 additional alternatives. We address each proposed alternative below.

A commenter asked that WS-Washington consider an alternative where the use of one lethal method is eliminated.

WS-Washington uses an adaptive approach to MDM, and does not implement every method in every situation, instead selecting the most appropriate methods for each situation. This alternative is unlikely to reduce take by WS-Washington, and could reduce the efficiency, safety, selectivity, etc. of the activities.

Commenters requested we consider an alternative that restricts MDM on public lands, with no exemption for HHS, to protect outdoor recreation interests and limit support to livestock producers that graze on public lands.

Under Alternative 1, MDM is already anticipated to be very limited on public lands. WS-Washington only works on 3.73% of the state's total acreage, and of that, 83.42% of WS-Washington's MDM occurs on lands inaccessible to the public (EA Section 3.4.1). Much of the acreage identified as "public lands" in the EA includes military bases, hydroelectric facilities, airports, etc., which are generally inaccessible to the public. Section 1.11.7.5 of the EA examines how much MDM WS-Washington has conducted for livestock protection, which amounts to only 4.2% of all MDM activities conducted. Section 1.11.7.6 of the EA explained that 97.6% of WS-Washington's livestock protection activities occur on private lands.

The analysis showed that MDM activities, as proposed in Alternative 1 are safe and unlikely to have any significant effect on the human environment, including public lands and the recreational experience. Therefore, an alternative restricting WS-Washington from providing the projected minimal MDM on public lands would not alter the analysis for Alternative 1 enough to warrant separate analysis.

We were asked to consider alternatives that use only non-lethal methods for beaver and predator management.

This was done under Alternative 2.

A commenter asked us to consider an Alternative where all non-lethal methods were exhausted before lethal action is taken, except for the case of human safety events or when WDFW has issued a permit for lethal management. The commenter referred to the agreement in Humboldt county California as an example of what should be done in Washington.

We considered an alternative that requires exhaustive use of non-lethal methods in Section 2.4.4 of the EA.

The amended agreement between WS-California and Humboldt County is not analogous to an exhaustion of nonlethal methods alternative for statewide or even countywide action. The amended contract language in Humboldt County includes a provision requiring the documentation of nonlethal method use for a reasonable time period prior to the use of lethal control solely when WS-California is responding to property conflicts in specified urban and suburban areas of the County. However, this provision does not apply to rural areas of the County, to requests for agricultural protection, to request for protection of natural resources, to human health and safety incidents, or any conflict in which the California Department of Fish and Wildlife (CDFW) has issued a depredation permit. As the Humboldt agreement only results in an increased reporting requirement for a small portion of the work performed by WS-California, the effects of operating according to the Humboldt Agreement in Washington would be similar to the already analyzed effects of Alternative 1.

21. 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 1.8 explains how WS-Washington works with federal agencies and how WS-Washington works on federally-managed lands and facilities. Work plans for MDM on federal lands are developed with the federal land management agency to ensure actions comply with their policies and plans.

22. Site-Specificity

One commenter stated that WS-Washington did not analyze site specific impacts and that the geographic scope of the analysis should be smaller than state-wide and consider population variations across geographic regions of the state where MDM may occur.

We disagree with this statement. The EA discussed the application of the EA to site specific analyses in Section 1.9.3. The commenter did not identify any specific geographic regions of concern. WS-Washington selected the level of analysis in the EA based on input from the natural resource management agencies responsible for species population management, the biology of the species analyzed in the EA, and the extensive literature review conducted for this EA.

WS-Washington worked with other wildlife management agencies to determine the appropriate level of analysis for the proposed action based on the best available data. WS-Washington uses the Decision Model to evaluate projects on a case by case basis, and if WS-Washington determines that any of the requests for assistance are outside of the scope of the EA, additional NEPA analysis would be conducted.

23. Federally Listed Species

A commenter asserted that the compliance with ESA does not alleviate an agency of compliance with NEPA and that the EA does not analyze impacts to federally-listed species. One commenter asked how we came to the conclusion that we would not affect listed species of pocket gopher while managing pocket gopher in the state.

The EA analyzed impacts to federally listed in section 3.6 and completed section 7 consultation with USFWS and NMFS regarding all activities proposed in this EA.

WS-Washington will not affect any of the federally listed subspecies of pocket gopher as we do not conduct any pocket gopher management in western Washington, where the listed species are present. The 2014 consultation and Biological Opinion prescribed protective measures for other MDM activities that protect pocket gopher habitat from disruption.

24. Mammal Populations Analysis

Commenters expressed concern about the number of coyotes, black bears, beavers, mountain lions, and other species that may be taken by WS-Washington. No new literature or information was provided with these concerns.

In Chapter 3 of the EA, WS-Washington thoroughly analyzed impacts to target, non-target, and T&E species, and determined that there would be no significant impact to any mammal populations as a result of the proposed activities.

A commenter expressed concern that WS-Washington underestimated ground squirrel take because WS-Washington does not excavate burrows and recover and count bodies.

Counting individual squirrel carcasses is a time-consuming process that is unlikely to significantly affect the data we collect on squirrel take. Instead, WS-Washington estimates fossorial animal take based on species biology, time of year, average litter size, extent of the treatment, density estimates from published literature, and the timing since last treatment. All of the Columbia ground squirrel work during the review period was on airfields to protect structural integrity of movement surfaces and human safety. Given the routine nature of managing ground squirrels on airfields, it's unlikely that ground squirrels fully re-colonize these areas between treatments. Those individuals that recolonize burrows on airfield airfields are generally dispersing first year males, as females tend to stay in their natal colony. Males don't mate until three years of age while females don't reproduce until their second year (Elliot et al. 1991). Ground squirrels are territorial and do not share burrows with the exception of female ground squirrels sharing burrows with their young. As not all burrows are occupied and the population is majority male with few non-reproducing females, the estimate of one squirrel per treated burrow is conservative. Additionally, excavating burrows to recover carcasses is not practical and digging larger holes into burrows is counter to the goal of reducing damage caused by burrowing mammals.

As presented in Section 3.4.22 of the EA, WS-Washington has analyzed a level of take considerably higher than anticipated along with using conservative population estimates to allow for a margin of error in take estimations, and we determined that the proposed actions will not result in significant impacts.

A commenter stated that we did not consider impacts to wolverines.

WS-Washington is not proposing to target wolverines in MDM activities, nor is there likely to be any overlap in the proposed activities and wolverine habitat. In the unlikely event that a wolverine is known to venture outside of its traditional range or habitat type where WS-Washington has ongoing MDM activities, WS-Washington would take extra precautions, in coordination with WDFW, to avoid impacting them. Precautions may include equipment removal or temporary suspension of MDM activities in the immediate vicinity.

25. Trophic Cascades

We received several comments and literature related to trophic cascades. Several commenters asserted that carnivore populations are necessary to keep ecosystems in balance. WS-Washington failed to show that the proposed action will not result in a change to the ecosystem that may result in a trophic cascade. Commenters cite to

Beschta et al. 2010, and state that WS-Activities are the equivalent of the actions in the study that resulted in adverse effects to riparian ecosystems.

The EA presents a comprehensive discussion on the role of predators in ecosystems, acknowledging their influence on ecosystems. Section 3.7 and Appendix F reviewed literature related to trophic cascades and analyzed the potential for such effects to occur as a result of the proposed activities. Beschta et al (2010) evaluates the extirpation and reintroduction of wolves on the Yellowstone ecosystem. The science from that ecosystem is unique in that an extirpated predator was reintroduced. WS-Washington is neither extirpating nor introducing any predators. WS-Washington is also not proposing to conduct MDM on gray wolves at all. Therefor the ecological conditions and processes that occurred in Yellowstone do not directly translate to activities in Washington. Analysis in Chapter 3 of the EA determined that the proposed level of take will not have significant impacts on any mammal populations, much less result in extirpation. We feel that the analysis of whether the proposed level of take may result in a trophic cascade, as analyzed in depth in Section 3.7 and Appendix F, is accurate and sufficient.

26. Beaver Removal Effects on Biodiveristy

A commenter claimed that the analysis in the EA in insufficient regarding the impacts of beaver removal on wetlands, T&E species, and other non-target species. Commenter stated that WS-Washington should work with permitted beaver relocators to end lethal removal of beaver.

The EA contains detailed analysis of the anticipated effects of beaver removal on biodiversity in Section 3.7.2. The potential impacts of beaver removal on T&E species was considered in detail in the Biological Assessment (BA) and Biological Opinion (BO) prepared for Section 7 consultation with NMFS. The analysis from the consultation was summarized in the EA (Section 3.6.4.1) and the BA and BO were provided as supplemental information in the Regulations.gov Docket for public review. As a result of the ESA consultation, WS-Washington has implemented several protective measures that minimize effects on sensitive habitats and species. Additionally, WS-Washington is part of the Washington Beaver Working group and had provided over 100 beavers to relocators since 2019. See Section 1.5.5 for additional information on how WS-Washington works with the state, relocators, and tribes to help conserve beaver and wetland habitat.

No new information was provided to alter the analysis and we feel the analysis in the EA is sufficient.

27. Climate Change

One commenter stated that the EA's analysis of climate change was insufficient.

We disagree with this assertion. The EA considered climate change in Sections 3.2 and 3.4.2.

28. Controversy of Lethal MDM

One commenter states that lethal MDM is often highly controversial.

The EA addressed controversy in Section 1.10.1.1. WS-Washington is aware that some members of the public believe that some MDM methods and strategies are controversial. Dissenting or oppositional public opinion, on its own, is not enough to make an action "highly controversial." The EA reviewed all relevant literature, including all literature provided by the commenters, and found no scientific controversy regarding the effects of the MDM activities, as proposed. No agencies with jurisdiction by law or expertise raised doubts about our methodology and data. WS-Washington collaborated with state and federal natural resource management agencies to develop the comprehensive analyses in the document. Additionally, the proposed action is to continue the current program, not introduce new or unidentified mammal damage management techniques.

Appendix A. What Mammal Damage Management Methods and Techniques Are Used in the Current Program?

Introduction

WS-Washington 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-Washington 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 WS-Washington. See Section 3.9 for a detailed discussion on humaneness of various MDM methods.

What Non-Lethal MDM Methods Are Available to WS-Washington?

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 damaging mammals 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-Washington 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-Washington employee may implement it. Land managers and property owners are encouraged by WS-Washington 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 MDM activities and facilitates coexistence between people and wildlife. Education can include information on how cultural practices and the biology/behavior of damaging species interact. 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 damaging species from accessing valuable resources or strengthen the resource's resistance to damage. Exclusion involves physically preventing animals from gaining access to protected resources by constructing a fence or erecting other barriers. Design of the exclusionary methods must accommodate logistical issues such as land use (e.g. airports have restrictions on fence placement), the scale of resource it is protecting (e.g. tree wrapping may be appropriate for a few ornamental trees but impractical for a timber plantation), impacts to non-target wildlife species (e.g. pond levelers may not be used where it may affect ESA-listed salmonids), and required maintenance (e.g. labor time or cost).

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 damaging species habituation.

Permanent exclusionary 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 mammals from jumping over or digging under. The initial cost of constructing a permanent exclusionary fencing often discourages their use, but may be economically practicable in small areas. This method is most often implemented on a larger scale at airfields.

Electric barriers have been used effectively to reduce mammal damage to crops, livestock, infrastructure, and other public resources. Bears have been dissuaded from landfills, trash dumpsters, cabins, and other properties using electric fencing. Electrical barriers have proven effective in limited situations for rodents; an electrical field through the water in a ditch or other narrow channel, or hot-wire suspended just above the water level in areas protected from public access, have been effective at keeping beaver out. The effectiveness of an electrical barrier is extended when used in conjunction with an odor or taste cue that is emitted because animals will avoid the area even if the electrical field is discontinued (Kolz and Johnson 1995). However, electric fencing can be expensive, requires constant maintenance to avoid short-circuiting, and is not compatible with ESA salmonid fish passage objectives.

Pond Levelers have been used for many years in many different states, with varying degrees of success. Various types of beaver pond levelers have been described (Arner 1964, Roblee 1984) and installation of beaver pond levelers can be effective in reducing flooding in certain situations (Miller 1983, Miller and Yarrow 1994). Water control devices such as the three-log drain (Roblee 1983), the T-culvert guard (Roblee 1987), wire mesh culvert (Roblee 1983), and the Clemson beaver pond leveler (Miller and Yarrow 1994) (Figure B-1) can sometimes be used to regulate water levels in beaver ponds. Installation of flow control devices generally requires an HPA permit from WDFW. However, pond levelers can be expensive, requires maintenance to avoid clogging and degradation, and are not typically compatible with ESA salmonid fish passage objectives.

Abrasives are materials that discourage, reduce or prevent gnawing behavior. Abrasives produce an unpalatable surface which irritates the teeth and mouth when the animal attempts to gnaw or chew on the surface. Flexible materials, such as sandpaper, grinder pads and fine-mesh stainless steel screening can be placed on or over objects (electrical wiring, plastic piping, fruit trees, etc) that are susceptible to gnawing. Fine sand can be mixed with paint, glue or other suitable liquid adherents to formulate a paste or heavy mixture that can be brushed-on or applied to a surface to discourage gnawing. This method has had limited success when applied or painted to tree trunks to discourage beaver from cutting down trees. Results of applying a textural repellent (sand mixed in paint) by WS' NWRC (Nolte et al. 2003) suggests that this method may be more applicable for large diameter trees. However, additional research is needed to fully evaluate the efficacy and practicality of abrasives.

Ground coverings in areas sensitive to burrowing animals can be used to discourage or prevent burrowing behavior protecting earthen dams, dikes, or personal property. Some examples of materials used are; rip rap, chain link fencing, and concrete slabs, these can be used for ground coverings that can be laid on the surface of the ground or buried.

Netting can be used to deter flying and some climbing mammal species from accessing structures or areas. Netting is used infrequently has limited effectiveness on most mammal species in this EA.

Animal Husbandry: Technical Assistance

Animal husbandry practices may minimize 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 employee 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 minimized 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 are can reduce coyote predation. All technical assistance regarding guard dogs is conducted in compliance with WS Directive 2.440.

Habitat Management: Technical Assistance

Mammal presence is often related to the type, quality, and quantity of suitable habitat. Habitat can be managed to reduce the attraction of certain mammal species. The effectiveness of habitat management to reduce mammal 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-Washington only provides advice on the type of modifications that have the best chance of achieving the desired effect. WS-Washington advises landowners/managers that they are responsible for compliance with all applicable regulations related to habitat management, including the Endangered Species Act.

Architectural and landscape design can often help to avoid potential mammal 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 mammal damage to parks, public spaces, or residential areas.

Managing the habitat, such as minimizing cover, planting lure crops, and vegetation removal, can sometimes reduce damage associated with mammals that use vegetation and crops for foraging and hiding. Habitat management is a primary strategy at airports to reduce aircraft damage and protect human safety. Generally, many problems associated with mammals loafing, breeding, or feeding on airport properties can be minimized through management of vegetation and water from areas adjacent to aircraft runways.

Reducing food attractants near homes, buildings, and pastures can reduce mammal 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 mammals. Additionally, proper and timely disposal of livestock carcasses also reduces mammal 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 device. 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 removal 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 utilized 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-Washington 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-Washington 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 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 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 mammals. However, damaging mammals 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-Washington and WDFW 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. This method is used most heavily by WS-Washington for the harassment of sea lions for the protection of T&E salmonids.

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 protective measures are provided in WS Directive 2.620 (Section 2.4.1.11). 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-Washington personnel, per WS Directive 2.501 (Section 2.4.1.7). WS-Washington only relocates mammals at WDFW's direction and coordinates capture, transportation, and selection of relocation sites with WDFW. WS-Washington assists in relocation efforts of beaver in Washington State by transferring damaging beaver to permitted relocators (when practical and relocators are available). These permitted relocators are authorized by WDFW to conduct beaver relocations. 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 MDM Methods That May be Either Lethal or Non-Lethal Are Available to WS-Washington?

WS-Washington specialists can use a variety of devices to capture mammals. Methods such as cage traps, foot snare, and trained pursuit dogs are used to non-lethally capture mammals but can be used lethally depending on the circumstance. For instance, WS-Washington can use a cage trap to capture an animal and then immobilize and relocate (non-lethal) or euthanize 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) states that the use of the BMP trapping guidelines developed by AFWA would be followed as practical. APHIS-WS policies and Washington state laws for using traps and foothold snares are listed in Section 2.4. Most of these methods can also be used by WDFW, landowners, and their agents, as approved methods for MDM or regulated fur trapping. WS-Washington staff consider environmental conditions when setting all live-traps.

Catch poles and hand gathering are used when an animal needs to be physically removed from an area in which use of traps or firearms is not feasible, the individual will not leave the area so that exclusionary methods can be applied, or relocating the animal from one area to another on the same site or to another site as authorized by WDFW permit. Examples of situations in which catch poles and hand gathering may be applied are; raccoons in a residence, capture of feral or free-ranging cats and dogs to be transferred to responsible authorities, removal of young from a nest or den, or relocating a bat from a building. Animals that cannot be relocated or be transferred to responsible authorities may be transferred to an appropriate animal transport container to be euthanized in a safe location, typically via firearm but chemical euthanasia may be used. All catch poles are equipped with swivel heads, coated cables, and coated poles close to the catch end to protect animals from injury. WS-Washington employees are trained and proficient with handling of animals to reduce stress to the animal and reduce handling time of the individual.

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.

Box and Cage Traps are live-capture traps for capturing a variety of mammal species. 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 on a wheeled platform or trailer. APHIS-WS most often uses this type of trap for 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 and target bears are either euthanized or relocated as appropriate and when authorized by WDFW.

Decoy traps are cage traps with another target animal in the trap, these have only been used with rats but may be effective for other rodent species. Decoy traps are only used when environmental conditions permit, when food and water can be provided to decoy animals, when decoy traps/decoy animals can be used with low risk of disturbance from predators.

Corral traps are another version of a box trap that are typically used to live-capture swine. Made of four panels with a door that can be closed manually or a passive system using one way doors (revolving or swinging door) that allow animals into the trap but not out of an enclosure. Because they typically do not have triggers and rely on manual operations of doors or use passive one way door systems there is little chance of injury to trapped animals. Their target specific design of short walls, open top, and sometimes access restricting door systems reduces effects to non-target species.

Suitcase Traps are special design of cage trap used to live-capture animals, constructed of a metal frame covered in heavy-gauged wire that is hinged with springs. The trap is set open, flat, and partially submerged. An animal climbs into the trap, trips a trigger mechanism in the center and the trap closes quickly like a suitcase around the trapped animal. Suitcase traps are typically used by WS-Washington to live trap beaver, muskrat, or otter. Since suitcase traps are set partially submerged, potential for drowning is a concern and must be mitigated. Traps are set so that the top of the trap will not be submerged when closed and traps are anchored to the shore to keep the trap from moving deeper into the water once activated or being moved by trapped animals.

Leg-hold snares can be used for live-capture and release or for holding for subsequent euthanasia 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 mammal by the foot. Leg-hold 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. Snare locks and loop stops are incorporated to prevent the loop from either opening or closing beyond a minimum or maximum loop circumference to reduce non-target captures and allow for opening again once the loop has closed around an animal for live-captures.

Leg-hold snares are also equipped with a swivel to minimize injuries to the captured animal and reduce twisting and breakage of the snare cable. Breakaway devices can also be incorporated into foot 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.

In general, foot snares are available to entities operating under special permit with WDFW to alleviate damage. Leg-hold snares offer several advantages over foothold traps by being lighter to transport or carry and not being as affected by inclement weather. Bears can be effectively captured using modified foot snares. These foot snares can be readily transported into and set up in the backcountry, which is difficult with large culvert raps pulled behind vehicles.

Padded 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 padded jaws of the trap around the foot of the target species. They are versatile for capturing small to large-sized mammals. These traps usually permit the release of non-target animals unharmed. Padded foothold traps 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 mammals 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).

Padded foothold traps set for coyotes, red foxes, bobcats, and similarly-sized mammals 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 non-target animal that is captured should be able to either pull free from the trap or be held to prevent escaping with the trap on its foot.

Use of drowning trap sets has been a traditional wildlife management technique in trapping aquatic mammals such as beaver, nutria, and muskrats. Trapper education manuals and other wildlife damage management manuals written by wildlife biologists recommend drowning sets for leghold traps set for beaver (Howard et al.1980, Randolph 1988, Dolbeer et al. 1994, Miller and Yarrow 1994). In some situations, drowning trap sets are the most appropriate and efficient method available to capture beaver and muskrats. For example, a drowning set attachment may be used with foothold traps when capturing beaver to prevent the animal from injury while restrained or from escaping (Miller and Yarrow 1994).

Drowning sets make the captured animal and trap less visible and prevent injury (i.e., bites and scratches) to people who may otherwise approach a restrained animal. Furthermore, some people are offended seeing dead animals and drowning takes the dead animal out of public view. Some sites may be unsuitable for body-gripping traps or suitcase traps because of unstable banks, deep water or substrate conditions. However, these sites would be suitable for foothold traps.

Effective trap placement also contributes to trap selectivity. To minimize 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-Washington follows state law and regulations regarding the setting and checking of traps and foot snares as follows per APHIS-WS Directive 2.450 and 2.210 (Sections 2.4).

Enclosed Foothold Traps are another type of trap that is used to live capture mammals. They are also called dog-proof, foot-encapsulated, or EGG™ traps. The trap requires the animal to reach inside to get a bait, which is located near a trigger. When activated, the spring that was compressed releases, causing a metal arm or cable to close around the animal's foot. The trap opening is tailored to the target species to prevent non-targets from accessing the bait. These may be places above the ground or buried, simulating a food cache.

Enclosed foothold traps were identified as meeting BMP standards for raccoons in the 2020 AFWA publication.

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 (National Wildlife Research Center 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-Washington continues to look for opportunities to test and use current and developing systems.

Dart guns are non-lethal capture devices (specially designed rifles) that fire darts filled with immobilization drugs. Once chemically immobilized, 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 immobilizing 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-Washington and other certified entities.

What Lethal MDM Methods Are Available to WS-Washington?

Quick kill traps are authorized for use in Washington State by WDFW under special permit. RCW 77.15.194 allows conibear traps in water to be set under special permits from WDFW. Conibear traps, typically used for beaver removals are a quick kill body-gripping trap that have adjustable triggers allowing animals to swim between them, reducing the chances of non-target capture. Traps are set so that when triggered the trap closes killing the animal. Other quick kill traps have a similar process though may have different mechanisms to activate the traps moving parts. Quick kill traps are best used by trained individuals or for low non-target risk applications (e.g. mouse trap inside of a residence). Site reconnaissance, trap selection, trap set adjustments, and limiting the timeframe of trapping efforts are all implemented by WS-Washington employees to reduce non-target take potential. WS-Washington staff are trained and proficient in the use of these traps to ensure traps are set appropriately to ensure a humane death for trapped animals.

Common rat and mouse traps are exempt from the definition of body-gripping traps and are used for small rodent species (e.g. rats, mice, voles). These quick kill traps operate take animals in a similar measure to other quick kill traps by closing on the animal's body, typically on the neck or head, resulting in an irreversible loss of consciousness by the animal.

Aerial Shooting: Technical Assistance or Operational Assistance

Aircraft, both fixed-wing and rotary-wing (helicopters) are used by WS-Washington 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-Washington conducts aerial activities on areas only undersigned agreement or in areas consistent federal Annual Work Plans, and concentrates efforts to specific areas during certain times of the year.

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 areas with a history of predation. WS-Washington only uses non-lead ammunition during aerial shooting operations.

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-Washington spends relatively little time flying and shooting over any one area.

The APHIS-WS program aircraft-use policy and APHIS-WS Aviation Rules (WS Directive 2.620; Section 2.4) 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-Washington 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) 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-Washington 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-Washington 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 weapon.

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 utilized. In addition, a spotlights, night vision, thermal imagery for night shooting, decoy 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 simulated 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 three months of their appointment and a refresher course annually thereafter (WS Directive 2.615; Section 2.4). The use and possession of firearms must be in accordance with federal, state, and local laws and regulations (also WS Directive 2.210; Section 2.4). 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 are 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-Washington complies with state laws, statutes, and WDFW authorized methods for ground shooting.

While on duty, APHIS-WS 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.

WDFW, commercial operators, and landowners/resource owners can also use ground shooting for MDM, in compliance with state laws and regulations.

Carcass Disposal: Technical Assistance or Operational Assistance

Carcass disposal methods are dependent on the species. WS-Washington disposes of carcasses according to WS Directives 2.515 and 2.510 (Section 2.4) and Washington state law and regulations (Section 2.4). Mammal carcasses are disposed of in approved carcass disposal sites on public or private lands or on-site where captured.

What Lethal and Non-lethal Chemical Methods are Available to WS-Washington?

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 mammals, 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. Effective repellents are not available for many species that may cause damage problems. Chemicals are not used by WS-Washington 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 (Section 3.9.5.2). 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 can also be applied for rodents in burrows though rodent behavior of plugging tunnels (which inhibits gas from reaching target animals) mean that special precautions to ensure humane application are taken so method is used sparingly.

Gas cartridges for fossorial rodents and mammal dens are normally applied in rural settings on both private and public lands. When dens and burrows are selected for fumigation, the fuse of the gas cartridge is ignited and hand-placed at least three to four feet inside in the active den. In the case of tunnels multiple cartridges in different locations must be used. Soil is then placed in the den or burrow 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 species. Given the omnivorous nature of some mammal diets and the direct competition for food that may occur when cohabitating in burrows, non-target mammals, reptiles, or amphibians are less likely to co-habitat. WS-

Washington conducts pretreatment site evaluation (such as tracks or droppings) to determine that non-target species are not present.

All animals removed by denning and burrow treatments are humanely euthanized per WS Directive 2.425 "Denning" and WS Directive 2.505 "Lethal Control of Animals" (Section 2.4). The gas cartridges used for denning (EPA Reg. No. 56228-21, EPA Reg. No. 56228-2, EPA Reg. No. 56228-61, EPA Reg. No. 56228-62) are registered by WS-Washington with WSDA. All pesticides used by WS-Washington are registered under the FIFRA and administered by EPA and WSDA. All WS-Washington personnel who apply restricted-use pesticides are state-certified pesticide applicators and have specific training by WS-Washington for pesticide application per WS Directive 2.465 (Section 2.4).

What Chemical Immobilization Methods are Available to WS-Washington?

Immobilization chemicals may be used by WS-Washington to aid in the humane handling of mammals to avoid injury to the handler and the mammals. 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 chemically immobilized. WS-Washington field personnel may use immobilization drugs to safely release captured non-target animals. Immobilizing drugs may also be used to safely release animals after collecting biological samples for disease surveillance or research studies.

When administering 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) provides detailed training and certification requirements for APHIS-WS personnel administering immobilization and euthanasia drugs. The following immobilization chemicals are under the jurisdiction of the United States Food and Drug Administration (FDA) and/or Drug Enforcement Agency (DEA).

Ketamine (Ketamine HCl; Ketaset™) is a rapid acting, non-narcotic, non-barbiturate injectable anesthetic agent that chemically 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 minimize sight, sound, and touch to minimize 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 cougars (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-Washington prefers to use Telazol™ for most of the species that are immobilized.

What Euthanasia Methods are Available to WS-Washington?

During MDM activities, most captured animals are euthanized since mammals rarely are permitted to be immobilized and relocated (Section 2.4). Euthanasia methods can include physical and chemical methods. Euthanasia techniques should result in rapid unconsciousness, quickly followed by death, in order to minimize 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). 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-Washington 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 (American Veterinary Medical Association 2020) can be used by WS-Washington and are under the jurisdiction of FDA and/or DEA. WS-Washington 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 (American Veterinary Medical Association 2020). 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. 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).
>
> **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 acceptable as part of the two-step procedure used by WS-Washington. 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).

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-Washington uses CO_2 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 mammals (e.g. skunks, raccoons, rats, and mice) and could be effective in urban/suburban areas where use of a firearm is not appropriate.

Physical Euthanasia Methods: Technical or Operational Assistance

Cervical dislocation is sometimes used to euthanize small predators which are captured in live traps. The animal is stretched and the neck is hyper-extended and dorsally twisted to separate the first cervical vertebrae from the skull. When done properly, the AVMA approves this technique as humane method of euthanasia. Cervical dislocation is a technique that may induce rapid unconsciousness and does not chemically contaminate tissue (American Veterinary Medical Association 2020).

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 (DeNicola et al. 2019, American Veterinary Medical Association 2020).

What Chemical Pesticide Methods are Available to WS-Washington?

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.

Zinc phosphide is a restricted-use toxicant that requires certified applicators or persons under their direct supervision to be applied. Aluminum phosphide and magnesium phosphide fumigants have similar modes of action, aluminum phosphide is discussed in Section 3.11.3.3. Zinc phosphide is a heavy, finely ground gray-black powder that is practically insoluble in water and alcohol. When exposed to acid, it breaks down by hydrolysis and releases phosphine gas (PH3). Zinc phosphide concentrate is a stable material when kept dry and hermetically sealed.

Zinc phosphide is a toxicant WS-Washington used to remove damaging ground squirrels, voles, northern pocket gophers, Columbian ground squirrels, and Californian ground squirrels. Although zinc phosphide baits have a strong, pungent, phosphorous-like odor (garlic like), this characteristic seems to attract rodents, particularly rats, and apparently makes the bait unattractive to some other animals. For many uses of zinc phosphide formulated on grain or gain-based baits, pre-baiting is recommended or necessary for achieving good bait acceptance (Timm 1994). The use of zinc phosphide on various types of fruit, vegetable or cereal baits (apples, carrots, sweet potatoes, oats, barley) has proven to be effective at suppressing a local population. Toxicity from zinc phosphide occurs from reaction with acids in the stomach creating phosphine gas that is absorbed into the respiratory system typically resulting in death from asphyxia overnight, for those individuals that consumed a lethal dose and do not succumb to asphyxia liver damage results in death in the next few days.

Specific bait applications are designed to minimize non-target hazards (Evans 1970). Zinc phosphide presents low secondary hazard to predators and scavengers as it breaks down into harmless phosphates in the bodies of animals that ingested it directly. Zinc phosphide also causes an emetic response in most non-rodents and for those animals that directly ingest and don't regurgitate a sub-lethal dose make a full recovery after 3 days. Monitoring during the pre-baiting period helps to determine the presence of non-target wildlife and appropriate measures to prevent zinc phosphide exposure to non-target wildlife will be implemented to include not treating with zinc phosphide. Zinc phosphide is not applied in locations where it can enter aquatic environments through direct contact or in runoff as detailed by the label.

Aluminum phosphide was first registered as a pesticide in 1958. Aluminum phosphide is frequently prepared in rounded pellets/tablets as a fumigant used to control insects and rodents. Aluminum phosphide concentrate is a stable material when kept dry and hermetically sealed. When applied to a burrow, entrances are sealed and aluminum phosphide exposed to moisture in the burrow reacts with the tablets and releases phosphine gas (PH3). Concentrations of phosphine reach their peak in 48-60 hours (USDA Wildlife Services 2019b). It is understood that any animals within the burrow, target or non-target, will inhale the phosphine which enters the bloodstream via the lungs, and for those individuals receiving a lethal dose, death is typically overnight due to asphyxia or within 3 days due to liver damage.

As aluminum phosphide is typically used to treat the burrows of fossorial rodents USDA-WS identify burrows of target and non-target mammals and birds based on tracks, observed activity, and presence of scat. Non-target vertebrate species do rarely co-habitat with target species but typically have identifiable burrow structures (including entrances) that if observed treatment of those burrows do not occur. Thus the risk of taking non-target birds and mammal species is low. Toxicity from aluminum phosphide comes from phosphine gas which breaks down readily in the atmosphere through reaction with hydroxyl radicals in the atmosphere degrading in 5 hours (USDA Wildlife Services 2019b). Aluminum phosphide presents minimal secondary hazard to predators and scavengers. Toxicity results from inhalation of phosphine gas which has been fully absorbed and converted to hypophosphite in urine or dissolved phosphines which have no toxic effect on predators and scavengers (USDA Wildlife Services 2019b). Additionally phosphine gas is an emetic forcing animals that ate a prey animal still containing phosphine gas in their lungs or stomach to regurgitate the prey animal, leaving the predator/scavenger unharmed.

Chlorophacinone in only used to manage damaged caused by mountain beaver and per the label is only applied underground. A special local need label has been issued for Washington State to use of chlorophacinone on mountain beaver. Unlike many of the other toxicants in this EA, pre-baiting is not used as it has the potential to increase non-target take by attracting other species to the easy access food source (Arjo and Nolte 2004). As burrows dug by mountain beaver are readily identifiable, chlorophacinone is applied directly inside the burrow either at the entrance or into the runway of an active tunnel. Chlorophacinone is only applied for management of mountain beaver damage to forest plantations in western Washington and is not authorized for use in eastern Washington. Chlorophacinone is an anticoagulated that causes fatal hemorrhaging in individuals that receiving a lethal dose.

Only one baiting is implemented per year which further reduces primary exposure to non-target species that frequent mountain beaver burrows such as rabbits, weasels, and skunks. Primary exposure of birds, amphibians, and larger mammals is unlikely due to lack of interest in the bait or the lack of accessibility to the bait placed underground. Mountain beavers cache food and would likely bring bait packets back into their burrow to their food cache further reducing access to species outside of the burrow. As dispersing mountain beavers move into unoccupied burrows the cached bait stores extend the effectiveness of a treatment to reduce mountain beaver populations throughout the year. Mountain beaver do not frequently co-habitat with other species as other residents would could feed on the mountain beaver food caches. There is a possibility for non-target fossorial rodent species reoccupying burrows and consuming the cached bait after target mountain beaver have been removed. This is one of the reasons that baiting is only conducted once per year.

The issues of secondary toxicity for anticoagulant toxicants, including chlorophacinone is well documented (Arjo and Nolte 2004, Riley et al. 2007, Salmon et al. 2007, Van de Brenk et al. 2018). The special label for its use in Washington State implements mitigation measures to reduce the impacts of secondary effects. Non-target take is reduced by restricting use to between October and February when juvenile mountain beaver are not present to limit secondary toxicity. The combination of underground applications (on a fossorial rodent species) and limiting applications to once per year on a site limits treated carcass access and availability to predators/scavengers. This short time period and reduced availability of treated mountain beaver carcasses limits exposure and the chances of harmful accumulation of chlorphacinone in predator/scavenger species.

Strychnine is a poison that has been used to control rats as well as other mammalian and avian pests since the 17th century. In the United States it is registered for below-ground use only to manage damage caused by pocket gophers. Provisions are included on the label to exclude use in areas with ESA species including the Mazama pocket gopher. Subsurface applications of strychnine can be made by either hand baiting or by using a mechanical burrow builder. Baiting by hand is done either by digging a hole into the gopher burrow or using a hollow probe that deposits the measured amount of bait into a burrow. The mechanical burrow builder is towed behind a tractor and digs an artificial burrow for the treated bait to be placed. Once consumed the strychnine is a neurotoxin that quickly disrupts the processes of the nervous system to include breathing, death typically occurs from asphyxia.

Acute toxicity from direct consumption and not cumulative effects are the primary concern of risk to non-target species and the public in general. Secondary and tertiary toxicity was assessed on scavenging birds and insectivores. Though pocket gophers rarely die above ground, other primary exposed non-target small mammals may. Rapid decay of carcasses due to insect activity typically excludes scavengers from finding available carcasses. Concentrations of strychnine in insects during the study were not enough to exceed harmful levels in the most sensitive species of insectivores (avian, mammalian, or amphibian) documented (Arjo et al. 2006).

Data exists from a few tests studies on dietary LC_{50} on larger mammals that indicate carnivores might be sensitive to direct consumption of bait (Durkin and Syracuse Environmental Research Associates 2010). The impacts on avian species directly consuming treated bait follows the same response as mammal species and dosages are lethal in similar qualities. Strychnine does not accumulate from multiple non-lethal doses in the body of exposed individual and negative impacts of the non-lethal dose subside after a short time period. So long as no other significant stresses are experienced by the individual during the recovery period (Durkin and Syracuse Environmental Research Associates 2010), a full recovery would be expected from a non-lethal dosing. Non-target species that use the same burrow systems as pocket gophers are potentially impacted depending on the season specifically Muridae and Microtus species. All applications are made underground and sufficiently sealed so exposures to members of the general public, secondary toxicity for avian species, and other scavengers are minimal. Non-target impacts are expected to occur with mice, mole, and vole species that occupy the burrow systems with the pocket gophers though this level of take is expected to be limited as pre-baiting will restrict the amount of Strychnine applied to the amount that will be consumed during the treatment. Monitoring during the pre-baiting period also helps identify any non-target species that may be affected and measures (so long as their consistent with the label) can then be taken to limit or prevent non-target species take.

Appendix B. Federal Laws and Executive Orders Relevant to WS-Washington Actions

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 utilize 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 and to prevent the destruction of designated critical habitat for those 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 federal 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 C. Lead Toxicity Discussion

This appendix is provided as a comprehensive discussion on lead toxicity, as it is a common concern among natural resources professionals and the public. However, WS-Washington uses non-lead ammunition for the majority of the proposed MDM activities, including aerial operations. Lead ammunition may be used for ground shooting operations for a few reasons, but carcasses of animals shot from the ground are almost always collected and disposed of safely. These strategies would result in very little lead being available to mammalian of avian scavengers, other predators, or humans.

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 (The Wildlife Society 1992, Golden et al. 2016).

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 (International Agency for Research on Cancer 2006). Lead, however, is retained in soils and sediments, where it can be stable and intact for long periods of time, re-suspended and re-deposited multiple times before further transport becomes unlikely, and released for transport through environmental and biological systems under certain conditions (U.S. Environmental Protection Agency 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. Bullets 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 (The Wildlife Society 2009).[55]

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,

[55] Further detail on risk associated with the use of lead ammunition may be found in *USDA, APHIS, WS Risk Assessment, Chapter XII: The Use of Lead in Wildlife Damage Management* (Appendix G).

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 (National Park Service 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 (International Agency for Research on Cancer 2006, Knopper et al. 2006, Agency for Toxic Substances and Disease Registry 2016, 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, ATSDR 2016, EPA 2013).

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 gutpiles 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). WDFW requires non-leaded ammunition for all waterfowl hunting, upland hunting, and on some state refuges, wildlife areas, and regulated hunt areas.

Ground and aerial shooting are critical components of APHIS-WS activities. 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. WS-Washington has committed to the use of non-lead ammunition for aerial shooting. Ground shooting activities will still use lead but WS-Washington personnel recover and dispose of carcasses greatly reducing the chance of exposure to wildlife.

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 (USDA, APHIS, WS Risk Assessment, Chapter XII: The Use of Lead in Wildlife Damage Management (Appendix G)). 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-Washington'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).

Average lead used by APHIS-WS programs nationally is approximately 11,249 pounds or approximately 5 metric tons per year. The amount of lead released into the environment from APHIS-WS activities less than 0.01% of the amount currently being released into the environment in the United States due to hunting, fishing and industrial activities (USDA, APHIS, WS Risk Assessment, Chapter XII: The Use of Lead in Wildlife Damage Management (Appendix G)).

For all activities throughout the country, APHIS-WS uses lead-free ammunition when practical, effective, and available to mitigate and/or minimize 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 takes a cautious approach to ensuring that adverse program effects are minimized 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-Washington 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):** U.S. Environmental Protection Agency (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:** U.S. Environmental Protection Agency (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 U.S. Environmental Protection Agency (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 (2019):** This website summarizes recent findings and provides links to many original papers and conference proceedings related to the effects of lead on wildlife (National Park Service 2019). 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 3.11.2.

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-Washington during wildlife and mammal 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 gutpiles left in the field, and human ingestion of game meat shot with lead ammunition, mitigation techniques such as carcass disposal and use of non-lead ammunition when carcass disposal is not feasible the environmental impacts from those concerns are low to negligible.

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-Washington MDM 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 mammals 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. Laidlaw et al. (2005) reported that, because of the low mobility of lead in soil, all of the lead that accumulates on the surface layer of the soil is generally retained within the top 8 inches.

Average lead used by APHIS-WS programs nationally is approximately 11,249 pounds or approximately 5 metric tons per year. The amount of lead released into the environment from APHIS-WS activities less than 0.01% of the amount currently being released into the environment in the United States due to hunting, fishing and industrial activities (USDA, APHIS, WS Risk Assessment, Chapter XII: The Use of Lead in Wildlife Damage Management (Appendix G)).

From FY 2011 to FY 2015 WS-Washington's IWDM used an average 71.5 lbs of lead from projectiles per year (USDA Wildlife Services 2017b). The majority of this lead usage from WS-Washington IWDM actions was primarily for aerial operations and with the change to non-lead ammunition future lead use is expected to be substantially lower. Unlike the aerial program where carcasses are not typically recovered, ground shooting operations typically recover the carcasses and lead, further reducing the impacts of lead from WS-Washington's MDM actions.

Although lead use is not distributed uniformly over land areas under agreement with WS-Washington (3.47% of the state's total land acreage), impacts from lead are primarily from bullet pass-through and the few carcasses that cannot be recovered due to extenuating circumstances (e.g. unexpected or unsafe conditions prohibiting recovery). Due to low localized impacts by WS-Washington personnel using the fewest number of shots on a particular targeted animal, with the intent of a clean kill with one shot, low total amounts of lead input into the environment, and carcass recovery efforts impacts of lead to soils, water, and plants from WS-Washington activities are expected to be negligible.

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 mammals, 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. U.S. Environmental Protection Agency (2005) 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 et al. (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 (USDA, APHIS, WS Risk Assessment, Chapter XII: The Use of Lead in Wildlife Damage Management (Appendix G)), 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, U.S. Environmental Protection Agency 2005).

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-Washington 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-Washington wildlife damage management in general and mammal damage management activities in particular to cause negative impacts to terrestrial and freshwater invertebrates, amphibians, and fish is negligible.

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, gutpiles, 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 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, National Park Service 2019).

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. (National Park Service 2019).

Pain et al. (2009), 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). Therefore, the contribution of lead to impacts on carnivorous, migratory, and scavenging birds would be at the individual bird level, based on the baseline lead load that the bird already has from the environment. 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 an individual bird.

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 ravens (Craighead and Bedrosian 2008).

Over the past three 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 (USDA Wildlife Services 2017b). 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 2019). 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 two 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 two 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 2019).

Exposure and risk to non-target birds will be greatest for those that consume animal carcasses containing with lead ammunition from APHIS-WS activities. However, the potential for lead exposure and risk to these types of scavengers will be reduced in most instances where carcasses are removed and disposed of 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. The use of non-lead ammunition and pellets by APHIS-WS will remove the risk of lead exposure through these two exposure pathways. 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 (e.g. aerial operations use only 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 potential for lead exposure and risk to scavengers and predators is reduced in most ground shooting situations during WS-Washington activities as carcasses are removed or otherwise rendered inaccessible to scavengers through burial or state, territory, or tribally approved carcass disposal practices. Consequently, cumulative impacts of APHIS-WS use of lead ammunition would be very low.

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 (The Wildlife Society 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 (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.

The potential for lead exposure and risk to these types of scavengers is reduced when carcasses are removed and safely disposed of by WS personnel. The current use of non-lead ammunition by APHIS-WS and WS-Washington during all aerial operations and, when practical, 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.

Mammals exhibit similar physiological, physical, and behavioral responses to chronic lead poisoning as humans, which are discussed in Section 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 (U.S. Environmental Protection Agency 2005).

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. (2009), Golden et al. (2016), National Park Service (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, National Park Service 2017).

Potential dietary exposure from APHIS-WS 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. APHIS-WS may participate in donation programs such as "Sportsmen Against Hunger" whereby meat is donated under WS Policy 2.510 . However, only meat that is processed by the carcass recipient or a licensed professional is donated. Hematomas tend to be cut out to avoid lead fragments and foul tasting meat (much of the edible meat donated by APHIS-WS is euthanized with CO_2, not lead or chemicals). 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-Washington activities is highly unlikely.

Impacts to human health from WS-Washington's MDM are very low due to the unlikely consumption of carcasses taken by WS-Washington. Additionally, the risk of contact with lead fragments from WS-Washington activities is minimal.

Appendix D. Land Designations Excluded from Analysis

USFS Wilderness Areas

Alpine Lakes Wilderness
Boulder River Wilderness
Buckhorn Wilderness
Clearwater Wilderness
Colonel Bob Wilderness
Glacier Peak Wilderness
Glacier View Wilderness
Goat Rocks Wilderness
Henry M. Jackson Wilderness
Indian Heaven Wilderness
Lake Chelan-Sawtooth Wilderness
Mount Adams Wilderness
Mount Baker Wilderness
Mount Skokomish Wilderness
Noisy-Diobsud Wilderness
Norse Peak Wilderness
Pasayten Wilderness
Salmo-Priest Wilderness
Tatoosh Wilderness
The Brothers Wilderness
Trapper Creek Wilderness
Wenaha-Tucannon Wilderness
Wild Sky Wilderness
William O. Douglas Wilderness
Wonder Mountain Wilderness

BLM Wilderness Areas

Juniper Dunes Wilderness

NPS Wilderness Areas

Daniel J. Evans Wilderness
Mount Rainier Wilderness
Stephen Mather Wilderness

USFWS Wilderness Areas

San Juan Wilderness
Washington Islands Wilderness

USFS Wilderness Study Areas

Alpine Lakes Wilderness Study Area

Areas of Critical Environmental Concern (ACEC)

Brewster Roost
Coal Creek
Colockum Creek
Cowiche Canyon
Earthquake Point
Hot Lakes
Iceberg Point/Point Colville
Juniper Forest
Keystone Point
Little Vulcan Mountain
McCoy Canyon
Rock Island Canyon
Sentinel Slope
Yakima River - Columbia River Islands
Yakima River Canyon
Yakima River Cliffs - Umtanum Ridge

National Recreation Areas (NRA)

Lake Chelan
Lake Roosevelt
Mount Baker
Ross Lake

Wild and Scenic Rivers

Illabot Creek
Klickitat River
Pratt River
Skagit River
Snoqualmie (Middle Fork) River
White Salmon River

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-Washington 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. 2005a, 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 (Ray et al. 2005a, Ripple et al. 2014). 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. 2005b, Wallach et al. 2009b).

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 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. 2005a). 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., Ballard et al. 1997, Stenseth et al. 1997).

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. 2005a, Beschta and Ripple 2006b). 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. 2005a, 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, Srivastava 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. 2005a).

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** (Section F.6.1). 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. 2005a, Berger et al. 2008, Estes et al. 2011).

Section F.13 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 Terborgh et al. (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, Hrbáček and Straškraba 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 suggested in Terborgh et al. 2001, Ripple et al. 2013, Ripple et al. 2015), 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 (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 (2006a)** 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 2006b). 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 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).
- **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.

- **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. (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 et al. (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 et al. 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**.

Cote and Sutherland (1997), 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 Soule 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 Soule 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. (2007)), 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 (Wallach et al. 2009a, Letnic et al. 2011, 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 two 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 Jr. (2005) disagreed with Hebblewhite and Pletscher (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 Jr. (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-Rodriguez 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;b). 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 minimize 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 minimize 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. 2003a). 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. 2003a). 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, Wilmers et al. 2003a, Atwood et al. 2007, Thompson and Gese 2007). 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. 2003a).

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 heterogeneity, 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). 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 five, 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. 2005a, 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. 2005a). 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 (Hooper et al. 2005, Balvanera et al. 2006).

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. 2005a, Balvanera et al. 2006, Cleland 2011).

The five 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 (Srivastava 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. 2005a).

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 (Srivastava 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. 2005a, Srivastava 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 (Srivastava and Vellend 2005).

Srivastava 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. 2005a).

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. 2005a).

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. 2005a). 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. 2005a), 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, Srivastava 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. 2005a, Letnic et al. 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. 2005a).

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. 2005a, Estes et al. 2011).

The most important questions regarding conservation of large predators, biodiversity, and ecosystem function remain unanswered:

1. In what locations and under what conditions to large carnivores play an ecologically significant role?
2. In what locations and under what conditions would restoration of large carnivores result in restoration of biodiversity?
3. What densities of large carnivores are necessary to produce the desired restoration of biodiversity?
4. What are the interactions between hunting by carnivores and hunting by humans? (Ray et al. 2005a).

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. 2005a, 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., Hebblewhite et al. 2005, Ripple and Beschta 2006b, 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 et al. (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 (Section F.8.1) and mesopredator release (MPR; Section F.8.2), in addition to non-consumptive factors such as adaptive anti-predator behavior and beneficial foraging behavior (Section F.9) 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 (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. (2005) 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. (2005a) 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 (Ray et al. 2005a, Ripple and Beschta 2006b, 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. 2005a, 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. 2005a, 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. 2005a).
- 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 (e.g., Ray et al. 2005a, Ripple

and Beschta 2006b, 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 (e.g., Litvaitis and Villafuerte 1996, Palomares et al. 1996, Fedriani et al. 2001, Ray et al. 2005a, 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 (e.g., 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 (e.g., Duffy 2003,

Schmitz et al. 2004, Briggs and Borer 2005, Ray et al. 2005a, Beschta and Ripple 2006b, 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) (e.g., Schmitz et al. 2004, Ripple and Beschta 2006b, 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 (e.g., Litvaitis and Villafuerte 1996, Palomares et al. 1996, Hooper et al. 2005, Balvanera et al. 2006, Ripple and Beschta 2006b;2007, Kauffman et al. 2010, Wielgus and Peebles 2014, Painter et al. 2015, 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) (e.g., Ray et al. 2005a).
- 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. 2005a, Estes et al. 2011, Letnic 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. 2005a, 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 (e.g., 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) (e.g., 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 (e.g., Ray et al. 2005a, 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 (e.g., Duffy 2003, Briggs and Borer 2005, Ray et al. 2005a).
- 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. 2005a, 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 (e.g., Ray et al. 2005a, 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 sage grouse conservation through release of mesopredators (foxes, badgers, and ravens) that prey on 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 2002). Rather than coyote predation being either directly or indirectly involved in adversely or positively affecting sage grouse, Danvir (2002) actually places the primary concern with heavy jackrabbit browsing in sagebrush habitat. Golden eagles, another predator of 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 sage grouse, instead emphasizing the habitat manipulations that had been performed on the ranch to benefit sage grouse was the primary factor. Danvir (2002) suggests that weather drives 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 sage grouse habitat can magnify or minimize 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, three 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 three 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 1998) 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.

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